International conference on SUSTAINABLE DEVELOPMENT 2016

4 - 5 February 2016
ULAB, Dhaka, Bangladesh

PROCEEDINGS

Editor: Basundhara Tripathy
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CSD Center for Sustainable Development
ULAB University of Liberal Arts Bangladesh

This publication is based upon the outcomes of the conference and has been compiled from the notes taken by the session chairs and respective rapporteurs. The publication is a summary from the organizers' point of view, and does not necessarily express the views of each individual participant.

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Message

A sustainable development pathway is now non-negotiable. The world is reaching social and environmental tipping points. A global change is required as few countries, rich or poor, have succeeded in integrating economic, social and environmental sustainability in their development strategies. The focus of the two-day International Conference on Sustainable Development 2016 was to discuss the issues of gender, migration, climate change adaptation, disaster management among others and its relationship with sustainable development. Delegates representing a wide range of sectors—academicians, researchers, policymakers, multilateral organisations, civil society organisations and the private sector—recognized these challenges and discuss the possible solutions to these complex issues.

The sustainable development agenda of 2030, adopted by the world leaders is a part of the core value of the University of Liberal Arts Bangladesh. The Center for Sustainable Development incorporates these values in academic curriculum, research, co-curricular programmes and other aspects of its operation. ULAB in collaboration with CSD is proud to host the International Conference on Sustainable Development 2016. I am looking forward to a reflective and productive conference that focuses on the key issues of sustainability and addresses certain challenges important to the world, particularly Bangladesh.

I wish the conference all the best and hope to engage in a constructive debate.

Professor Imran Rahman

Vice Chancellor

University of Liberal Arts Bangladesh

Contents

Conference Background

Sustainable Development comes as a wave of modern environmentalism heralding a new approach to tackle environmental issues. Global warming, forest degradation, soil erosion, rising sea levels reflect not only ecological changes but also the political processes at the local, national and international levels. Political-ecological forces will mediate a 'common future' in unprecedented ways in the future.

The year 2015 was pivotal for sustainable development as we moved from the MDGs to the SDGs. To mark this momentous transition the Center for Sustainable Development (CSD) at the University of Liberal Arts Bangladesh (ULAB) organized an International conference on Sustainable Development (ICSD). The SDGs are a set of global goals and targets for sustainable development and the political declaration on the post-2015 development agenda. The aim of the conference was to identify and share empirical research findings or practical, evidence-based solutions that can support the Sustainable Development Goals (SDGs). The ICSD provided a unique opportunity to bring together stakeholders from government, academia, international agencies, NGOs, and grassroots organizations to share practical solutions towards the achievement of more sustainable and inclusive societies. The conference was attended by 200 participants, with 41 presenters lead by young researchers who shared their research findings and deliberated on key issues related to sustainable development. The themes of the conference included i. Sustainable Livelihoods, ii. Climate Change Adaptation, iii. Migration, iv. Gender and SDGs, v. Coastal Zone Management, vi. Disaster Management, vii.Disability and Development, viii.Public Health and Nutrition, ix.Sustainable Agriculture and Food Security, x. Green cities and human settlements, xi.Integrated Water Resources Management and xii. Business and Sustainability .ICSD had an international body representing the advisory committee with academicians from UNSECO-IHE, Wageningen University, Kyoto University, University of Cologne, BUET, University of Dhaka, University of Paradeniya among others.

Additionally, theconference marked the 10th Anniversary of CSD which began as a development and social research center of the University of Liberal Arts Bangladesh and has evolved into a global platform to share research and inform policy decisions about the most important issues facing the world. This conference encourages young researchers and practitioners to submit papers appropriate in achieving sustainability.Positive reception of the conference and spirited exchange of ideas on an important issue of sustainability has led ULAB to support the conference as an annual CSD event. The International Conference on Sustainable Development 2017 will be held on the strengths of the first conference and focus on certain themes of sustainability. Involvement ofresearchers, academicians, policy makers and development organizations will address the need for sustainability and provide deliberation along with possible solutions or way forward in achieving our goals. This publication provides proceedings of the International Conference on Sustainable Development held on 4-5th February, 2016.

Programme Summary

DAY 1- THURSDAY, 4 FEBRUARY 2016				
9.00 onwards	**Registration**			
9:30- 10:30	**Inaugural Ceremony** **Location:** ULAB Auditorium, Campus A **Chair**: Professor Imran Rahman, Vice Chancellor, ULAB **Welcome address**: Dr. Hamidul Huq, Professor & Director, CSD, ULAB, and Conference Convener **Conference Inaugural Speaker**: Dr. A Mustaque R Chowdhury, Vice Chair, BRAC			
10:30-11:00	**Tea Break & Registration- Auditorium Lobby**			
11:00-12:45	**Plenary Session**: Sustainable Development & National Long-term Plan: Bangladesh Delta Plan 2100 **Location:** ULAB Auditorium, Campus A **Chief Guest**: Professor Dr. Shamsul Alam, Member, GED, Planning Commission, Government of Bangladesh **Chair**: Prof. Dr. Rezaur Rahman, IWFM, BUET **Speaker**: Dr. Taibur Rahman, GED, Planning Commission **Moderator:** Dr. Hamidul Huq, Professor & Director, Center for Sustainable Development, ULAB			
1:00- 2:00	**Lunch- ULAB Canteen, Basement**			
2:00- 3:30	**PARALLEL SESSIONS**			
	Parallel Session 1: GENDER & SDGs Location: ULAB Auditorium **Chair: Professor Margreet Zwarteveen,** UNESCO-IHE, The Netherlands Moderator: **Joke Muylwijk**, ED, GWA Panellists: **Prof. Dr. Mahbuba Nasreen**, IDMVS, DU **Palash Kanti Das:** Assistant Country Director, Poverty Reduction Cluster, UNDP **Paper Presenters:** **1. Khandaker Josia Nishat -** Eliminating violence against women and girls: A study on the role of Women Councillors of Local Government in Bangladesh. **2.Tunvir Ahamed Shohel -** Socialization and Gender: A Socio-political Learning Process of Role Determination that is more than Biological. **3. Md. Shafiqur Rahman -** Addressing gender inequalities to enhance women's economic empowerment in food security interventions. An example from Southern Bangladesh.	**Parallel Session 2: Disability and SDGS** Location: Room 601, Level 5 **Chair: Dr. Jeroen Warner**, WUR, Netherlands **Paper Presenters:** **1.Dr. M. Tariq Ahsan**, Professor Institute of Education and Research (IER), University of Dhaka "Exclusion in Inclusion: Bringing Children with Disabilities in the Mainstream Education in Bangladesh. 2.Key note presenation by **Shafiqul Islam,** Country Director, ADD International Bangladesh	**Parallel Session 3: Public Health & Nutrition** Location: Room 401, Level 3 **Chair: Prof. Dr. Musatafa Hossain**, BAU **Paper Presenters:** **1. Dr. Meherun Ahmed-** Intra household Bargaining and Investment in Child Health **2. Md. Tanvir Hossain-** Reproductive Health Knowledge of Female Adolescents in South-western Region of Bangladesh. **Speech by Session Chair**	**Parallel Session 4: Sustainable Agriculture & Food Security (Round I)** Location: Room 402, Level 5 **Chair: Prof. Nimal Gunawardena**, University of Peradeniya, Sri Lanka **Paper Presenters:** **1. M. K. Mondal -** Productivity improvement opportunities in the coastal polders to address food security challenges of Bangladesh. **2. Debanjali Saha-** Assessing the Impacts of Climate Change on Dry Season Crop Yields Using the Aqua Crop Model. **3. Md. Kamruzzaman:** Local Rice Varities in Climate Vulnerable Areas of Bangladesh: prospects and barriers **Speech by the Session Chair.**

3:30- 4:00	**TEA BREAK, Auditorium Lobby**			
4:00- 5:30	**PARALLEL SESSIONS**			
	Session on Gender and SDGs continues **4. Dr. Rokeya Khatun** - Gender mainstreaming through capacity building of Water Sector Professionals **5. Runia Mowla -** Lessons learnt on gender mainstreaming and empowerment in the SaFal and CDSP IV projects through inquiry method 6. Shaila Shahid – Gender, Water and Empowerment in some of the SDGs. **Speech by the Session Chair Prof. Dr. Margreet Zwarteveen**	**Parallel session 2: Migration** Location: Room 601, Level 5 **Chair: Prof. Munsur Rahman**, BUET **Paper Presenters:** **1. Dr. Sohel Firdos -** Climate Induced Migration and Urban Vulnerability in Eastern Himalayas. **2. Shouvik Das -** Physical Vulnerability and Poverty as Determinants of Labour Migration in the Indian Sundarban. **3. Kumiko Fujita -** Migration and Flood in char areas, Pabna, Bangladesh. **Speech by the Session Chair**	**Parallel Session 3: Sustainable Livelihoods** Location: Room 401, Level 3 **Chair: Dr. Atiq A. Rahman,** Executive Director, BCAS Moderator: **Shakeb Nabi**, Country Director, Christian Aid **Paper Presenters:** **1.Dr. Dwijen Mallick -** Resilient Livelihoods of the Extremely Poor in Hard To Reach Areas **2. Abu Syed -** Post 2015 Sustainable Development Agenda: Challenges of Inclusive Social and Economic Development in Bangladesh **3. Asfia Gulrukh -** Application of Sustainable Livelihood Framework at the Community Level: An Indigenous Critique. **4.Shah Md. Ashraful Amin -** Energy for All: Access of the Poor to Sustainable Energy Systems **Speech by Session Chair**	**Parallel Session 4: Business and Sustainability** Location: Room 402, Level 3 **Chair: Prof. Dr. Milan Kumar Bhattacharjee, ULAB** **Paper Presenters:** **1. Ahmed Saad Ishtiaque** – Self-sustaining of Multipurpose Telecommunications Centers in Bangladesh. **2. Iftekhar Ul Karim -** Portraying conflicts among project stakeholders from a sustainable project management perspective. **3. Hasan Mahmud -** Food Sustainability in Megacities & Green Business **4. Shubhankar Shil -** An Inquiry into Bangladeshi Inclusive Business Models focusing on Base of the Pyramid. **Session Chair's speech**
DAY 2- FRIDAY, 5 FEBRUARY 2016				
9.00 onwards	**Registration**			
9:30-11:00	**PARALLEL SESSIONS**			
	Parallel Session 1: Coastal Zone management (Round I) Location: ULAB Auditorium, Campus A **Chair:Prof. Dr. Rajib Shaw**, Kyoto University **Paper Presenters:** **1. Momtaz Jahan -** Preliminary Assessment of Socio-economic Vulnerability in the coastal Region: A case study of Barguna District. **2. Abdullah Al-Maruf -**Contribution of Vocational Education and Training (VET) to Enhance Disaster Resilience: A case study through Human	**Parallel Session 2: Integrated Water Resources Management** Location: Room 601, Level 3 **Chair: Prof. Dr. Nimal Gunawardena**, University of Peradeniya. **Paper Presenters:** **1.Mohammad Sujoun Lasker -** Application of GIS and RS to monitoring Bar Dynamics and Channel Shifting of the Padma- Jamuna Confluence in Bangladesh. **2. Arpan Paul -** Salinity Problem in Groundwater: A study in Shariatpur District, Bangladesh. **3. Ujjwal Dadhich -** Groundwater Depletion and its impact on Life & livelihood: a study of Textile district of	**Parallel Session 3: Climate Change Adaptation** Location: Room 401, Level 3 **Chair: Dr. S. M. Munjurul Hannan Khan**, Ministry of Environment & Forests **Paper Presenters:** **1. Muhammad Shahriar Shafayet Hossain** - An assessment of important climate change adaptation practices in Coastal Regions of Bangladesh. **2. Sanjoy Kumar Chanda-** Climate Change and Coping Strategies of the Household-Dwellers in Bangladesh. **3. Md. Shariful Islam-** Impacts of Climate Change on Shrimp Farming in the South-West Coastal Region of Bangladesh. **4. Towfiqul Islam Khan –** Climate Change Adaptation	**Parallel Session 4: Disaster Management** Location: Room 402, Level 3 **Chair: Prof. Dr. Mahbuba Nasreen**, University of Dhaka **Paper Presenters:** **1.H.M. Shahid Hasan -** Adaptation and learning riverbank erosion; a char land experience on Kazipursadar union, Kazipur, Sirajganj **2. Md. Shafiqul Islam –** Farmers' Perception on Drought and its Impacts in Barind Tracts **3. Nasira Karim Audhuna-** Role of NGOs in Sustainable Disaster Management of Bangladesh: A Comparative Analysis between the Policy Guideline and Practices

	Capital Lens in Coastal Area of Bangladesh. **3. Md Sarwar Hossain -** Participatory modeling for conceptual system dynamic model of social-ecological system in Bangladesh delta. **Speech by the Session Chair.**	Bhilwara, Rajasthan. **4.Dr.Mohammad Abdul Baki -** Fresh Water Dolphins in Polluted Buriganga-Turag River System: abundance, behavior and its threats	with Agriculture: A study on Tangail district in Bangladesh **Speech by the Session Chair.**	**4. Md. Easin Ali -** Sanitation System and Health: A Case Study at Teghori-Kalagachi Mauza in Chuadanga Sadar Upazilla. **Speech by the Session Chair.**
11:00- 11:30	**TEA BREAK- Auditorium Lobby**			
11:30- 1:00	**PARALLEL SESSIONS**			
	Parallel Session 1: Coastal Zone Management (ROUND II) Location: ULAB Auditorium, Campus A Chair: **Engr. Saiful Alam,** Director General, WARPO **Paper Presenters:** **1. Wasif-E-Elahi -** Relating MorphologicalChanges withHydraulic Regime for the Estuarine Systems of Ganges-Brahmaputra Meghna Delta **2. Mohiuddin Sakib -** Storm Surge Flooding due to SIDR-AILA and SIDR-AILA-LIKE Cyclones along the Bangladesh Coast **3. Md. Gulam Kibria -** Canal Re-excavation: A Viable Option for Agricultural Productivity Enhancement in a Coastal Region of Bangladesh. 4. **M. Selim Hossain -** Community-Based Mangrove Aqua-Silvi-Culture (CMAS Culture): Promoting as a community Adaption tool & an Alternative to Commercial Shrimp Culture. **Speech by Session Chair**	**Parallel Session 3: Sustainable Agriculture & Food Security (ROUND II)** Location: Room 401, Level 5 Chair: **Prof. Boris Braun**, University of Cologne **Paper Presenters:** **1. Masakazu Hashimoto -** Flood hazard mapping using **a nested flood simulation model**: a case study of the Jamuna River Basin, Bangladesh. **2. Ahsan Habib -** An assessment on the perception Alternation of the local people on the conventional land Use pattern to achieve livelihood sustainability. **3. Md. Shariful Islam –** Organic Farming Prospects and Constraints in Bangladesh: a case study of Daynna Union of Tangail Sadar Upazila **Speech by Session Chair**	**Parallel Session 3: Green Cities & Human Settlements** Location: Room 402, Level 3 **Chair: Prof. Boris Braun**, University of Cologne **Paper Presenters:** **1.Shamima Arju-** Analysis of Female's Perception on Earthquake Risk in Dhaka City **2. Md. Badsha Miah -** Evaluation of Microbial Quality of Hatirjheel in Dhaka City **3. M. Asger Raju -** Regenerations guidelines for the neighborhoods located in residential areas of Khulna city, Bangladesh: a case study on Housing Tintola. **Session Chair's speech**
1:00 -2:30	**LUNCH (Canteen, Basement) & JUMMA PRAYER**			
2:30- 4:00	**Closing Session** **Location:** ULAB Auditorium, Campus A **Chair:** Dr. Ainun Nishat, Professor Emeritus, BRAC University **Chief Guest:** Kazi Nabil Ahmed, M.P, Member, ULAB Board of Trustees **Conference Closing Speaker:** Dr. Saleemul Huq, Director, ICCAD, IUB **Conference Summary:** Professor Dr. `Margreet Zwarteveen, UNESCO-IHE, Delft, The Netherlands **Vote of Thanks:** Juditha Ohlmacher, Member, Board of Trustees, ULAB **Moderator:** Dr. Hamidul Huq, Professor and Director, ULAB-CSD and Conference Convener			
4:00-5:00	**Refreshment**			

International Conference Advisory Board

International Conference Advisory Board with the representation from Universities, Research organizations, practitioners from Bangladesh and overseaswere formed to guide the ICSD:

Professor Imran Rahman, Vice Chancellor	University of Liberal Arts Bangladesh
Professor Brian Shoesmith, Dean, Academic Development	University of Liberal Arts Bangladesh
Professor MargreetZwarteveen	UNESCO-IHE, Delft, Netherlands
Professor MunsurRahman, Institute of Water and Flood Management	BUET, Bangladesh
Dr.Jeroen Warner, Associate Professor, Sociology of Development and Change Group	WageningenUnivesirsity, Netherlands
Professor Rajib Shaw, Graduate School of Global Environmental Studies	Kyoto University, Japan
Professor E.R. NimalGunawardena, Dept. of Agricultural Engineering, Faculty of Agriculture	University of Peradeniya
Professor Boris Braun, Institute of Geography	University of Cologne, Germany
Professor MahbubaNasreen, Director, Institute of Disaster Management and Vulnerability Studies	University of Dhaka
Professor HamidulHuq, Director, Center for Sustainable Development,	University of Liberal Arts Bangladesh

Session Summary

Gender and SDGs

The session on Gender and SDGs was chaired by ProfessorMargreetZwarteveen from UNESCO-IHE, TheNetherlands. The moderator of this session was Ms.JokeMuylwijk, ED,GWA. Two panellists were part of this session: Professor MahbubaNasreen,IDMVS,Dhaka University and Mr.PalashKanti,Das,Assistant CountryDirector,Poverty ReductionCluster,UNDP. The moderator Ms.Muylwijk, opened the session by introducing the issue of Gender and Sustainable Development Goals. The focus was on the plight of women in Bangladesh, the challenges they are facing, the process of empowerment and addressing gender inequalities to enhance women's economic empowerment.

The presenters- Ms.KhandakerJosiaNishat, Mr.TunvirAhmelSohel, Md. ShafiqurRahman, Dr.RokeyaKhatun, Ms.RuniaMowlaand Ms.ShailaShahidpresented their research and practical knowledge on the role of women councillors and local government, gender and socialization, addressing gender inequalities to enhance women's economic empowerment in food security through interventions andgender mainstreaming through capacity building of water sector professionals. Some of the key takeaways from the discussions following the presentations were as follows: i. Improving women's access to resources, ii. Strengthening their entrepreneurship capabilities, iii. Analyzing 'gender' as a relational concept based on the context, iv. Improving understanding and research on socio-economic situation of adolescent girls who are coerced into early marriage and face a range of issues and complexities, v. Local governance, inclusion of women and its advantages, vi. Addressing food insecurity by promoting gender equality and vii. Linkages of gender and sustainability, which could be a significant contributor in achieving the SDGs.

The panellists stressed the need for a union between the researchers and the practitioners where the outputs and findings from the studies could be put to practical use. Professor MargreetZwarteveen summed up the discussion by evoking the essence of the session - deconstructing the idea of gender. What is gender? What are the linkages of gender with resources? The fruitful discussion and participation from the audience led to an invigorating session which explored the various dimensions of gender and sustainability.

Migration

Movement of people on a large scale has highlighted migration as a global phenomenon. The various factors leading to this mobility and its relationship with vulnerability, risk and resilience were discussed in this session. ProfessorMunsurRahman, IWFM, BUET was the Chair for the session and the paper presenters included Dr.SohelFirdos, Shouvik Das and Kumiko Fujita.

The key focus was on climate induced migration with emphasis on physical vulnerability in Sundarbans, urban vulnerability in Himalayan region and the linkages of migration with flooding of the Char area in Pabna, Bangladesh. The rise of labour migration was well documented in this session while the vulnerabilities and coping strategies were discussed at length. An insight was given on mapping the vulnerable flooding areas of coastal Bangladesh with the use of improved technology and scientific mapping of the geographical areas for better planning of movement away from the fragile areas. This could be a useful and path breaking research contributing to humanitarian aid work, evacuation and resettlement planning for the government and NGOs alike.

Professor Rahman led the discussion post the presentations focusing on the global phenomenon- migration which needs to be addressed in a systematic manner. Lack of appropriate policy and empirical research were the areas that could be targeted in future. Migration as an adaptation strategy was promoted by the researchers and practitioners who supported their arguments by giving valuable evidence. Remittances were seen a source of poverty reduction and means to build resilience among poor communities in the climate affected regions. Forced migration and the movement in the Middle East to Europe were debated and the significance of it for developing countries such as Bangladesh. Climate induced migration which is a recent discourse in the study of migration- the drivers and impacts, vulnerability, risk, resilience, coping mechanisms, adaptation, remittance and sustainable development were the concepts discussed in the session that improved the understanding of the participants and session attendees.

Disability and SDGs

Action on Disability and Development (ADD) is a right based international development organization supporting organizations of disable people to campaign for equal rights and to ensure social justice. Mr. Shafiqul Islam, Country Director of ADD led this session. Discussion on how do we see disabled people? Do we actually recognize them? How can we work for the disabled in achieving the SDGs? These were some of the critical questions raised by the team at ADD.

Experts and practitioners led by ADD shared their experiences. The disabled people in the both rural and urban levelwere a focus of this session with emphasis on mainstreaming NGOs to work with disabled people. ADD is playing a significant role in Bangladesh to strengthen disability movement and to implement the Disability law to establish the socio-economic and political rights of the persons with disabilities. In trying to integrate this excluded category, the speakers has a vision of "a world where all disabled people are able to enjoy their rights, fulfill their responsibilities and obligations and participate as fully as they choose at every level of society"

The ADD model views disability as a human right or social issue related to attitude and access to equal opportunities and resists definitions which relate to the impairment of an individual, i.e. the social model of disability as opposed to the medical model.

It believes that all people have the same fundamental rights to determine their won futures and control decisions that affect their lives and all people have the same rights to enough food and clean water, education, home and relationships, live hood, mobility, safety, influence, recreation, health care and security. The session explored the work of the organization in Bangladesh and discussion in engaging, promoting the disabled people in an inclusive manner.

Public Health and Nutrition

The public health and nutrition session was chaired by Professor Mustafa Hossain, BAU. There were three paper presenters for this session by Dr.Meherun Ahmed, Md. TanvirHossain and Mr.ShubankarShil. The public health scenario in Bangladesh, an overall analysis was provided by the chair Prof. Hossain.

Children's health and economic investment, reproductive health knowledge among adolescents were key discussions in this session. Inclusive business models were also a part of this debate. Challenges faced in this sector including raising awareness in providing healthcare and problems related to sanitation and hygiene was discussed. The materials and education available to young adolescents on health which were limited and misunderstood in the context of Bangladesh was presented in the form of a research paper.

The lack of initiatives and policies on social elements that influence behavioural change along with improving health and nutrition was an interesting takeaway which led to the discussion of way forward for Bangladesh in this sector. Monetary management on health, a critical factor due to absence of government support and subsidies on this front revealed household dynamics and communities' dependency on decision making.

Reducing the risk of chronic diseases and concentration on individuals to promote health through the medium of nutrition was stressed upon by the chair. On the knowledge front, lack of awareness and information was found to be a critical issue which could be addressed through better dissemination processes and awareness drives along with policy decisions which could improve the skills of local level health workers.

Business and Sustainability

More companies are managing sustainability to improve processes, pursue growth, and add value to their companies rather than focusing on reputation alone. Many companies are actively integrating sustainability principles into their businesses. This was elaborated with research on telecommunications, green business and urbanization. Professor Milan Kumar Bhattacharjee was the chair for the session. The paper presenters included- Mr. Ahmed SaadIshtiaque, Mr.IftekharUlKarim and Mr.Hasan Mahmud.

The sustainability of project management and conflict resolution was portrayed by one of the presenters. Food sustainability in Megacities constituted another presentation. Sustainability of multipurpose telecommunication centres in Bangladesh was also explored. These research papers generated discussions on managing growth and development by improving efficiency in businesses.

Ready Made Garment (RMG) factories and businesses dominate the Bangladesh market and have been seen as a viable option for the integration of businesses with growth. New business models, expansion of RMG factories are giving rise to a new generation of RMG industry that is striving to provide its workerswith a decent life along with fair wages and create an environment for sustainability that will be boost the growth of this sector.

Green business a move supported by the Bangladesh Bank is spearheading change in the business world with an aim to secure the environment while providing a boost to the economy. Deliberations on this new phase of business management and growth model took place post the presentations. An integrative approach for business with sustainability was the way forward that was echoed by the chair and the presenters.

Sustainable Livelihoods

A wide range of issues related to sustainable livelihoods was discussed in this important session. Dr.Atiq A. Rahman was the chair for the session along with the moderator Mr.ShakebNabi.

Dr.DwijenMallick, Mr. Abu Sayed, Ms.AsfiaGulrukh and Mr. Shah Md. Ashraful Amin were the presenters for the session. The enhancement of local and global capabilities, assets and environment making it socially sustainable with the capacity to cope and recover from shocks and stresses was the underlying debate under this theme. Building resilience among the extreme poor and improving their livelihood in rural communities was discussed.

The Sustainable Development Goals and inclusiveness of social and economic development in Bangladesh needs further research and examination. Practitioners outlined the sustainable livelihoodsframework which could be a strategy used at the community level but was challenged by academicians who highlighted the problems faced by the lack of inclusion of the local context and analysis. Energy systems, a growing a scientific, mathematical and economic approach towards energy efficiency and sustainability and its use and access for the poorer communities has been a challenge. New models backed by research are currently promoted to reach the 'energy for all' goal.

Dr.Atiq Rahman summed up the session by highlighting certain issues that affect livelihoods and need to be deliberated further to achieve sustainability. i. Rise in GHG emissions and global warming, ii. Sea level rise, iii. Change in livelihood strategies due to climate change and anthropogenic interference and iv. Increase in human mobility. Risks, vulnerability and resilience, these underlying issues in achieving sustainable livelihoods were recurrent in the debate.

Sustainable Agriculture & Food Security

As the world population continues to grow, much more effort and innovation will be urgently needed in order to sustainably increase agricultural production, improve the global supply chain, decrease food losses and waste, and ensure that all who are suffering from hunger and malnutrition have access to nutritious food. Many in the international community believe that it is possible to eradicate hunger within the next generation, and are working together to achieve this goal. The theme sustainable agriculture and food security covers a vast range of issues and was thus divided into two sessions for in-depth discussion. The first session was chaired by Prof. NimalGunawardena and included presentations from M.K. Mondal, DebanjaliSaha and Md. Kamruzzaman. This session focused on costal polders and productivity to address food security in Bangladesh, Assessing the impacts of climate change on dry season crops and the local rice varieties available in the climate vulnerable areas of Bangladesh.

The theme directly corresponds with the SDGs: GOAL 2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture. The chair highlighted the need for more research and grassroot work on this theme and stressed on the importance of this goal. Technological and scientific collaboration along with social research would help practitioners and policymakers achieve this goal in the next 15 years.

The second session for sustainable agriculture and food security was chaired by Prof. MargreetZwarteveen. The presenters included Masakazu Hashimoto who presented on Flood hazard mapping using a nested flood simulation model in theJamuna River Basin of Bangladesh, AhasanHabib who presented on perceptions of locals on land use patterns for achieving sustainable livelihoods and Shariful Islam on prospects and constraints of organic farming in Tangail. Development of sustainable agriculture could be assured by improving resource efficiency, strengthening resilience and securing social equity/responsibility of agriculture and food systems in order to ensure food security and nutrition for all, now and in the future. This was re-iterated by the expert panellists and chair who focused on solutions and dissemination of successful strategies and practices.

Coastal Zone Management

The concept of coastal zone management is a relatively new one, emerging less than four decades ago from the need to tackle an array of interconnected problems associated with population growth, disasters, human hazards and development along Bangladesh's coastline. This theme was divided into two sessions with a total of seven papers presented on this issue. The first session was chaired by Dr.Jeroen Warner and second session was chaired by Engineer. SaifulAlam.

The presenters were: MomtazJahan, AbdullahAl-Maruf, Md. SarwarHossain, Wasif-E-Elahi, MohiuddinSakib, Md. GulamKibria and M. SelimHossain. A range of papers were discussed highlighting case studies on the vulnerability of the coastal zone, socio-economic mapping among others. Various scientific research on the coastal zone included participatory modelling for conceptual systematic model of social-ecological system in Bangladesh and identifying morphological changes with hydraulic regime for the estuarine systems of Ganges-Brahmaputra Meghna Delta. SIDR and AILA cyclones devastated the coastal areas of Bangladesh. A study on storm surge flooding due to these cyclones was presented which highlighted the issues in the coastal belt. Some solutions were provided in technical papers on promotion of community based adaptation tool to commercial shrimp cultivation, re-excavation of canals to enhance agricultural productivity in the coastal region and contribution of Vocational Education and Training (VET) inenhancingdisaster resilience.

As one-fourth of the population in Bangladesh lives in the coastal zone, this theme is of immense importance. The coastal zone is referred to as a zone of disaster and opportunities. Management of the coastal zone and efficient use of the resources with proper planning can make this area prosperous and in turn positively affect the growth of Bangladesh.

Integrated Water Resources Management

As a steady growing economy in the developing world, the need for water resources is growing rapidly in Bangladesh to ever-increasing and conflicting demands from agriculture, industry, urban water supply and energy production. The demand is fueled by factors such as population growth, urbanization, dietary changes and increasing consumption accompanying economic growth and industrialization. Integrated Water Resources Management (IWRM) is linked to a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. In the context of Bangladesh, this theme is extremely crucial to attain sustainable development. The interesting session was chaired by Prof. Dr.NimalGunawardena and the presenters were- Mohammad SujounLasker, Arpan Paul, UjjwalDadhich and Dr.Mohammad Abdul Baki.

The need for IWRM in South Asia was discussed with special focus on Bangladesh and India. Scientific analysis of GIS application to monitor channel shifting of the Padma-Jamuna confluence was presented, while social research on groundwater depletion in water affected Rajasthan was also debated. Problems of salinity and polluted rivers affecting the marine wildlife were a part of the presentations.

The discussion initiated by the chair contributed to the effective approaches of using IWRM in Bangladesh. The institutional arrangements and the innovative participatory approaches with governance mechanisms would help Bangladesh. Water management and planning reflects in the national plans of the country which requires further research in effectively implementing strategies. The traditional fragmented approach is no longer viable and a more holistic and coordinated approach to water management is essential. This is the rationale for the Integrated Water Resources Management (IWRM) approach that has been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources. The emergence of climate change as a major new threat that primarily manifests itself through the hydrological cycle underscores the importance of incorporating climate change adaptation in the water sector.

Climate Change Adaptation

The scale of the long term impacts of climate change can be controlled through mitigation, the process of reducing the concentration of greenhouse gases in the atmosphere. However, the effects of climate change are being experienced now. Worse, because of long delays in the climate system, the level of greenhouse gases in the atmosphere today means that further climate change is now unavoidable, regardless of efforts to reduce greenhouse gas emissions. Thus the need to adapt to the impacts is equally unavoidable. Poor communities therefore face the challenge of adapting to climate change through a process of building adaptive capacity and reducing vulnerability.

The session on climate change adaptation was chaired by Dr. S. M. MunjurulHannan Khan, Ministry of Environment & Forests and the presenters included Muhammad Shahriar, ShafayetHossain, Sanjoy Kumar Chanda, Md. Shariful Islam and Towfiqul Islam Khan. The climate change adaptation practices of coastal regions, coping strategies of households, impact of shrimp farming in the coastal regions of Bangladesh and climate sensitive adaptation methods in agriculture were some of the main topics presented.

The discussion at the end of the presentations paved way for three major ways for climate change adaptation: i. Building adaptive capacity, ii. Reducing vulnerability to climate change and iii. Use of cost effective technology. These could mean incorporating climate change into community-based development and improving the availability of appropriate information and skills, effective institutions, access to technology and opportunities to raise incomes. Reducing vulnerability to climate change requires the protection of existing assets (including the ecosystems on which communities depend), improving risk management, increasing assets and broadening the available range of livelihood options. The challenge is simultaneously to protect existing livelihood assets against the new risks posed by climate change, whilst securing more assets that can be accessed to help cope with the disruption and change that climate change will bring.

This fruitful discussion session ended with a focus on the importance of empirical or evidence based research which could make climate change adaptation more sustainable.

Disaster Management

Disaster Management could be termed as the organization and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters. Disaster management is linked with sustainable development, particularly in relation to vulnerable people such as those with disabilities, elderly people, children and other marginalised groups.

Dr.Rajib Shaw chaired this session which had four presenters: H.M. ShahidHasan, Md. Shafiqul Islam, NasiraKarimAudhuna and Md. Easin Ali. The papers highlighted experiences in the Char areas where river erosion is prevalent, farmer's perceptions of drought and its impacts, role of NGOs in sustainable disaster management in Bangladesh and sanitation and health systems that are affected due to disasters.

Disaster Management aspect was discussed in 3 broad categories: Disaster Preparedness, Disaster Relief and Disaster Recovery. These could be interlinked with the human experiences at the local level, policy decisions and the global framework. Dr. Shaw stressed on the need for research to support these disaster management plans which could reduce the vulnerability and increase coping mechanisms of communities in Bangladesh.

The interactive session also touched upon the government's disaster management plans and suggested areas where research could fill some gaps in policy. Disaster Management would have to be a coordinated multi-agency, organization and institutional response to reduce disasters, mitigate them and plan for a gradual recovery process.

OBSERVATIONS

Dr.Saleemul Huq, Conference Closing Speaker

"The issues about Sustainable Development goals, disaster risk reduction framework and the climate change Paris Agreement that came out of last year's discussions reflect on how we might take our agenda forward into the future. In the context of Bangladesh we need to promote and engage the young scientists and researchers particularly Bangladeshi young scientist and

researchers.

As of the 1st of January 2016, we have entered in anew era, the whole world has entered into a new era. Why do I say that? As you have already heard from other speakers- in 2015 we had three major global agreements. Firstly in March, SENDAI in Japan- the disaster risk reduction agreement, secondly in New York in September of that year we got 17 sustainable Development Goals(very comprehensive set of goals for the future world) and thirdly in December in Paris we had a path breaking Paris agreement where we have agreed all countries need to take action on climate change including ours but every country in the world. I would argue that this- SENDAI, 17 goals and in the context of climate change I will divide the climate change goals into mitigation goal which is to reduce emissions to keep temperatures down and an adaptation goal which is to prevent the most vulnerable people from suffering unnecessarily by making them adapt. So two climate change goals, 1 disaster risk reduction goal, 17 sustainable Development goals makes a very convenient round figure of 20 goals that we have to achieve over the same time frame 2016- 2030. In 15 years' time frame achieving this goal is going to require a very significant shift in the world at the global level, national level and the local. This is possible only with the help of our young generation who are the future generation leaders. We need to promote scientific and social research, with quality outputs that can support the policies at all levels."

Dr.Kazi Nabil Ahmed, Chief Guest

"It is our privilege and we are very happy as ULAB family is hosting this conference on Sustainable development. Center for Sustainable at the University of Liberal Arts Bangladesh is now 10 years old and this is our 1st center that was established here. We now have 5 more

centers and we are very proud that of all private universities in Bangladesh, ULAB has the 3rd largest budget for funding research. At the very inception of ULAB as an institution, our desire was not only to have excellence in learning but also in pioneering research not only to be in par in Bangladesh but the whole world. And one of the 1st things that we took up for that was Sustainable Development and we are very glad today that we could host this conference.

I thank all the members of Center for Sustainable Development, the Vice Chancellor, and everyone else for successfully organizing this event. And I want to thank all the distinguished guests who made their time from abroad and from here to be with us for the last two days. Sustainable Development, as it has already been said by most of our guests, academics and researchers, I will only be stating again- but last year was a very big landmark years- I was in those two international events as well. And what we have in 2016 following from MDG (from 2000 to 2015) is a new set of goals or 17 holistic goals.The SDGs are going to be very important in the next two decades and as a country which would strive to achieve the goals, we would require a closer interaction between the academic community, researchers and the policy makers. This conference has been one such event that brings these important stakeholders together. We need to deliberate on our future and make informed and balanced decisions in achieving the global goals. I thank everyone again for attending this wonderful conference and hope we can all use this knowledge and contribute in making the world better."

Margreet Zwartveen, Session Chair

"This conference is showing three very important things. The 1st thing that shows is the mobilizing power of Professor HamidulHuq. He has managed to make a large number of people enthusiastic for the conference. He has been able to get 43 presenters in a very short time.

The second thing that the conference shows is the organizing power of ULAB and of the Center for Sustainable Development Team as mentioned earlier. The conference is extremely well organized, everything went smoothly. The food was nice, everything was in time, all the facilities worked so that again is very telling. On top of that I must also say the atmosphere in the conference was a very good one. It was a very pleasant open atmosphere that was very productive to have good discussions. People were very interested to listen to each other and went to debate without being aggressive.

I also want to mention that I think the good organization of the conference is also largely to do with all the people, young people appropriately dressed in green [volunteers]. And lastly I must say that the conference is the testimony, tells us something both of the urgency of the questions – how do we achieve sustainability? How to link development with sustainability?The conference is also very telling in respect to the wealth of information available here in Bangladesh about these questions. The conference brought together a huge diversity of experiences of studies and I think that this is tremendously promising. I think what this shows perhaps or what I think it showed is that- these people here in the conference bring together a very fertile combination of strong commitment, a deeply grounded sense of urgency and the enormous intellectual potential and energy. So I think yes, Bangladesh and should and can become one of the main centres in the world providing good knowledge about sustainability & I also think that ULAB and the Center for Sustainable Development should and can play an accurate role in this."

Prof. Hamidul Huq

"The young researchers showed their interest in inter disciplinary research towards contributing sustainable development and sustainability which is the core value of University of Liberal Arts

Bangladesh. As we have it in our theme- societies are on the brink of challenging the future to develop a sustainable society. It is therefore our responsibility of the time to do more empirical research to strengthen our knowledge so that we can also contribute more and more in building knowledge based society not only in Bangladesh but also in other countries who are struggling towards development in sustainable way."

Technical Papers

Business & Sustainability

Title: "An Exploratory Study on what are the Critical Success Factors to make Multipurpose
Telecommunication Centers Self-sustaining in Bangladesh"
Ahmed Saad Ishtiaque

Introduction:

This study takes us to Bangladesh, one of the more overpopulated nations in the world and has been on the least developed countries list for a while now. It is a nation where about 76% of the population still lives in the rural areas and majority is primarily employed in the primary (agricultural) sector (Islam and Tsuji, 2009). Although the country has been a democratic republic for over 40 years now the country still face many of the basic problems a society has to deal with. One of the biggest problems facing Bangladesh is the excess population which is continuously growing, although the growing rate has reduced somewhat over the last 20 years due to social awareness programs on family planning. However there is the problem of seasonal natural disasters as the country is in a region which gets hit with monsoon seasons. Of course there is a major problem of poverty and the population is suffering from malnutrition, particularly in the rural areas. Although there has been great efforts taken by several governments to improve the literacy rate of the nation the quality of education is no up to international standards. Also unemployment is a major problem because good portions of the population are youth with advanced degrees but no job are being provided to them by the government. Some headway has been achieved from the contribution of the private sectors but it is not close to meeting the demand of the nation. One of the major contributors to this is corruption at all levels. Other issues are also worth mentioning like the poor quality of health care and continuous exploitation of the nations natural resources by our leaders. Transportation and communication costs are also quite high and rising. Recent promises by the government have set a new concept in the country of "Digital Bangladesh" "Vision 2021", which to most are just catch phrases. On a positive note the government along with NGOs and donor organizations are trying to reduce the digital divide of Bangladesh by using ICT, particularly at the rural levels to create a knowledge base society and make the general public more information rich. The usage of ICT by many is being looked at as the major tool for providing information to the rural poor so that they can make more informed decision and in the process bring themselves out of poverty (Islam and Tsuji, 2009; Islam and Hasan, 2008).

This study is an attempt to look the gap the implementation of ICT in rural Bangladesh has left in its attempt to reduce poverty. More specifically the current model being implemented by most donor organization for rural areas of developing nation is being led by ICT. The set up of what they now call multipurpose telecommunication centers which becomes the focal point of access to information for the poor living in the rural areas. The goal of these donor funded projects is to establish these Telecenters as successful self sustaining businesses that not only provide the local unemployed population with an opportunity to own and operate their own business; but they can also contribute to the community by providing jobs to others in the area and more importantly provide relevant information to the local community which

are vital for their business success regardless of whether the mass in the villages are operating a small retail business or involved in light engineering or farming their lands.

One of the major problems we are suspecting from our own research experiences in rural Bangladesh is that these Telecenters are operating only as long as the donor funds are coming in. When they are asked to sustain themselves majority of them are failing to cope with the challenges. Literature has talked about variables that are essential for sustainable ICT businesses and the theories they focus on mainly are Sustainability and Development theory and also Innovation theory. It is our understanding that majority of the ICT projects are failing not because they are not properly transferring the technology from the developed country to the developing countries and not due to gaps in these theories that have been and is still being extensively looked at; but rather we believe that the failure of these businesses have to do with the owner/manager of these Telecenters who are solely in charge of running the centers as a business and making it a successful self sustaining business. Another theory attempts to shed some light into this matter, which is the Capability Approach suggested by Sen, (1989) which basically talks about the non-income variables used to identify quality of livelihood instead of the traditional economic indicators. Also in line with Sen's Capability Approach Theory, Heek, (2005) argues that for developing nations there is a major challenge of transferring accessed data from the net or any telecommunication devises into something which is meaningful information. Furthermore the availability of social resources to use the information gathered in practice among the rural communities is an even greater challenge. Other researches has argued that the Sen's (1989) capability approach can derive potential findings at micro level focusing on its non-income variables (Comim, 2001; Gigler, 2011; Gigler, 2004)

We argue that these partially literate unemployed youth of rural Bangladesh are not adequately equipped with the proper business skills or rather Entrepreneurial Skills needed to run and maintain a successful business. Other researchers support Sen's Capability Approach and argues that CA can bring out potential findings at the micro levels focusing on the non-income variables rather than going for the traditional style of evaluating economic indicators.

Literature Review:

When it comes to defining rural development many theorists believe that there has come a major shift over the century where we have moved away from the modernization paradigm and are now looking into a new rural development paradigm. It is seen in Europe that rural development as far as the farmers are concerned have moved away from the concept that economic power and success are derived from the scale of operations and economics of scale and vertical integration should be the target. They are now looking into more flexible small farm models, which is a natural response of farm enterprises in terms of contributing to the general restructuring trends. As most developing countries such as Bangladesh are mostly agriculturally bases the models being used by farmers can contribute to regional employment and the overall development of an area. Thus the modern version of what exist today as rural development can also be considered as new agricultural development model (Ploeg, Renting Brunori, Knickel, Mannion, Marsden, Roest, Guzman & Ventura).

If we look into the literature on theories on rural development that have come up over the latter half of the century one of the more common body of thoughts would be the Small-Firm Efficiency Paradigm. At around the 1960s and 1970s when people were looking into economies of scale with large scale farming which suited the developing countries that had socialist government this concept of small farm focus would have to be one of the early

paradigm shifts. Although there were a lot of skeptics of this idea and many still believed that large scale farming using technology to mechanize everything was the more efficient way to go the idea stuck around and is being implemented in developing countries such as Bangladesh where majority of farmers have very small size farms to begin with (Ellis & Biggs 2001).

Another approach proposed at that time was the Sustainable Livelihood approach (SL), Carneyand Scooner (as cited in Marsden & Banks 2000, p. 444). The concept of SL is derived from literature on the 'asset vulnerability framework' see Amartya Sen's, (as cited in Marsden & Banks 2000, p. 445). However previous empirical studies have indicated that farming activities only explains about 40-60% of the SL package looking into South Asia and sub-Sahara Africa, see Reardon, (as cited in Marsden & Banks 2000, p. 445). Other factors such as remittance, wages and salaries from non farming activities seem to be more important for part time farmers, farmers with small land or landless farmers who work off others' land. This issue of landless farmers or farmers with small farm land is commonly due to sub-division of land due to inheritance where father's land is sub divided among his sons after his death. This seems to be a common scenario in countries that are more agriculture base such as Bangladesh Bryceson and Jamal, (as cited in Ellis & Biggs 2001, p. 445).

Above mentioned information focuses on the history of relevant theories particularly looking into the primary industry (agriculture) because the major aim of this study is to look into rural development and sustainability schemes in the case of a developing country, namely Bangladesh which is a nation still having about 75% of its population working for the primary industry. Most development projects and poverty evaluation schemes operating in Bangladesh are targeted towards the poorest within the population; majority of whom are farmers living in rural areas.

The more recent trends in poverty elevation and sustainable development are leaning towards the usage of Information and Communication Technology (ICT) as the primary tool for information/knowledge dissemination among the poorest. Although there were a lot of debates on whether ICT is proper tool to use for poverty elevation particularly in developing countries, the more recent literatures have identified that access to information is one of the major barriers for the poor to overcome poverty and ICT is successful in dealing with that issue (Wilson and Heeks, 2000). Today the discussion has shifted from whether ICT is a proper tool to how it can be better used to achieve sustainable developments. Majority of the authors in this field accept the premise that ICT has become an essential part of our lives and as it has achieved its success in the developed world it is equally important for the developing worlds, particularly in the field of health, education, public service and also business (World Development Report, 2000). In fact, coming from a developing nation such as Bangladesh and from many years of experience working with aid agencies on rural development, we believe it is vital that the less developed nations and specially their rural population get access to information on the above mentioned issues. Also many international aid organizations have jumped on the bandwagon of ICT for development; for example 'SPIDER' which is an initiative by the Swedish Program for Information Technology in Developing Countries (Sida); as have the United Nations with their 'UN ICT Task Force' initiated by Mr. Kofi Annan.

Another important trend regarding ICT for rural development have seen most aid agencies and donor funded projects trying to establish ICT as the major tool in rural areas in the form of establishing Telecommunication Centers as their focal point of information dissemination. This will become the focus of our study as we try to scale down existing conceptual

frameworks from a macro level to a micro, business level. This will be further discussed later.

Within the field of ICT current researchers have worked on identifying critical factors that are required for ICT projects to become successful in rural settings of developing countries. However, according to many top authors of this field not much work has been done on looking into ICT from a rural, particularly developing country context (Odedra_Straub, 1996;Waema, 1996;Heeks, 1996;Keniston, 2002;Mayanja, 2003;Sunden & Wicander,2003).

There have been numerous reports on the failure of ICT projects, specially they are shifted from developed nations and implemented into a developing nation's context. One of the more cited report estimates the failure rate of ICT projects is about one third (Standish Group, 1994). Others give a grimmer picture that the scenario is worse in developing nations due to lack of proper infrastructural support and other barriers towards implementation (Heeks, 2002;Caspary and Connor, 2003).This is a devastating blow to all working towards rural development and poverty elevation through the use of ICT.

A working paper by Grunfeld, (2009) takes a closer look at Bangladesh and talks about the Capability Approach (CA) theory, embraced by UNDP, has been an appropriate framework which explains how ICT4D had worked for Bangladeshi people towards improving their lives. It is suggested by Grunfield that the Capability Approach gives us another view on how technology can help improve living standards as the approach talks about what capabilities the people of the region have and how they can be used to their advantage. The critics would argue that the difficulty of this particular framework and why it has not worked in other developing nations is that fact that it is quite difficult to operationalize (Comin, 2001; Gasper, 2002). Although capabilities are important to improve the quality of life of a person according to Sen, (2000) capabilities is just one of the four major criteria that has to be fulfilled for a person to achieve before he/she can bring themselves out of poverty and the other three essential criteria are:

- Opportunity-which includes access to information, market, finance etc.
- Security-this could be reduction of all economic risks & risk of violence (specially against women)
- Empowerment-which included mobility for women & right to own property & wealth

The research conducted by Grunfield focused directly to Sen's five freedoms which are:

1. Political freedom: is the awareness of legal issues, preparedness of the community to play a more active role in the planning and maintenance of village facilities, desire and ability to express their opinions openly, taking active participation when it comes to setting agenda for issues related to the welfare of the village in general and the ability of the local community to interact with their local government officials without fear
2. Economic freedom: The ICT4D project's contribution to improving livelihoods/quality of life of the local communities e.g. this has to come in the form of entrepreneurial skills particularly for those entrepreneurs running the Telecenters, increasing access to economic resources for the locals so that they are not completely dependent of their seasonal corps which in a country like Bangladesh which is prone to natural disasters can be easily effected, knowledge of alternative credit sources and

credit procedures is required so that locals are not restricted to the influences of a few local elites who are out to exploit the farmers by charging them exuberant amount of interest and finally market information in a must for local community to be economically free where they can sell their products at a competitive price instead of a price determined by a hand full of local elites-for instance the example of the market extension services BIID is trying to establish using ICT as an enabler

3. Social opportunities: whether the ICT4D project has been appropriated by the community, the level of information sharing within the family and broader community and the type of information being shared is important here particularly keeping in mind that Sexual and Reproductive Health (SRH) information needs to be properly discriminated to adolescents and the community as a whole and they need to be accepted by all as Bangladesh is deeply rutted in its religious and cultural beliefs which sometimes clash with the free flow of information, improvements in leadership and management skills is essential before social opportunities are improved as rural Bangladesh still has a old fashioned slow pace of life where young man walking around the house and not completing an education nor working is not necessarily seen as a waste of human potential, improvements in social status through use of ICT is possible as new knowledge will provide greater respect among the community, how family members view the involvement other family members in the project is also very improvements as mobility for young women is still a problem in Bangladesh and if going to the CICs is not looked upon as a positive educational institute by the husband /father that could restrict mobility for half the population of a nation, and benefits from local institutes private and governmental in terms of health, education, sanitation, marriage system, legal support against violence/dowry/abuse are still hindering social development in a mass scale
4. Informational freedom: availability of access, ease of access to and the ability to process and critically analyze the information being provided by Telecenters is essential as the information is not worth anything if the local community does not even have the basic knowledge on let say using a computer or something more simple as just knowing that the information will be helpful for you and that such information is available and you should be seeking it, ability to produce and publish local content in a must as many ICT based projects have faced this problem on having useful content by in a foreign language which the locals could not discriminate and hence could not use, knowledge of how to collect specific and relevant information what type of information is needed by you and where to collect it from is essential for that the community and the users need to be aware of the services/information available out there so awareness and promotional campaigns via local community court yard meetings or using local drama shows seems to be an effective tool, extent of information obtained about government welfare services may also be relevant in many cased depending on how friendly the nation's government is about becoming more digital, transparent and user friendly
5. Protective security: impact on soil fertility of using chemical fertilizers, pesticides needs to be provided to the communities if we are to improve the human capabilities of the nation, mechanisms for obtaining information on the weather and natural disaster warnings is paramount for Bangladesh as we are highly susceptive to adverse climate changes and regular natural disasters therefore having proper technology to provide up to date weather information could be useful for farmers in better protecting their crops also private organizations such as insurance companies may find a interest in investing in micro-insurance programs for farmers given that they are given access to accurate weather data that would be useful for their business decision making,

reactions when notified of extreme weather conditions via on time disaster warnings, views on whether disaster warning systems can help protect the community from natural disasters, also how general security is practiced in the neighborhood by the community can be improved using ICT enabled services

The author acknowledges that as there may be other factors contributing to the socio-economic development of a particular area it is not with absolute certainty the any changes can be attributed to ICT4D only.

Heeks (2005) has developed an information chain model on how to achieve successful ICT implementation in the context of development. What the model tries to illustrate is that technology must be understood in its context of economic, social, and action resources which then transforms the data into information for the users to understand what they actually needs to achieve from ICT4D projects being implemented by donors and NGOs at the community levels. Heeks' information chain model (Figure 1) illustrates how raw data needs to be accessed, assessed and applied by the users, before actions can take place.

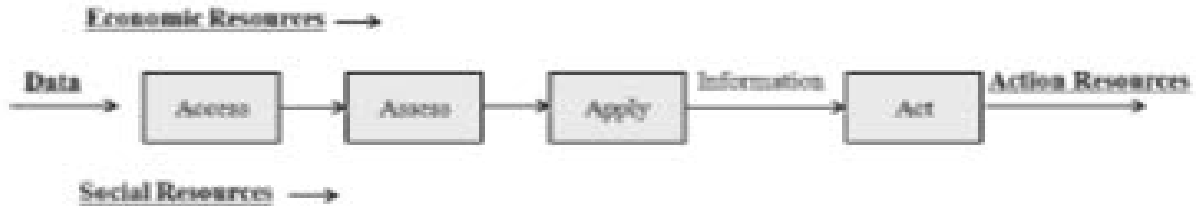


Figure 1. The Information Chain Model (Heeks, 2005)

Heek's Information Chain Model seem to compliment the Capability Approach which is a common tool being used by various researchers around the world and the reason for its popularity could be the face that it focuses on the non-economic factors instead of just looking at the traditional economic indicators which may not give us a true picture when searching for impact of ICT usage on livelihood improvements in pro-poor rural communities of less developed nations.

An exploratory qualitative research that have been conducted by the author as an attempt to take a snapshot of the current scenario of the use of ICT4D and more specifically looking into the variable of this study in question, namely Sustainability of Multi-Purpose Telecommunication Centers in Bangladesh. The qualitative study was an attempt to link the present situation with current literature on ICT4D and it was found that the Capacity Approach along with Heek's Chain Model explains quite a good amount of the reasons for success of many of the Telecenters. In fact when it comes to looking into the sustainability of the centers it also looks more closely into the capabilities of the entrepreneurs who are responsible for running the centers and it also looks into the capabilities of the community as a whole and tries to assess if they have the basic capabilities to develop their capacities further and together make the Telecenters a more viable sustainable project capable of operating on its own once the donor funds stop supporting the projects.

Capacity Approach theory talks about the Telecenters having a positive impact on the community to such an extent that in the long run human capabilities are improved and if it is not possible to improve the capacities/capabilities of the people living in the communities where these ICT based projects are targeted for, the Telecenters would not be able to sustain

either. Therefore to better understand the impact levels of the Telecenters this paper looks at four aspects of impact analysis which are:

- Situated success
- Information culture and tradition
- Topology of resources
- Functioning

To better understand these factors a qualitative approach was taken by the author where In-depth interviews were taken, with a semi structured questionnaire, of the entrepreneurs running the Telecenters and opinion leaders of the community. This short qualitative approach is an attempt to conduct impact analysis of the factors mentioned above.

Methodology:

As this was an expletory qualitative study we have identified 35 telecenters among the 7 divisions of the nation (5 centers per division were selected; 2 community leaders per location were also interviewed). The respondents were selected from a sampling frame made available by GrameenPhone which listed all their active Telecenters nationwide.

In terms of the interviews it was In-depth interviews with a semi structured questionnaire was used. The interviews lasted from one hour to about one and a half hour depending on the respondent.

The categories of respondents were:

a) Local Entrepreneurs/ owners of the Telecenters
b) Local Community Leaders/ government officials who would have some sort of influence over the local community

The owners of the Telecenters were selected from the sampling frame randomly and the local community leaders were selected on the basis of convenience and availability. In some cases snowballing technique was used to identify these respondents.

The sample size for the qualitative study were:

a) 35 Telecenter owners
b) 14 community leaders

Findings:

The information collected from the in-depth interviews in this study is used in this section to link the current findings with the current literature on the topic. The information collected on the GPCIs are used to explain the factors mentioned above by the theories from a Bangladesh perspective focusing on the issues what are relevant for this region and hence giving us a clearer picture of what are the challenges that are needed to be tackled for this multipurpose telecommunication centers business to become self sustaining in the South East Asian Region, particularly Bangladesh.

1. Impact in terms of 'situated success':
This portion of the study looks to bring out the key opportunities and threats of the different (government & private) ICT based programs that are running the 5000 plus Telecenters that are currently operating in Bangladesh. The information is divided into 3 time frames starting

from the project Inception to a Transition period and finally to a sustainable Self-Operated stage.
For instance GrameenPhone, the market leader among the Telecoms in Bangladesh has 500 plus of such ICT based Telecenters and during the inception stage it was all about awareness building. They did a lot of promotional campaigns in the rural areas of Bangladesh such as miking promoting using folk songs or dramas using local artists. The plan was to include the entire community and make them aware that a new technology is available which could provide basic services to their door steps; services such as e-agricultural information extension services, e-health services like talking to a renowned doctor living in the capital city without going there via video conferencing etc. The process also included getting the community leaders involved such as getting religious acceptance from the local Imams of the Mosks, the head master from local schools & colleges and getting approvals the local government officials such as the local Chairman. At the initial stage the centers also included basic services such as e-mail checking, browsing, getting agricultural information from a qualified agriculturalist such as which pesticides and fertilizers to use and in what ratio for a particular crop, doing video conferencing with family members who live and work abroad, providing basic computer trainings at the centers etc. The purpose at this stage was to make everyone aware of the potential services available at the centers and also to develop knowledge of the community as a whole on what additional information/services they require. This of course was done using a participatory approach where donors operating Telecenters used local NGOs and private companies such as GrameenPhone used other private companies that already had a reach among the communities through previously established youth networks for instance the example of Bangladesh Institute of ICT for Development (BIID) that had just such a network of youth workers.

There were a lot of positive responses from the community, particularly the educated mass such as young school/college students, school teachers, employees of local companies (NGO workers) who regularly used the Telecenters at least for some of their services. Due to the situational demands from the local communities centers which were better positioned, for instance in and around the local Bazaars, those centers what did a lot or promotion, had an entrepreneurs who the local community know and trusted did much better at every stage. Even at the 'Self-operated' stage many centers has a lot of opportunity because of the state's policy of digital vision of Bangladesh (Digital Bangladesh Vision 2020 recently declared by the Prime Minister of the nation). Also as the Telecenters moved from their initial inception to a more matured stage most of the communities had a general idea about the Telecenters and their services along with knowing the benefits of technology and are eager to know, how they can exchange and share their information through ICT. Therefore evidence from this short study suggests that the success of the centers situated which is bound to social, cultural, political and environmental contexts. It could be said that the apparent success of the centers is due to 'situated success', because most centers, particularly the ones being operated privately had been bounded to the particular combination of local contexts and good timing opportunity of digital Bangladesh vision being lead by the present government.

2. Impact in terms of 'information culture and tradition'
If I look at the ICT initiatives in terms of this perspective then it is evident that the Telecenters utilized the 'Forum theater', 'folk music' and 'Court Yard Meetings (CYM) Uthan Boithok' approaches to disseminate the social need based information such as creating awareness among the farmers of an alternative agricultural extension services which is far efficient and cheaper and has a greater potential for higher reach than what is currently being provided by the agricultural extension officers of the government who are underpaid and

overworked and have too much of an area to cover which is physically impossible. According to the rural community people and the program officers of the centers, the Theaters & Folk songs were very popular to local people because it was a blended show with new technology (ICT) and traditional entertainment approaches. The privately owned Telecenters have move on to a more commercial and self sustaining strategy, but are facing problems as most villagers are not accustomed to taking out their cash and buying information even though they know it is something they require. Culturally it is still expected (particularly among farmers) that if you know something about farming you will openly share the knowledge with your fellow farmers for free. The concept of paying for information is still difficult for them to grasp. Therefore the motivation to use the ICT based services is highly dependent of information culture and tradition.

3. Impact in terms of 'typology of resources'

ICT4D project carried out in Bangladesh looks at the resources that are required for the projects to be self sustaining and according to Heeks, (2005) there are four major types of resources which better explains the sustainability of Telecenters and they include:

- Data resource
- Economic resource
- Social resource
- Action resource

1. Data resources: The digital contents on various issues such as information on healthcare; for the rural urban poor reproductive rights of the women are more of a regular concern where adolescents and even adults with no formal education can have access to accurate data of their desired issues; human rights focused on women and child rights issues; rural people have access to specialized doctors for the cities via video conferencing and online database of the patients can be accessed instantly by the doctors for detailed diagnosis; government forms and information available online fulfilling the dream of the government to make this a digital Bangladesh by 2020; instructions/manuals for computer programs; job announcements for the young masses of unemployed people living in the villages can use web sites like bdjobs and easily apple for jobs; educational information and video conferencing making short online classes such as crash course on IELTS available for works looking to go abroad for work etc.

2. Economic resources: The facilities of the centre (computers, printer, scanner, etc.); the funding to allow subsidization of cost for the marginalized people; the knowledge and skills of the centre operator, instructors and the volunteers gained.

3. Social resources: The form of motivation, confidence and knowledge found in the users, community people and operator. The credibility and trust gained by the centre staff and volunteers among members of the local community and the local government officers. The presence of peers in the centre also serves as a pivotal social resource for the users/learners as trust and acceptance comes easily, especially when it comes for parents not feeling secure to send their teenagers to a shop to learn something, it feels more secure when the operator is someone the parents know from the local community or when it is supervised by the community peer groups.

4. Action resources: For instance users who had improved employment opportunities due to using the net for searching for jobs and applying online through bdjobs. As Telecenters provide technical training on things like basic computer skills or more advance skills get better opportunity in ICT environment and the enrolment as volunteer into the centre or other NGO's. The notice board can be seen as action resources. The operator arranges the notice board with transformed data resources considering the rural peoples' information need and understanding level and this could consider as an outcome of his skills and motivation. It is

observed from the study that the ICT center has been using different types of resources to adopt ICT and ICT-enhanced community development activities in rural areas, but it is also visible that capability development can be evolved in every stages of its operation. In many of the local Telecenters in Bangladesh users have taken computer training and many now work independently on outsourcing jobs on the web using platforms such as Odex. Many have sent their younger brothers and sisters to learn computers in the training centers of the GPCICs. These training cells have become a viable business centers for many entrepreneurs.
From such examples mentioned we could extract three basic kinds of resources to this ICT initiative; social resources (motivation, skills, knowledge of ICT), action resources (able to take new job) and economical (send siblings for ICT training). It is possible that ICT4D can use their resources properly if the conditions are right and it would be possible to target the marginalized community of Bangladesh into such development initiative as the ones GrameePhone is conducting with their 500 plus Telecenters all over the country. It would seen that at the initial stage there is economical resources like the funds coming from the donors and social resources such as youth of the community working in groups and motivating each other to learn in the process. When the people realize that the data being put into their heads (learning computers) can be transmitted into meaningful information (potential for jobs in new sector IT department) it is easier to motivate larger communities to participate and develop new capabilities.

4. Impact in terms of 'functioning':
In a particular GPCIC center it was found that one youth was provided with computer training and now he has his own center with about 10 to 12 computers where he teaches young school children how to use the computer and the net and he even has trained up some of his students to such an extent that he gathers outsourced work off the net and pays his students to the jobs by them. This entrepreneur was motivated by the future business prospects of the use of ICT. The motivation came over time as he was trained and made aware of through the regular court yard meetings (CYMs) conducted by the GP promotional team. Now it is his self motivation for making his business successful that has made him consider thinking about not only himself, but in a more participatory approach by thinking about the unemployed youth group in the local communities how he now sees as potential work force for him training center. If we consider the capability building approach with resource perspective then social and economical resources are strongly associated with the human capability building process. The qualitative data collected from some field visits to the CPCIC centers via in-depth interviews shows that some ICT centers have played a potential role improving local community's 'functioning'.

Critical Success Factors Identified:

Based on the In-depth interview that were taken of the various rural entrepreneurs who are running the GPCICs we were able to identify ten Critical Success Factors which we believe are curtail for any Telecenters if they want to move away from donor dependency and become a self sustaining business. These factors are:

I. National Economy of a country:
"No, no computer. The computers are provided by the donors as the government agencies have no money to allocate for ICT" (A Senior Officer of Local Government). The economic status of the country will strongly affect the possibility of implementing any ICT support. In our study, we found that neither the national government nor the local ministries had the financial means to make an investment to provide ICT support to these centers. The computers that were available within the district were funded by international

development agencies operating there.

II. Financing of ICT adjuncts:

"No, not connected, I would like it to be connected, but I am not able to pay for the internet connection" (store owner). Financing of both accessories and spare parts for ICT equipment is also dependent on the economic situation within the organization. The economic situation is also relevant for the possibilities to financing different fixed charges such as Internet subscription. We noticed during our study that a lack of accessories resulted in an inefficient use of the available ICT equipments.

II. Capacity of the Electricity Network:

"There we have a problem! We are not using the computers so much, because when we want to use them we have no electricity" (A Senior Officer of Local Government). The capacity of the electricity network will affect the use of ICT in a village to a great extent. The electricity supply within our research area was both insufficient and unstable. The access to the internet was interrupted constantly and the ICT users could only expect a supply of electricity for three to four hours per day. This resulted in problems with planning the use of the computers, lost files and even computer breakdowns. Not to mention loosing of regular customers as they turn away from such internet based services due to frustration created with the long waiting hours for the electricity to come back and for the net to be available again.

III. Condition of the Telecom Network:

"There is a shortage of available connections in the district" (A shop owner). The condition of the telecom network will influence Internet connection. The telecommunication network within the district consisted of only a few fixed lines which were of poor quality. This results in occupied lines as well as repeated interruptions when accessing the Internet. Another effect from the limited access to the telecommunication network is that it creates problems when it comes to downloading information from the Internet. This resulted in difficulties with planning the use of Internet and forced users to operate during night time. But this has other problems such as greatly reducing the mobility of women users of such services.

IV. User literacy:

"As a matter of fact, Bangladesh has been recently improving their volume and quality of literacy at the rural level. However it still lacks behind most of the south ease nations. To be able to handle a computer efficiently the user must have a basic knowledge in reading, writing and counting. Within our district we assume that the level of illiteracy was at least 20 percent as the majority of the local population are farmers with limited possibilities of attending school. We believe there is a relation between illiteracy and ICT illiteracy.

VI. User ICT Maturity:

"We have been taught that in the future we will be using computer for any job, but I don't know the reason" (student). To the users ICT maturity is of importance in the wider perspective of ICT usage. In our research district there was no computer education, neither within the school system nor within the local governmental administration. This was according to our respondents due to the district's rural location. This resulted in a limited knowledge concerning ICT and limited ICT awareness concerning capability.

VII. The Accessibility to ICT Specialists:
"If the computer is broken we have to take it to the major city center. Someone here should be able to repair the computer" (A shop owner). The accessibility of ICT specialists such as service and support staff is necessary to keep the ICT equipment functioning. In our research district the possibility of receiving ICT support or service. In case of a computer breakdown the user has to transport the computer personally by bus either to the province town 100 to 200km away or to the capital city which is about 400to 500 km away. The time taken to get the computer repaired could vary from one week up to two months.

VIII. The Delivery system of ICT equipments:
"All accessories are found in Dhaka and it is not easy; you have to go there in person. You cannot send any accessories by post" (shop owner). There is a need for an efficient and functional delivery system of ICT equipment. In one of the district the postal service was not reliable and there is always a risk of losing the item. Furthermore, the postal service in the district was not frequent and this resulted in difficulties with delivery of ICT products. Also, the delivery time could range from a couple of days up to several months.

IX. The adaptation of ICT:
"The cost for software licenses cannot be of Western dimension; instead it must be adjusted after the presumptive users' economic capacity" (an aid worker). It is imperative to adapt ICT to the local condition and its disposal resources. In our research area the resources were very limited and the concept of open source and open net could make a wider ICT use possible. Moreover, the technology needs to be adapted to the physical environment. In our area there is a need for robust ICT equipment considering the high temperatures, high humidity and dust in the area.

X. A user-driven ICT development:
"It is important that there is a soft meeting between the individual and the technology where the technology as much as possible must adapt to the user" The development to ICT applications together with the user is key. The development process should start by investigating the socio-economic and cultural characteristics within the area. The process should continue by identifying and analyzing the needs of the local area and the users' demand. In the geographical area focused in our study, we noticed a great need for information in the local language.

Conclusion:

In conclusion of the expletory study the findings suggest that the most critical factors required for Telecom Centers to survive in Bangladesh are still coming down to the basics such as:

- Developing financial capabilities of the business owners
- Infrastructural support like better Electricity & Telecom networks in the rural areas
- Improvement in General Literacy & ICT Literacy at the primary school levels
- Better support system such as regarding delivery of ICT equipment
- Develop skill sets for ICT specialists at the national level
- Development of Local Content & User Driven Content & Services

Although many of these issues can be addressed by the private sector or donor organizations, the most vital ones are related to the nation's infrastructural issues which can only be solved by working together with the local and central government. The study was an attempt to highlight the critical factors which have to be addressed before this sector can take the shape of a full fledged self sustaining business. However further studies are required to look into the relationship of the factors identified. The author suggests a detailed quantitative survey focusing of the factors identified where we can critically measure the relevancy of the identified factors in terms of their level of significance or how much they actually affect the sustainability of the Telecenters.

Title: Food Sustainability in Megacities & Green Business
Hasan Mahmud

1. Introduction to future megacities and LED farming

Food security is crying need of the urban dwellers as the population of the planet is increasing day by day in a rapid growth. In fact, by 2008 over 50 percent of world population was living in urban areas which have gone up to 54 percent by the end of 2015. It was only around 3 percent by the year 1800. It is projected that on an average two third of all people will be calling cities home by 2050 and 70 percent more food will be required to reach the demand. With the blessings of new technological boost a new idea of LED farming proves that food can be grown vertically in warehouses using the bulbs requiring less water and little energy.

2. Acute food insecurities in megacities

a. Why Worry About Mega-city Food Insecurity?

The justification for actively including urban populations in efforts to monitor, prevent acute food insecurity rests on three considerations.
First, urban areas are sinks for food commodities from rural areas. An urban food shortage will draw food out of adjacent rural areas, possibly leading to acute food insecurity in these rural source areas. If these centralized supplies do not meet the full needs of the urban population, both urban and rural areas can experience concurrent acute food insecurity.
Linked rural and urban shortages cannot be addressed without monitoring and assisting both areas. Only providing food to rural areas can result in these commodities simply moving into the urban areas, in response to greater effective demand, without improving the rural food security. Only providing food in urban areas can draw food insecure populations from rural areas.

Second, ignoring potential food security disasters means discriminating in favor of rural populations. This disregard of the needs of urban populations conflicts with the generally accepted standard of providing humanitarian assistance without discrimination. Disregarding the needs of urban populations is even more serious when not based on clear and well-documented comparisons of food security in rural and urban areas.
Finally, the number of people affected is often a key determinant of the magnitude of a disaster. Big disasters happen in big cities because of the number of people present, and often present in geographically small areas. Big cities - mega-cities - can be the sites of very big disasters.

b. Mega-city Disasters and Food Insecurity

Many of the risks, hazards and disasters, and the compounding factors arising from the nature of a mega-city, are discussed in Mitchell's Crucibles of Hazard: Mega-cities and Disasters in Transition. Interestingly, the book contains almost no discussion of acute food insecurity as a risk in urban areas. Yet, a mega-city food crisis can arise from a wide range of social, economic, technological and natural causes.

The latter include, of course, drought, floods, and earthquakes, all of which can affect the supply of food available to urban residents. Fewer examples exist of technological disasters which have contributed to acute food security problems, although the exodus of people from Bhopal after the chemical release probably contributed to some transitory food insecurity within the city and among those who left.

Examples of economic and conflict disasters contributing to serious food security problems are more numerous. Among the former are the economic crises in South East Asia and the former Soviet Union, which have resulted in various degrees of food crises in mega-cities (but apparently less so in surrounding rural areas). Conflict disasters, underline how threats to food security can result from, or contribute to, disasters in mega-cities.

Specifically in the case of conflict disasters, the links with acute food security can be two-way and reinforcing. As Bonnard points out, real famine may be "an unlikely outcome of urban food insecurity, famine is replaced with riots and mayhem". Efforts by urban residents to avoid acute food insecurity may lead to further unrest and disaster, leading in turn to more food insecurity or change which addresses the causes of the food supply crisis.

At the same time, no mega-city in the periods since World War II has become totally cut off from outside food supplies and under siege for any length of time. Whether it is even possible to isolate and lay siege to, rather than simply depopulate, a mega-city is both a political and practical question. However, it is likely that the threat of acute food shortages in a mega-city will result in action by the residents to reduce this threat to acceptable levels. Whether this happens through fighting or shipment of food depends on the circumstances of each disaster.

The key factor defining the potential for food security problems in a mega-city is the dependence on a periphery for food. Although food is processed (and often grown) within a mega-city, most food commodities needed for consumption or processing come from outside the core urban area. Failure of the systems which move food to and within a city, due to floods, war or economic collapse, will result in acute food insecurity. While supply system problems can affect any community, the number of people who can be affected in a mega-city makes this peripheral dependency the most important element of mega-city vulnerability to acute food insecurity. The risk of food insecurity is increased where a mega-city also depends on tight food supply systems, where there is little excess within the system and no large stocks of food held in reserve. Urban food supply systems can be tight at three levels:

a) At the processing level, where factories do not maintain large stocks of raw or finished products on hand,
b) At the commercial level, where retail outlets have only a few days stocks on the shelf, and,
c) At the family or personal level, where stores of food are not kept against supply shortages.

Disruption of this tight supply system at any level can lead to consumer shortages and increasing prices. For the poorer mega-city residents, with limited income and limited

supplies of stored food, market shortages and increased prices will have an immediate impact on food security.

An additional factor contributing to acute food security problems for mega-cities is that rural areas around mega-cities may have limited food reserves. If large numbers of urban residents displace from a mega-city they take their demand for food with them to destination areas which themselves may be food insecure. Perversely, residents fleeing a mega-city food crisis may, like plague victims, take the disaster with them.

Finally, urban agriculture and livestock production contribute to urban food security, in some cities significantly. At the same time, it is unlikely that urban agriculture can quickly produce the volumes of food needed to sustain mega-city populations during periods of quick-onset acute shortages. Similarly, the large scale selling off of livestock for income with which to buy food in response to decreasing supplies and increased prices will likely result in an oversupply on the market and falling livestock prices. Thus, while urban agriculture serves as an important supplementary source of food (e.g., Vitamin A from vegetables), it does not appear to be a complete solution for acute urban food insecurity.

3. Project Analysis

a. Project Design

Using research (Garside et al, 2004) from the Sugar Yield Decline Joint Venture (SYDJV), key management practices were selected for implementation on the demonstration blocks. These included:

- Controlled traffic farming
- Legume rotational crops (where possible with seasonal conditions)
- Minimum tillage
- Optimized irrigation scheduling and water re-use
- Optimized nutrient management (BSES “6 Easy Steps”)
- Minimal usage of residual herbicides
- Farm planning and record keeping

b. Biophysical Results

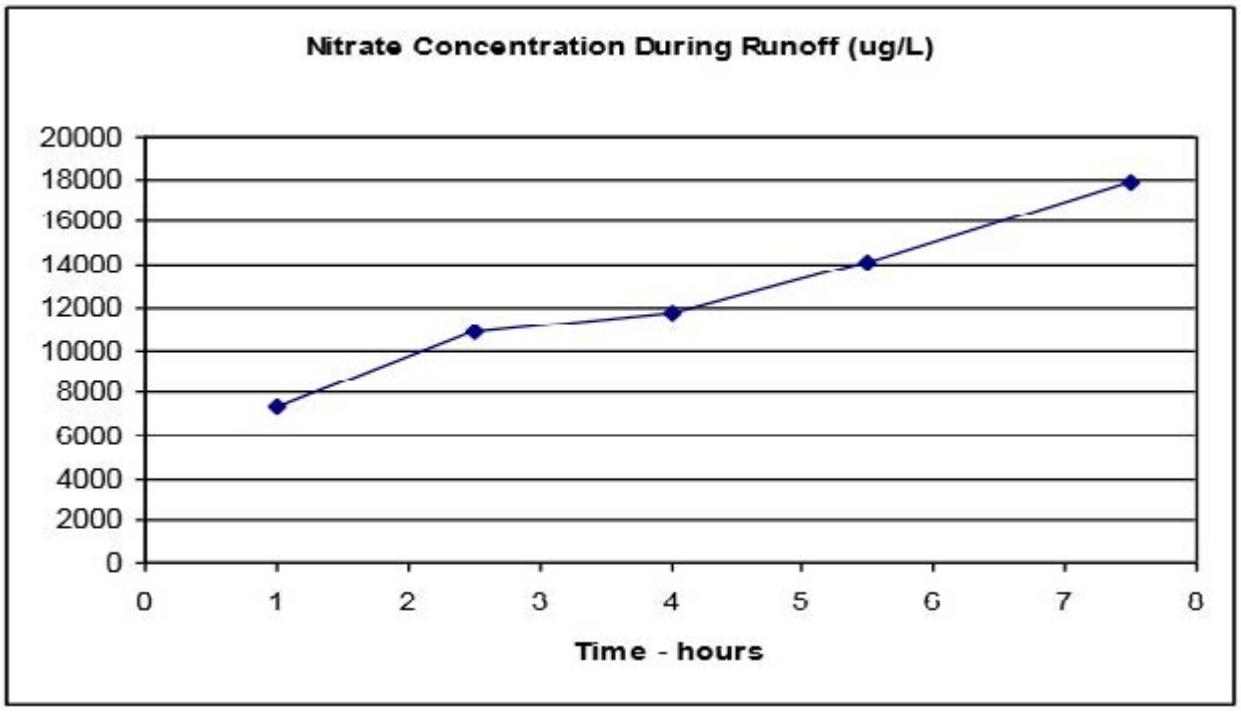
Current results from the project have been consistent with past research (Ham 2007), particularly involving nutrient movement off paddock. These results include:

- All blocks recorded the highest nutrient (nitrogen and phosphorous) loss during the second irrigation after application of nutrients;
- All blocks recorded the highest herbicide losses during the 1st irrigation after application;
- The highest herbicide losses occurred during the first flush of water leaving the paddock;
- The highest nitrate concentration was consistently found toward the end of each irrigation event.

c. Nutrient Loss

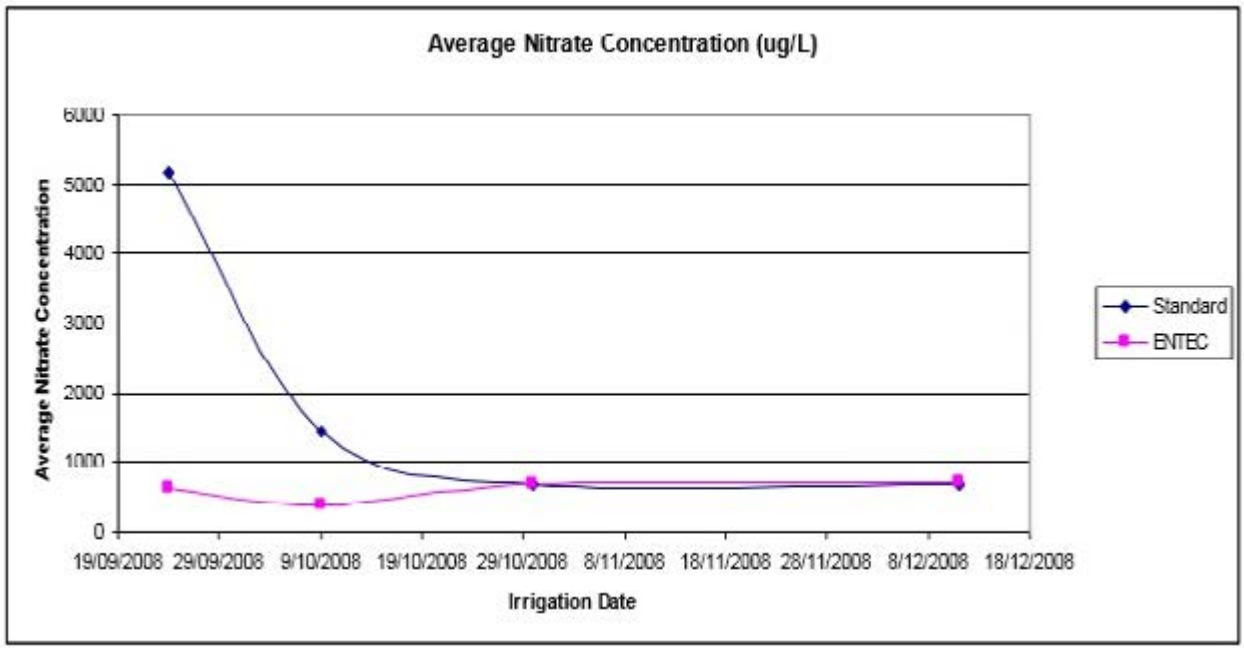
Nutrient export (primarily nitrogen) from cane farms into receiving water bodies has been identified as a major process linked to water quality decline in northern Queensland.

Mitigation of nitrate losses is, therefore, a key focus of the demonstration farms project, with the monitoring of water quality flowing off farms as a key component of the program.



Results from monitoring nitrate levels in runoff water have shown that the highest nutrient (nitrogen and phosphorous) loss occurs during the second irrigation after application of nutrients. Results have also shown that the concentration of nitrate in runoff water increases with irrigation time, with the last water to leave the block containing the highest concentration of nitrate. However, further data will need to be collected before any conclusions can be made.

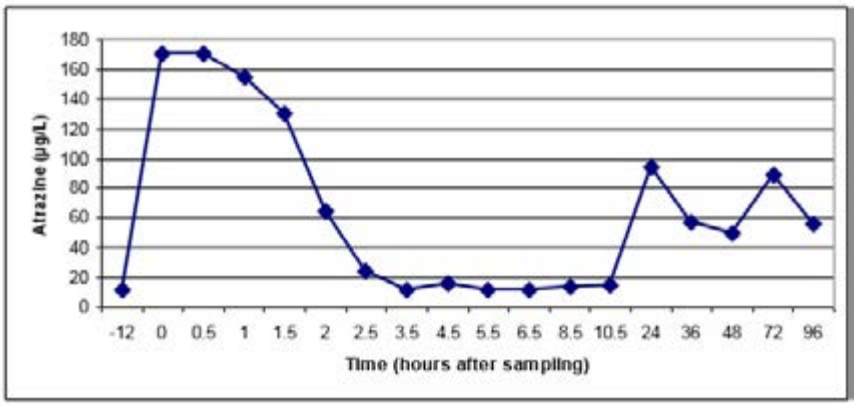
While nitrate concentrations in previous chart are quite high, it is important to note that 100% of farm irrigation runoff in this example is captured and reused on farm; thus ensuring no losses to the wider environment. The "cutting edge" trial block has also highlighted potentially significant water quality benefits. A replicated strip trial carried out in partnership with Incitec Pivot to explore the use of a slow release fertilizer product –ENTEC. Results from the first five irrigation events after application are very promising, showing up to 10 times less concentration in nitrate-N losses when compared to standard fertilizer in tail water. This trial will continue throughout the crop cycle and will include a full economic analysis. At the time of writing, the crop had not been harvested so the ability to compare productivity differences between the treatments has not been recorded. ENTEC is not yet commercially available, although it is anticipated to be released in the near future.



Difference in nitrate-N concentrations in irrigation runoff water between ENTEC and standard fertilizer

d. Pesticide Loss

Pesticide losses are a concern for reef catchments, particularly residual products such as atrazine and diuron. A field-scale trial explored the use of an enzyme to break down atrazine into products. The first trial was an outstanding success with 90% of atrazine removed from a recycle pit within 3.5 hours of applying the enzyme. The chart shows below the decrease in atrazine concentration after product application.



Effect of enzyme on Atrazine concentration in tail water

Background levels of atrazine in the recycle pit were around 16 µg/L prior to irrigation tailwater input, and once irrigation tail water entered the pit, the levels increased to around 170 µg/L. After treatment at this point in time, the enzyme reduced atrazine concentrations to around background levels over a 3 hour period. Atrazine is a relatively persistent herbicide that has a half-life of 60 days (in soil). Therefore, the pronounced decrease evident in atrazine concentrations was due to enzyme action. The increase in concentration 24 hours after treatment is due to diluted runoff water entering the pit from a separate irrigation event. Further trials of this product are planned, and CSIRO are seeking a commercial partner to ensure this product can be available for commercial use.

4. Agronomic and Economic Results

a. Irrigation Efficiency

Throughout the cane industry, the most widely used method of irrigation is furrow irrigation. While this method of irrigation is often inefficient, modifications to irrigation scheduling on demonstration farms has led to significant improvements in water use efficiency and crop performance.

An example of this improvement was seen when capacitance probes were installed on a co-operating producer's blocks. Previous irrigation practice, which used furrow inflow rates of around 1.2 L/s with irrigation events running for up to 36 hours, showed periods of water logging of up to 8 days. This period of water logging increased potential for nutrient loss and decreased crop growth. With the aid of SIRMOD (surface irrigation modeling tool), it was demonstrated that an increased furrow inflow rate of around 3.5 L/s and subsequent decrease of irrigation time to 12 hours should result in approximately 20% water savings. These results were then applied to the demonstration block, with inflow rates increased to 3.6 L/s, and irrigation time decreased to 12–13 hours. Data from the capacitance probes showed a decrease in waterlogging time to 2–3 days which resulted in an increase in uniformity of irrigation run times as well as a 20% water saving. The potential for nutrient losses is also decreased due to less waterlogging and increased crop growth.

b. Nutrient Management

Significant improvements in nutrient management occurred as a result of project activity. Application rates and methods were determined by „6 Easy Steps" the current industry BMP for nutrient management. A resulting reduction of around 30% of applied nitrogen was achieved in some cases, with cost savings around $380/Ha. Crop yield was not affected by this reduction due to the fact the project took a systems based approach. If the co-operating growers had not improved irrigation management (ie: reduced waterlogging potential and meeting crop demand) in combination with nitrogen management, a yield penalty could have very well resulted.

Another significant improvement was the introduction of a harvested legume crop as part of a fallow management strategy as well as soil health and nutrient improvements. The soybean crop was harvested to generate a profit of around $610/Ha. Cane was planted with a double disc opener planter into the existing soybean beds the day after harvest. Applied nitrogen chemical fertilizer was further reduced to 50kg/Ha (compared to 150 –170 kg/Ha) due to the nitrogen supplied by the legume crop. This led to a further cost saving of around $350/Ha in fertilizer costs.

c. Pesticide Management

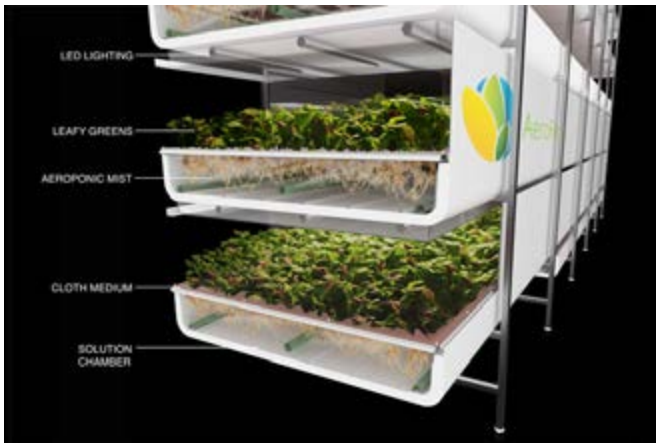
The overall approach on the Demonstration sites in relation to pesticide management was to minimize use of residual pesticides while maintaining appropriate weed control. On two of the sites, due to a high level of weed pressure, some residuals were used. On the third demonstration site, due to less weed pressure, residual chemicals were not used. A shielded sprayer was used with only knockdown products being used (2,4-D and glyphosate) sprayed under the shields –resulting in application of only 50% of the paddock. This strategy resulted in savings of around $50/H a when compared to past practices on that block. Importance was also placed on irrigation management in relation to pesticide applications. Irrigation events were delayed at least 5 days after pesticide application to minimize potential off farm movement.

d. Farming System

The success of the project to date has been a result of implementing a farming system based approach as well as collaboration between all project partners –most importantly the co-operating producers. Significant emphasis was placed on the importance of managing the whole farming system rather than looking at only improving selected components. The adoption of a complete well managed farming system resulted in a range of profitability increases for the three demonstration sites from 11% to 59% improvement in whole of farm operating return when compared to previous practices. Caution should be taken using these results as they are specific to the individual enterprise and involve some production assumptions (due to the fact the project has only just obtained one year's worth of productivity data). Major aspects of the system that contributed to these improvements were; optimized nitrogen application, integration of a harvested legume crop (Dry Tropics only), improved irrigation management (Dry Tropics only) and significantly reduced tractor operating hours –up to 70%. While the results to date have been extremely promising, caution is being exercised by the project team as the data generated are from only one year when a full cane production cycle lasts for 5 years. Until a production cycle has been completed, the true economic and biophysical benefit of an improved system for water quality outcomes cannot be calculated.

5. The AeroFarms system

With state-of-the-art, clean-tech technology using aeroponics and LEDs, AeroFarms



is the commercial leader for indoor vertical farming, utilizing a totally controlled growing environment without sun or soil and minimizing harmful transportation miles.

a. Innovation

AeroFarms has developed a patented, reusable cloth medium for seeding, germinating, growing, and harvesting. Cloth has a number of benefits such as durability and reusability, increased cleanliness and sanitation, and the efficient harvest of a dry and clean product.

AeroFarms has been pioneering the use of LED (light emitting diode) lighting for growing and vertical farming systems, targeting specific wavelengths of light for more efficient photosynthesis and less energy consumption. LEDs can also be placed much closer to the plants, enabling greater vertical growing for even greater productivity per square foot.

Aeroponics is a cutting-edge type of hydroponic technology that grows plants in a mist. The aeroponic mist most efficiently provides roots with the nutrients, hydration and oxygen

needed, creating faster growing cycles and more biomass than other growing approaches. AeroFarms has designed its aeroponics as a closed-looped system, recirculating our nutrient solution and using over 95% less water than field farming.

b. Clean, safe and green

Growing indoors changes both pest pressure and the pest environment. Plants are grown in a machine inside the building and not out in the open where they attract pests. Our proprietary cloth growing medium is sanitized between every growing cycle of 12-16 days. The typical pest cycles of more than 21 days are broken. With our pest-resistant design, pesticides are unnecessary.

By removing soil from the growing of greens, we improve food safety by avoiding completely contaminated manure and irrigation water.

By growing pesticide-free and without soil, AeroFarms produces greens that are very clean at harvest. While growing clean greens significantly improves food safety, it also improves the shelf life of the produce. The washing of greens after harvest potentially exposes them to bacteria and creates a damp microbial growing environment, which reduces shelf life. By growing greens clean and dry upon harvest, our systems can extend shelf life from the 1-2 weeks to 3-4 weeks for many leafy greens.

We use a closed nutrient method that re-circulates the nutrients to conserve water and utilize all of the minerals

c. Advantages

- ✓ Year-round, high-quality production with better yields.
- ✓ Faster 12 to 16-day crop cycles for 22 to 30 crops a year.
- ✓ Patented, reusable growing cloth medium.
- ✓ No pesticide usage.
- ✓ 95% less water usage.
- ✓ Closed-loop system able to recycle nutrients.
- ✓ No harmful run-off protecting the environment.

6. Green business opportunities

Urban Harvest is no normal plant business exclusively focused on the maximization of production and profit and employing all available means. In the opinion of many experts, the non-profit company represents the future of modern vegetable cultivation.

a. Helping people in need

The aim of Urban Harvest is the energy-efficient and resource-conserving production of pesticide-free healthy vegetables for an urban population, and without long shipping distances. In addition, the company wishes to support people in need. In cooperation with the non-profit Millionaire Club Charity, Urban Harvest seeks to improve the living conditions of the unemployed and even homeless by creating job opportunities and building professional qualifications. With these activities, the initiative aims to promote the independence of individual persons. People without income also receive nutritious meals on a daily basis, prepared from the harvested products.

b. A local business reduces the CO^2 footprint

The corporate philosophy focuses on sustainable management and distribution. Urban Harvest grows 10,000 heads of lettuce each year and delivers exclusively to local restaurants, grocery stores and vegetable wholesalers in Seattle, thereby significantly reducing the product's CO^2 footprint compared to conventionally produced vegetables.

c. State-of-the-art LED light effectively promotes plant growth

The production halls are illuminated with highly modern LED lights. LEDs of the OSLON product range from OSRAM Opto Semiconductors are used. In total, several hundred OSLON SSL hyper red (660 nanometers), OSLON SSL deep blue (450 nanometers) and OSLON Square EQ white ensure lighting precisely matched to the needs of the plants.

With respect to the cellar location, this is not a necessary alternative to sunlight but a blessing for plant growth. The reason being that while natural light conditions contain factors disruptive to plant growth, LED lighting can be precisely coordinated to the specific light wavelengths required by plants in their various stages of growth. These consist of different wavelengths for each type of plant. The advantage: Cultivation is not negatively affected by adverse weather and plants no longer develop strong stems for growth towards the sun due to the optimum all-round lighting conditions. As a consequence, the plants grow more horizontally and achieve greater yield. This method is so pioneering that even Google has now become interested in the urban farming concept.

d. Current product launch of the OSLON SSL far red (730 nanometers)

LED technology is developing at a highly rapid pace. In February 2015, OSRAM Opto Semiconductors brought its latest product version of the OSLON SSL range to the market with the "far-red" model. The ultra-compact LED with a wavelength of 730 nanometers is ideal for the control of plant growth.

e. LED achieves 40% more growth compared to sunlight

Kevin Wells, CEO of the luminaire manufacturer LumiGrow, comments on his product selection for the Urban Harvest project: "OSRAM LEDs were the ideal choice globally to achieve the growth and efficiency targets of the project." The matched system of LEDs and luminaires emits precisely the right light intensity and light spectrum required by the seedlings in their various phases of growth. And without damaging hotspot lighting.

Optimally utilized LED lighting is able to increase plant growth by up to 40% compared to sunlight due to its completely flexible controllability targeted at healthy plant growth.

f. 70% energy savings with LED – and rapid amortization

Compared to traditional high-pressure discharge lamps primarily used until now by greenhouses and vegetable farms, modern LED systems achieve energy savings of up to 70%, along with ten times the lifespan and constant light performance. Investments are amortized, therefore, after just a few years.

g. A mega trend: Urban farming, urban planting and urban gardening

Producing agricultural products for people in areas of high population density with very low levels of energy, without pesticides and with the use of already existing urban spaces. And, of course, with distribution channels that are as short as possible. The result is healthy products and a low carbon footprint. These are the main characteristics of urban plant cultivation initiatives that are becoming increasingly popular on a global scale. Projects range from

individual residencies in large cities with roof terraces and groups of interested people using small open spaces, to highly potent start-ups cultivating on a large scale and now financed by investment companies. The plant project in the London underground, also exclusively illuminated with LEDs, is comparable to the Urban Harvest project.

7. Conclusion

According to the definition a megacity is pegged with more than 10 million residents and this whole lot population is hardly busy with direct food production which may be a threat to our food security in megacities. That's why people need to change their thinking about greening technology and use this technology to a direct greening process and make it significance to green business through making the world a better place.

8. References

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Title: Portraying conflicts among project stakeholders: From a sustainable project management perspective

Iftekhar Ul Karim

1. Introduction

1.1 Stakeholder discrepancies in Project management

The success of the project vastly depends on how the project managers analytically and intuitively identify key stakeholders (Bourne & Walker, 2005) and work with them to frame their expectations and influence upon the overall project outcome (Golob & Podnar, 2014; Hörisch et al., 2014; Moriarty, 2014; Ni et al., 2014). In this context, a stakeholder is someone affected by a project and having a right to influence its outcome by any means (Cobb, 2012). Bourne and Walker (2005) have argued that successful completion of project deliverables is critically dependent on the need to achieve the project objectives that fully address stakeholder expectations all through the project lifecycle, whereas stakeholders are also considered asset to the project resource-base (Retolaza et al., 2014;
Scheer et al., 2014; Yang et al., 2014). However, conflicting range of needs and wishes among the project stakeholders is proved to be a fundamental challenge for the project managers (Adderley & Mellor, 2014; Alladi & Vadari, 2011).

The ability to recognize the influence of various stakeholders is a significant skill for successful project managers (Chakhar & Saad, 2014; Garriga, 2014; Bourne & Walker, 2005), however without consideration to the conflicting needs and expectations of a diverse range of project stakeholders at various project phases (Golob & Podnar, 2014; Hörisch et al., 2014), a project will not be considered sustainable despite the fulfillment of time, budget and scope – commonly known as the "iron triangle" of any project (Bourne & Walker, 2005). The multi-stakeholder perspective is often deemed as the sustainable perspective for the project management (Silvius et al., 2012), nevertheless the underpinning conflicts among the project stakeholders inevitably exist with due scale and scope – tackling which determines the project success end of the day (Retolaza et al., 2014; Scheer et al., 2014).

1.2 Theoretically how this conflicting scenario can be understood?

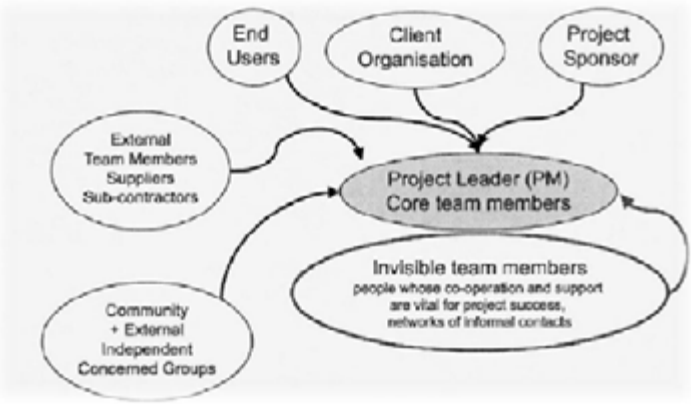


Fig. 1: Stakeholder Model (Source: Bourne & Walker, 2005)

As per the figure 1, the stakeholder orientation of project management is positioned in order to view the possible conflicting scenarios from the project management set-ups and in the eyes of a project manager (Bourne & Walker, 2005). Herein, a conflict is a construction and composition of the project interface (Grossman, 2001) visualized by the project manager in one context and captured otherwise by the project team internally and externally in another context depending on the internality and externality background and several varied constructions of stakeholders of several typed and tycoons (Adderley & Mellor, 2014; Alladi & Vadari, 2011; Retolaza et al., 2014; Scheer et al., 2014; Yang et al., 2014). "Management for stakeholders" perspective as elucidated by Eskerod and Huemann (2013) delineates the focus on the stakeholders scoping out the underlying conflicts among them in order to device the project management strategies to cope up with them and thus accommodating a balanced approach eventually (Golob & Podnar, 2014; Hörisch et al., 2014; Moriarty, 2014).

In line with this, strategic CSR window of opportunity reflects the balance of economic value and social value (Werther & Chandler, 2011), which is instrumental for the project managers to focus upon by balancing the requirements of both the economic stakeholders and social stakeholders in an effective way (Retolaza et al., 2014; Scheer et al., 2014; Yang et al., 2014). This avoids the CSR deficit (Werther & Chandler, 2011) which is caused in more conflicting and imbalanced situations among the economic and social stakeholders with an array of non-aligned influences and demands (Golob & Podnar, 2014; Hörisch et al., 2014) creating a conflicting obstacle for sustainable project management (Silvius et al., 2012).

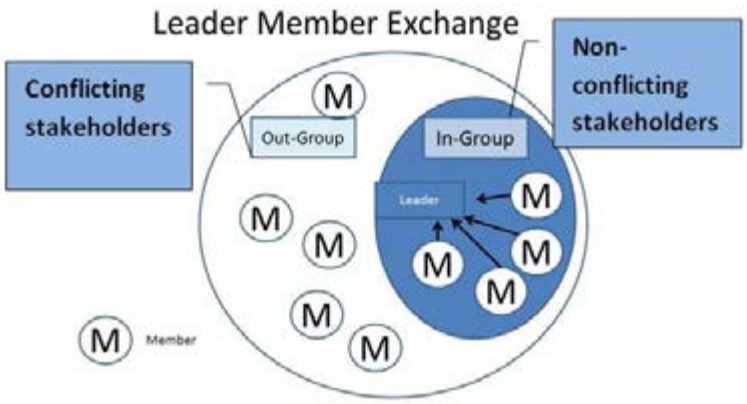


Fig. 2: Stakeholder conflict through LMX (Source: Own illustration)

Depicting the broader instrumental approach of leadership (Northhouse, 2013) and focusing on the part of influences and interactions among project leaders and stakeholders (Adderley & Mellor, 2014; Alladi & Vadari, 2011) in their dyadic relationships, the Leader-member exchange (LMX) theory as proposed by Graen and Uhl-Bien (1995) relates to the context of in-group and out-group stakeholders of the project. This naturally entails the higher amount of intimacy of the closer stakeholder group and lower amount of engagement of the outer stakeholder group in the project management scenario resulting in a conflicting gap (Ni et al., 2014; Oriordan & Fairbrass, 2014). In this context as per the figure 2, thus stakeholders in the in-group receive more information, influence and confidence from the project team than that of the out-group stakeholders (Northhouse, 2013). Ensuring high quality leader-member exchanges (Northhouse, 2013) will avoid stakeholder conflicts building effective dyads and network partnerships throughout the project life-cycle (Cobb, 2012; Tolbert & Hall, 2009). The studies of Graen and Uhl-Bien as elucidated by Northhouse (2013) are quite relevant for project management which suggests leaderships making in three progressive stages: (1) the stranger phase – with lower quality LMX exchanges and self-interested actions / performances of stakeholders, (2) the acquaintance phase – with medium quality LMX exchanges and room for more roles, responsibilities and challenges for stakeholders, and (3) the mature partnership phase – with high quality LMX exchanges and effective dependencies with the stakeholders of the project – in order to understand the progressive conflict stages amongst the project stakeholders as well (Carlon & Downs, 2014; Chakhar & Saad, 2014; Garriga, 2014).

In this stakeholder management and project leadership context (Cobb, 2012; Silvius et al., 2012; Werther & Chandler, 2011), the understanding of the construction and composition of conflict based on the internalities and externalities become instrumental (Scheer et al., 2014; Yang et al., 2014). Having said that, the conceptualizations of unexpected events essentially constitute conflicts among the project stakeholders, whereas these constructions do not actively take a posture on whether the occurrence was sudden to all project team members or merely to some (Tukiainen et al., 2010). Expectations toward the folk and peers in the project

management landscape and what amount of goodwill received or shared at what particular time cater to the ignition of conflict which Tukiainen et al. (2010) have produced as "unexpected dynamic events" those emerge, evolve and change during the project lifespan. With this evolutionary, emerging and changing properties of conflicts in the project management context (Tukiainen et al., 2010), therefore understanding the different set-ups of conflict also becomes significant for the sustainable project management (Adderley & Mellor, 2014; Ayuso et al., 2014; Carlon & Downs, 2014; Chakhar & Saad, 2014; Garriga, 2014; Golob & Podnar, 2014; Hörisch et al., 2014; Moriarty, 2014; Ni et al., 2014; Oriordan & Fairbrass, 2014; Retolaza et al., 2014; Scheer et al., 2014; Yang et al., 2014).

1.3 Research gap in understanding the types of conflicts among project stakeholders

In line with this aforementioned quest, a fundamental question that arises is what the contemporary research has to say about the greater typology, categorization and classification of conflicts relevant to the project management domain holistically?

Okoye et al. (2013) have examined the nexus of corporate disclosure of social performance on corporate stakeholder conflict management where stakeholder groups represent divergent interests in the activities of any corporation. Thus it was perceived that managing social stakeholder needs is crucial in sustaining a long-term relationship between management and stakeholder groups establishing the critical link between the three constructs of sustainability, i.e. social and economic performance relationship; social and environmental performance relationship and environmental and economic performance relationship (Okoye et al., 2013). In this context, Zietsma and Winn (2008) have deepened the understanding of the processes and specific actions aimed at influencing and shaping business practices through dynamic stakeholder relationships building elaborative influence chains and worked to direct influence flows. Zietsma and Winn (2008) have offered a refined understanding of both bilateral and mutual-influence tactics in the context of conflict management through bilateral relationships, and highlighting the use of dependence relationships among multiple embedded organizations to build influence over a specific target, and more generally, an organizational field which is encircled by its key stakeholders – the organizational employees (Zietsma & Winn, 2008).

Stakeholder negotiation processes, on the contrary become difficult due to values differences among stakeholders as defended by Crow and Baysha (2013). These values can be reflected in the language used by stakeholders leading to conflict in negotiation processes perceiving a higher degree of miscommunication in stakeholder negotiations (Crow & Baysha, 2013). Thus clarity of language and transparent discussion of key value-representative terms may lead to stakeholder negotiations involving minority stakeholders with more aware of values and language differences than their majority counterparts researched by Crow and Baysha (2013).

As different stakeholders have different levels and types of interest in projects and can be seen as multiple clients or customers for the project in which they are involved, Newcombe (2003) has argued that the concept of client is now obsolete and is being replaced by the reality of project stakeholders demonstrating the importance to project managers of conducting the analysis of the power, predictability and interest of key project stakeholders (Newcombe, 2003). According to the research of Newcombe (2003), contemporary management theory focuses the role of stakeholders as major players in organizational dynamics via a pluralistic view of the identity of those who have an investment and an interest in an organization, whereas the concept of stakeholders has been applied to projects in general but has not that extensively to deal with the conflict categories of project management (Newcombe, 2003). This entails an interesting research gap in understanding the typology, categorization and classification of conflicts relevant to the project management domain.

Rogan (2006) sought to extend existing research on framing conflict categories by exploring the number and types of frames individuals use to describe their conflict events with an assessment of the relationship among the frames suggesting that particular frames dominate individuals' descriptions, while significant differences were also found between males' and females' use of certain frames in conflict management (Rogan, 2006). Accordingly, Bhadra (2013) focused upon the concept of stakeholder theory and integrated corporate social responsibility in operational risk management approach and in a value creation approach respectively in reactive way and in proactive way to deal critical conflicting scenarios in organizations in a Conflict-Consensus-Collaboration context leading to more chances of replicating the concept in the domain of project management through further research (Bhadra, 2013).

Cuppen (2012) interestingly elaborated on diversity as recognized as a key issue for learning in stakeholder dialogue which entails the articulation of a diversity of perspectives and the confrontation of claims and ideas pointing out constructive conflict as a new phenomenon but not in the context of project management. In line with this, Wang et al. (2009) have identified that everyone involved in the project brings different requirements, which should be satisfied on the premise that project should be accomplished successfully offering for more focus in project management academic field that how to deal with conflicts from different stakeholders' conflicts in categorical manner (Wang et al., 2009).

Mainardes et al. (2012) defended that mutual influence and participation were found to be important in explaining the organization and stakeholder relationship where just like simplifying stakeholder classification and in explaining the relationships between parties, it has found out to be interesting to further simplify the conflict categories in a project management organizational context. In this context, it is correspondingly necessary to target research on aspects such as conflicts of interest between stakeholders and management in coping with multiple objectives of the projects (Mainardes & Raposo, 2011).

Carney et al. (2011) have furthermore pointed out that the stakeholder management literature is dominated by the 'shareholder value' and 'inclusive stakeholder' views of the corporation focusing on inter-functional conflicts between stakeholder groups, e.g. between investors and managers or managers and employees with an idealized corporate structure. It is characterized by the separation of ownership from management, while the modality of conflict varies by system; substantial intra-functional conflict is endemic to each. Carney et al. (2011) critically uplifted the intra-stakeholder type of conflict in various organizations and provide a basis for understanding their various manifestations and consequences under the different systems of governance lacking the context of project management approach clearly subjects to further research (Carney et al., 2011).

Having said this, such different phenomena of stakeholder-centric constructions and compositions of conflicts pose an interesting research exploration into the project management landscape and contemporary literatures laying the foundation for prototyping the potential typology of conflicts from multifaceted perspectives (Adderley & Mellor, 2014; Ayuso et al., 2014; Carlon & Downs, 2014; Chakhar & Saad, 2014; Garriga, 2014; Golob & Podnar, 2014; Hörisch et al., 2014; Moriarty, 2014; Ni et al., 2014; Oriordan & Fairbrass, 2014; Retolaza et al., 2014; Scheer et al., 2014; Yang et al., 2014). The problem formulation thus depicts the clear-cut research gap in understanding the typology, categorization and classification of conflicts relevant to the project management domain at a meso level of analysis as focused on an organization's project management context.

1.4 Purpose

In order to meet up with this research gap, the purpose of this study is to describe the categories of conflicts in a project management context through a literature review.

2. Methodology

2.1 Positivist / Social Constructivist standpoints for Critical Realism

From the ontological philosophical standpoint, which is the view of reality (6 & Bellamy, 2012), this study is mainly developed and approached from a positivist viewpoint. 6 and Bellamy (2012) have asserted that under the

philosophical position of positivism, inferences can only be drawn from the observable facts and correlation or association (but not causation) can be observed with the underlying factors. By attempting to typify the observed types of conflicts among project stakeholders, the researcher is inclined more toward positivism in terms of ontology, which is mostly about data creation and collection (6 & Bellamy, 2012).

Again from the epistemological philosophical standpoint, which is the view of knowledge (6 & Bellamy, 2012), this study is mainly developed and approached from a social constructivist

viewpoint. 6 and Bellamy (2012) have asserted that under the psychological position of social constructivism, individual's learning the meanings of the concepts is focused upon together with how individuals develop understandings and ways of framing issues. By analyzing the observed types of conflicts among project stakeholders with the typological meanings argued by the researcher, it has become more inclined toward social constructivism in terms of epistemology, which is mostly about data analysis (6 & Bellamy, 2012).

Combining together this ontological and epistemological standpoint on positivist and social constructivist viewpoints respectively, this altogether constitute the critical realism approach of the researcher to address the reality of this study. Critical realism stands for both philosophically sophisticated and psychologically forward looking approach (Rom, 2009), and develops a qualitative study of causality in contrast to empirical study of causality (Schilbrack, 2014). Critical realism embraces that there is a reality which exists independent of its individual's conception, and thus unobservable and underlying events might cause the observable facts and facets, which entails that the social world can be understood through the structures that generate such unobservable events (Phillip et al., 2007). Critical realism approach therefore requires a profound understanding of the given situation, going beyond the observable and exploring the design behind any scenario (Schilbrack, 2014; Rom, 2009; Phillip et al., 2007). By going beyond the existing (observable) conflicts among project stakeholders in order to describe the types of conflicts (unobservable) with a qualitative study of associations, the researcher is inclined more toward critical realism perspective in terms of combined ontological and epistemological standpoint overall.

2.2 Descriptive Inference

In the field of social science, it is not possible to observe everything solely and hence researchers must make inferences (6 & Bellamy, 2012), consequently the inference of this study is to describe. In this context, typology and taxonomy constructions are progressively used as part of descriptive inference in various fields of research, including organizational contexts (Da Silva, 2013). Even though there remain slight distinctions between taxonomy and typology, nonetheless in academic research these terms are regularly used synonymously and found in many fundamental studies. For instance, Da Silva (2013) argued that conceptually developed configurations are called typologies, whereas empirically derived configurations are put forth as taxonomies. Da Silva's (2013) theoretical framework therefore suggests that taxonomies mainly generate homogeneous groups taking into account interactions among multidimensional variables, while typologies focus on non-variable oriented conceptual, thematic and qualitative categorization. In this context, typology is the core essence of this study which is conceptually developed on descriptive inference in order to describe and categorize conflicts on thematic, qualitative and conceptual proceedings.

2.3 Inductive Role of Theory

Without a theoretical framework and a conceptual model, this study utilizes theories to pre-understand the theoretical basis of conflicts among project stakeholders; as such the level of inductivity of the research seems to adopt the theory building approach, which is the inductive role of theory (6 & Bellamy, 2012). This is processed as per 6 and Bellamy (2012) that an inductive approach starts with a question that leads straight to data collection, with no real idea of what might turn out to be plausible (6 & Bellamy, 2012). In contrast, the theory testing approach, which is the deductive role of theory, is not relevant for the context and scope of this study as the types of conflicts among project stakeholders are not available beforehand to hypothesize, but only after inductively reviewing the observed literatures to be theorized at the end of this research (6 & Bellamy, 2012).

2.4 Qualitative Data and Analysis type

With a literature review research design, the type of data and analysis of this study is mainly literature based and qualitative from a theoretical standpoint to finally come up with concrete categorical conclusions for further research. As the understanding of the conflict types can be codified as qualitative dataset, whereas the description embodies the qualitative analysis to typify the conflict types among project stakeholders qualitatively, thus the type of data and analysis of this study is both suitably qualitative (Silverman, 2011). Literature review is considered a handy methodology to get in-depth understanding on a research subject; thereby systematic qualitative assessment of published articles can help the researcher in identifying the conflict types among project stakeholders effectively (Silverman, 2011). As per the descriptive inference and inductive approach, the main data collected for this study is secondary data from existing studies about stakeholders in project management in order to understand and typify the conflict types among project stakeholders allowing the researcher to understand, interpret and explore in line with the purpose of this study (6 & Bellamy, 2012).

3. Methods

3.1 Data creation methods

Data creation methods refer to actions of building raw material for further examination (6 & Bellamy, 2012). Therefore, in the context of this study data is created through reviewing literature, which included academic textbooks, academic journals and peer-reviewed articles. Utilizing the core keywords, e.g. “stakeholder”, “project management” and “conflict” – the exploration of data began delving into the summon engine at MAH bibliographic database, and concurrently filtering out the peer-reviewed articles from

academic journals based on maximum relevancy with regard to abstracts and contents apparently. Newspaper articles, book reviews, and dissertations were eliminated during the data creation process while it was restricted to the social science discipline solely. From an array of articles from bibliographic database, and several rounds of explorations in order to look at the concepts from different perspectives to ensure the variety of input (Silverman, 2011), the core dataset which was created for this study is presented as follows:

Tab. 1: List of core scientific articles as the literature dataset

S/N	Article title	Author(s)	Journal
01	Coping with an unexpected event: Project managers' contrasting sense making in a stakeholder conflict in china.	Tukiainen, S., Aaltonen, K., & Murtonen, M. (2010)	International Journal of Managing Projects in Business, 3(3), 526-543.
02	Incorporating stakeholders' knowledge in group decision-making.	Chakhar, S., & Saad, I. (2014)	Journal of Decision Systems, 23(1), 113-126
03	Learning from conflicts? The relations between task and relationship conflicts, team learning and team performance.	Woerkom, M.v., & Engen, M.v. (2009)	European Journal of Work and Organizational Psychology, 18(4), 381-404.
04	Toward a theory of managing organizational conflict.	Rahim, M. A. (2002)	International Journal of Conflict Management, 13(3), 206-235.
05	Learning from multi-stakeholder networks: Issue-focused stakeholder management.	Roloff, J. (2008)	Journal of Business Ethics, 82(1), 233-250
06	The principle of good faith: Toward substantive stakeholder engagement.	Dawkins, C. E. (2014)	Journal of Business Ethics, 121(2), 283-295.

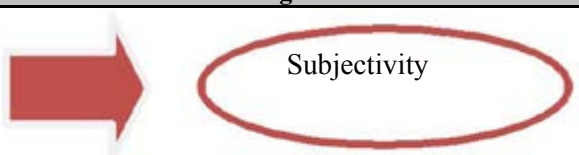
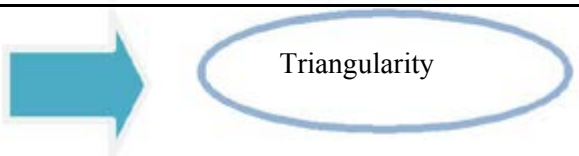
3.2 Data collection methods

Data collection methods refer to actions of capturing what is essential for answering the research question with regard to the purpose of the study (6 & Bellamy, 2012). Aiming at gathering substantial amount of knowledge from the selected and sorted out articles in terms of qualitative data as justified beforehand, all the articles were printed out and read out thoroughly to demarcate the relevant parts on conflicts among project stakeholders which posed interesting relevancy for this study (Silverman, 2011). This demarcation proved useful to order, highlight and pinpoint necessary data regarding conflict types among project stakeholders based on the thematic relevancy of this study that constitute the theoretical sampling for data collection (6 & Bellamy, 2012; Silverman, 2011).

3.3 Data coding methods

Data coding methods refer to actions of classifying the information under thematic categories with regard to the purpose of the study (6 & Bellamy, 2012). In order to look at the concepts from different perspectives on conflict among project stakeholders to ensure the variety of input (Silverman, 2011); the final stage of coding is presented as follows:

Tab. 2: Concepts leading to categories as part of coding

Concepts	Categories
Sense making processes	
Cultural diversity and backgrounds	
Decision making complexity / differences	
Different choice and preferences / priorities	
Systems and processes	
Norms and objectives	
Learning systems	
Team relations and defined tasks	
Project networks	
Inter-organizational projects	
Multi-stakeholder networks	
Partnership issues / cross-sector collaborations	

3.4 Data organizing methods

Data organizing methods refer to actions of laying out whole sets of data that have been created, collected and coded accordingly with regard to the purpose of the study (6 & Bellamy, 2012). In order to arrange the concepts from different perspectives on conflict among project stakeholders, the data was organized through tabulation that enabled coding to be less time consuming and highly efficient. Setting up linkages to organize the data has been proved useful to link up the aspects of conflict among project stakeholders from selected research, while also cross checking the coverage of all the inputs concerned (Silverman, 2011).

3.5 Data analyzing methods

Data analyzing methods refer to actions of identifying important patterns where data is manipulated with regard to the purpose of the study (6 & Bellamy, 2012). The analysis method used in this study is desk research together with content analysis and it is basically analysis and synthesis of already existing aforesaid literature defended beforehand through

codes, concepts and categories. In analyzing methods, the data was developed to reflect multifaceted ideas inductively inspired by a grounded theory analysis approach to add value to the research (Silverman, 2011). Therefore, the data analysis in this research was approached from grounded theory using groundwork concepts from theories in interaction with the findings of the literature review above with regard to conflict among project stakeholders (Silverman, 2011).

3.6 Validity and Reliability of the research

Depending on the ontological and epistemological standpoint on positivist and social constructivist viewpoints respectively, which altogether constitute the critical realism approach of the researcher, this study provides the similar shoes, viewpoints and lenses to other researchers to see the reality and knowledge of the conflicts among project stakeholders in the same understanding and light. Depending on the fundamental and foundational type of this research, it will pave the path for further research as well, disregarding the negligible differences which might occur due to the subjectivity of the researchers in their own constructions.

3.7 Ethics and Quality of the research

The ethical considerations of the study have been respectfully regarded, which ensures the quality of this research as well. In doing so, developing conflict types among project stakeholders without distorting information and respecting intellectual properties have remained a key concern of this research. Furthermore, to establish the overall quality of the research, the types have also been discussed relevantly as and when needed underpinned by relevant theories, and the selection of literature dataset is kept as representative as possible to look at the concepts from different perspectives to ensure the variety of input (Silverman, 2011).

3.8 Delimitation of this study

The research has been limited to the broader types of categories of conflicts among project stakeholders based on the constructions of the researcher, disregarding the possibility of sub-categories which is subject to further research.

4. Analysis, Results and Discussions

4.1 Type 1: Subjective Conflict among project stakeholders

Managers' responses in unexpected events in international project groups largely depends on their sense making processes where project managers develop some sort of sense regarding

what they are up against, what their own position is relative to what they sense, and what they need to do in the project team (Tukiainen et al., 2010). Based on this notion toward coping with uncertainty in teams, the main proposition of this research is that project managers' sense making processes are highly subjective, leading to the coexistence of multiple, and highly conflicting responses to the unexpected event (Tukiainen et al., 2010). Further to this, the paper also focuses on how the sense making processes between project managers coming from culturally different backgrounds can yield highly contrasting interpretations and responses to the same event given the international project team setting (Tukiainen et al., 2010). Summing up the propositions of this article as concluded by Tukiainen et al. (2010), the overall findings suggest that different interpretations and enactments of the unexpected event are able to carry on concurrently in an international project team.

Depending on the contemporary literature review on conflicts, Witmer (2015) presented that "Human Relations view of conflict" considers conflict a natural and inevitable outcome in any group. In this natural process, where conflict is bound to take place in a homogenous group, having conflicts in heterogeneous groups is more inevitable (Rogan, 2006) in line with the finding of Tukiainen et al. (2010). Leader-Member Exchange (LMX) Theory as elucidated by Northouse (2013) points out the distance between leader and member as a prospective reason of having in-group conflicts, whether that distance is due to communication gap or preferential associations toward project leader, or even lack of social climate in the group (Muhonen et al., 2013). Likewise, in the context of an international project team, the cultural differences which disassociate members might play a vital role in hampering the sustainable nature of the project (Silvius et al., 2012), which in the long run will create conflicting sense making by different project members in the same group (Jehn & Mannix, 2001). In line with the article findings of Tukiainen et al. (2010), project members sense risks and unprecedented scenarios differently which therefore requires a collaborative understanding among the team members since the outset of the project (Cobb, 2012). The structure of teamwork is so diverse as argued by Crawford and Lepine (2013) that the diversified views in the form of healthy discussions from divergent viewpoints constitute a sustainable development of the team in the long run. Managing this diversity of team in producing multiple viewpoints and sense making processes to understand different scenarios ultimately contributes to the team success benefitting all the members (Hayes, 2001).

Likewise, Chakhar and Saad (2014) distinguishes and discusses several elements characterizing the group decision-making process regarding extracting, combining and communicating multi-stakeholder preferences given complex group dynamics and decision systems. Summing up the propositions of this article as concluded by Chakhar and Saad (2014), the noteworthy findings suggest for (1) mixed aggregation strategies (both input and output oriented) which advocates for collaboration between decision makers, (2) categorized aggregation rules which advocates for consensus between majority and minority of decision makers, (3) preference parameter elicitation techniques (both direct and indirect) which

denotes the level of cognitive efforts from experts in group decision-making process, and (4) weighting of stakeholders for contribution of each decision maker to the collective decision. In this context, the main proposition of this research signifies the importance of acquiring knowledge from multiple sources with solid efforts by the group in order to reach a constructive group decision to avoid conflicts in the long run (Chakhar & Saad, 2014).

The Stakeholder Theory as elucidated by Werther and Chandler (2011) advocates for the integration of multi-stakeholder viewpoints in group's decision making process, which Tolbert and Hall (2009) have argued for preferring the dominant coalition amongst the stakeholders in an organizational development context. In line with the findings of Chakhar and Saad (2014), group decision making process is highly complex and subjective which could depend on the agenda set by the dominant coalition or even participation of the key deciders in the decision making process as per the Garbage Can Model of decision making (Tolbert & Hall, 2009). Depending on the contemporary literature review on conflicts, Witmer (2015) presented that expansion of resources is a key conflict resolution technique which supports the findings of the aforementioned study by Chakhar and Saad (2014) that suggests for acquiring knowledge from multiple sources before group decisions in order to avoid conflict later on. The sustainable development of the organizations largely depends on the effective decision making and integrating the demands of the key stakeholders as proposed by the CSR filter (Werther & Chandler, 2011). In this context, the research by Chakhar and Saad (2014) is interesting to make constructive group decisions integrating organizational stakeholders and maximizing group efforts for the sustainable development of the organization. The collaboration between group members is a key prerequisite to take the project to its set goal (Cobb, 2012), and "management for stakeholders" is of paramount importance to ensure the sustainability of the organizations (Silvius et al., 2012), which this article has concluded by proposing collaboration between decision makers, consensus between majority and minority groups and weighting of stakeholders for contribution of each decision maker to the collective decision (Chakhar & Saad, 2014).

Depending on this amount of subjectivity in the project teams, project members sense risks and unprecedented scenarios differently (Tukiainen et al., 2010) giving rise to subjective conflict among project stakeholders. This therefore requires a collaborative understanding among the team members since the outset of the project (Cobb, 2012). Synthesizing this with the findings of Chakhar and Saad (2014), group decision making process is highly complex and subjective and thus acquiring knowledge from multiple sources before group decisions in order to avoid conflict later on is inevitable for project success and sustainable development of the organization. Summing up the propositions of the articles as concluded both by Tukiainen et al. (2010) and Chakhar and Saad (2014), the overall findings suggest that different interpretations and enactments of the unexpected event are able to carry on concurrently in an international project team (Tukiainen et al., 2010), which requires solid efforts by the group as a whole in order to reach a constructive group decision holistically

and collaboratively to avoid conflicts in the long run as conflicts turn out to be subjective in nature (Chakhar & Saad, 2014).

4.2 Type 2: Objective Conflict among project stakeholders

In contrast, the conflict among the project stakeholders which is not due to subjectivity, rather is concrete due to systems and processes, is understood as objective conflict. Team-based working facilitates collective learning in project organizations contributing to the overall performance of the organization itself (Woerkom & Engen, 2009). Based on this notion toward learning, the main proposition of this research is that one of the core processes that could facilitate team learning is team conflict (Woerkom & Engen, 2009). Further to this, the paper also focuses on how task conflict is not related to team learning but negatively related to team performance; whereas relationship conflict negatively affects team learning (Woerkom & Engen, 2009). Summing up the propositions of this article as concluded by Woerkom and Engen (2009), the overall findings suggest that team learning is a strong predictor of the perceived team performance and partially mediate the relation between relationship conflict and performance as part of organizational learning.

Management of organizational conflict involves organizational learning at all the interpersonal, intra-group and intergroup levels inside a learning organization (Rahim, 2002). Based on this notion, the main proposition of this research is to determine the type of intervention needed in: (a) maintaining a moderate amount of substantive (group) conflict in non-routine tasks, (b) reducing affecting (personal) conflict in all levels and (c) enabling organizational members to select apt styles of handling conflicts so that various organizational situations can be effectively dealt with (Rahim, 2002). Further to this, the paper also focuses on the significance of organizational diagnosis in determining the need and type of intervention needed for managing organizational conflicts (Rahim, 2002). Summing up the propositions of this article as concluded by Rahim (2002), the overall findings suggest that organizational learning and effectiveness can be enhanced through an appropriate diagnosis of and process and structural interventions in organizational conflict that seems to be objective in nature.

Depending on the organizational learning systems as objective phenomenon, Lundsten (2015) presented that double loop learning in organizations questions the reasoning behind what went wrong where underlying assumptions, norms, and objectives are open to confrontation (Jehn, 1997; Argyris, 1977). Therefore, double loop learning is adjustable with the theme of conflict playing a critical role in organizational learning itself by opening up the organizational platform for questioning and confrontation as also suggested by Woerkom and Engen (2009) in this selected article where one of the core processes that could facilitate team learning is deemed as team conflict. Likewise, in the context of an organizational set-up, the conflicting differences which disassociate project members (Cobb, 2012) might play a vital

role in hampering the sustainable nature of the learning process (Silvius et al., 2012), which in the long run will diminish the sustainable value of the organizations (Hart & Milstein, 2003) in line with the findings of Woerkom and Engen (2009) in the given article. As team learning is a strong predictor of the perceived team performance (Woerkom & Engen, 2009), organization learning can cater to the concept of sustainable organizational development by focusing on effective team relations inside the organizations which ensure sustainable information sharing and communication process (Santos-Vijande, 2012; Jehn, 1997). Therefore, depending on the organizational systems, processes and policies – this gives rise to the objective conflict among project stakeholders.

4.3 Type 3: Triangular Conflict among project stakeholders

In contrast, the conflict among the project stakeholders which is triangular due to project networks and involving more actors in the project networks is understood as the triangular conflicts among the project stakeholders. Keeping the network perspective as a linchpin, Roloff (2008) has focused on the way projects that collaborate in multi-stakeholder networks organize their stakeholder management arguing that it differs significantly from approaches used by companies that are not engaged in collaboration with their stakeholders. Based on this notion toward inter-organizational collaboration, the main proposition of this research refers to the typical life cycle of multi-stakeholder networks and thus coins the issue-focused stakeholder management that affects relationship with other societal groups and organizations depending on an analysis of the role of organizations in multi-stakeholder networks and a critical review of stakeholder theory (Roloff, 2008). Summing up the propositions of this article as concluded by Roloff (2008), the overall findings suggest that issue-focused stakeholder management dominates in multi-stakeholder networks, because it enables corporations to address complex problems and challenges in collaboration with stakeholders (Roloff, 2008).

Depending on the inter-organizational collaboration, Caullier-Gustavsson (2015) pointed out that an inter-organizational project is embedded within its environment; it depends on collaborations between participants who furthermore share risks and ensure resources to develop and deliver products and services (Bakker et al., 2010; Bryson et al., 2006). In this context, inter-organizational collaboration paves the path for a networked environment of the key participants critical to the organizational growth as also suggested by Roloff (2008) in this selected article by uplifting the multi-stakeholder networks based on issues of the participants. Likewise, in the context of an organizational network perspective, the conflicting differences which disassociate members (Cobb, 2012) might play a vital role in hampering the sustainable nature of the network's learning process (Lundsten, 2015; Silvius et al., 2012), which in the long run will diminish the sustainable project leadership (Kaulio, 2008) in line with the findings of Roloff (2008) in the given article. This gives rise to the triangular conflicts among the project stakeholders in the project networks.

In order for cross-sector collaboration involving multi-stakeholder networks (Bryson et al., 2006), it has been argued by Roloff (2008) that most multi-stakeholder networks are tripartite which means that representatives from business, civil society and the state participate at some stage in the network process where different actors emerge in order to address a specific issue or problem that concerns actors from different societal spheres. Depending on this, the issue-focused stakeholder management that dominates in multi-stakeholder networks as proposed by Roloff (2008) eventually contributes to the sustainable development of the inter-organizational collaboration in line with the CSR filter that prioritizes the issues of the stakeholders in strategies (Werther & Chandler (2011; Roloff, 2008; Bryson et al., 2006). When the issues of the stakeholders in the networks pose conflicts, then this gives rise to the triangular conflicts among the project stakeholders in the project networks.

In this context, keeping the trust orientation as the essence of this article, Dawkins (2014) has focused on strengthening the normative stakeholder theory through a more vigorous notion of stakeholder engagement derived from the concept of good faith (Dawkins, 2014). Based on this notion toward inter-organizational stakeholder collaboration, the main proposition of this research positions good faith stakeholder engagement as a form of substantive stakeholder input that realizes power asymmetries among networks while providing mechanisms dissolving those disparities toward stakeholders' greater impact on distributive outcomes (Dawkins, 2014). Summing up the key learning of this article as concluded by Dawkins (2014), the overall findings suggest that characteristics of good faith as dialogue, negotiation, transparency, and totality of conduct mobilize the stakeholder collaborations and relations in a network perspective (Dawkins, 2014). Stakeholder engagement based in pluralist notions of conflict resolution and modeled on the principle of good faith can thus sustain the inter-organizational networks effectively as argued by Dawkins (2014) in this given article. In order for building trust in inter-organizational projects (Maurer, 2010), this trust is facilitated through a number of trust building factors which Dawkins (2014) have put forth as processes of dialogue, negotiation and arbitration further complementing the research of Maurer (2010) and Paasovaara and Lassenivs (2003) on building trust between several parties. Depending on this, good faith stakeholder engagement in multi-stakeholder networks as proposed by Dawkins (2014) eventually contributes to the sustainable development of the inter-organizational collaboration in a network perspective. When this trust is remained unmet, then this gives rise to the triangular conflicts among the project stakeholders in the project networks.

5. Conclusion

Depending on the amount of subjectivity in the project teams, project members sense risks and unprecedented scenarios differently (Tukiainen et al., 2010) giving rise to subjective conflict among project stakeholders. Apart from that, group decision making process is highly complex and subjective which leads to acquiring knowledge from multiple sources

before group decisions in order to avoid conflict later on. Different interpretations and enactments of the unexpected event are able to carry on concurrently in an international project team (Tukiainen et al., 2010), which requires solid efforts by the group as a whole in order to reach a constructive group decision holistically and collaboratively to avoid conflicts in the long run as conflicts turn out to be subjective in nature (Chakhar & Saad, 2014). The focal point for project managers is this type of subjective conflict among project stakeholders.

Depending on the amount of objectivity in the project teams, team learning is a strong predictor of the perceived team performance (Woerkom & Engen, 2009), therefore organization learning can cater to the concept of sustainable organizational development by focusing on effective team relations inside the organizations which ensure sustainable information sharing and communication process (Santos-Vijande, 2012; Jehn, 1997). Therefore, depending on the organizational systems, processes and policies – the focal point for project managers is this type of objective conflict among project stakeholders.

Depending on the inter-organizational project collaboration, an inter-organizational project is embedded within its environment; it depends on collaborations between participants who furthermore share risks and ensure resources to develop and deliver products and services (Bakker et al., 2010; Bryson et al., 2006). Considering the "lack of faith" amongst the network participants as a "critical issue" requiring immediate attention, Dawkins (2014) and Roloff (2008) both complement each other's research and thus synthesize altogether as good faith serving the best issues in and around the multi-stakeholder organizational networks (Dawkins, 2014; Roloff, 2008). The focal point for project managers is this type of triangular conflict among project stakeholders.

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Climate Change & Adaptation

Title: Climate Change and Coping Strategies of the Household-Dwellers in Bangladesh
Sanjoy Kumar Chanda

1. Introduction

Climate change carries the changes in characteristics of gradual change phenomenon and natural hazards which consequences changes in the physical, social and production system. Now in the age of industrial aggression nature and society are deeply intertwined. Ritzer (2008) identified that changes in society often affect the natural environment, and those changes, in turn, affect society. Thus, in broad way, today "nature is society and society is also 'nature '" (Beck 1992, p.80). Moreover, in the extent of climatic impact, still developing countries are more vulnerable compare to developed (CCC 2010). Impact of climate change in the rural society of Bangladesh is an enduring phenomenon and it has become significant after the beginning of 21st century. Frequency and intensity of natural disasters are likely to increase especially in the coastal part of the country. The socioeconomic condition of the climate affected region devastated enormously. Several early evidences of the above phenomenon and its associated impacts in the agriculture, health, water and sanitation, biodiversity are already visible in Bangladesh. It is estimated that climate change could affect more than 70 million people of Bangladesh due to its geographic location, low elevation, high population density, and poor infrastructure, high levels of poverty and high dependency on natural resources (UNDP 2007). It is evident that the population living in coastal area is more vulnerable compare to the population in other areas (Alam and Murray 2005). Coastal resources upon which the most people depend are likely to be affected severally due to climate variability and change (OECD 2003).

Being Bay of Bengal is an ideal breeding ground for tropical cyclones; the coastal areas have been facing frequent severe disaster every year (Islam 2011) and cyclone Aila is a great example of it. Super cyclone Aila as a leading climate disaster has affected in the south west coastal region of Bangladesh. It is formed as a deep depression in the west central Bay. It has been hitting in the southwest coast in 4.30 pm to 7.45 pm on 25 May 2009 (Shushilan 2009). South-west region of Bangladesh were seriously affected as Aila founded a tidal surge to break through embankments, destroying hundreds of thousands of homes and outnumber of people were killed and injured (Ahmed et al. 2009). Similarly, MoHFW (2009) reported that no household left to be severely affected of three districts of southern part of Bangladesh by the cyclone Aila in 2009. Moreover, several problems including physical illness, food crisis, and breaking down the family life are identified in the coastal area after Aila (Azad and Khan 2015). Theoretically the impact of cyclone Aila can be understood from the ground of both basic and superstructure in Marxian term. Moreover, the impact of cyclone is clear in 'materialist model' depicted in Black Report in the UK as, "the …diffuse consequences of the class structure: poverty, work conditions…and deprivation in its various forms in the home and immediate environment at work, education and the upbringing of children and more generally in family and social life" (Black et al. 1982, p.134).

Reducing the vulnerability, it needs group action from 'collective conscience' (Durkheim 1893/1964). When people take action to cope with the adverse situation, they maintain some logics that are rooted consciously or unconsciously. This is related to habitus and Bourdieu explains it as 'structured structuring structure' (Bourdieu 1990: 53). Recognition of adverse impacts of climate change on economic development, life and livelihoods of the poor and ultimately impeding Millennium Development Goals (MDGs) has pushed urgent need for adaptation to deal with unavoidable impacts of climate stimuli including variability and extreme events in Bangladesh (MoEF 2009). Addressing the impact of cyclone on the livelihoods of people and the capacity and opportunities for quick recovery and increased resilience to future events is a vital part of the response to disaster (Chowdhury 2012). But Aila-affected people, at present, has shown poor capacity to adapt with the deep consequences of disaster risks and residents still live with critical vulnerable conditions, namely social (waning social togetherness), economic (declining of plants, shrimps and fisheries) and institutional (seldom access to community clinics) (Saha 2013). Similarly, Rahman (2015) reported that six years after cyclone Aila killed at least 200 people in Bangladesh and households in coastal districts of Khulna and Bagerhat are suffering from different problems, drinking water crisis is one of them.

In response to the impending problem, this study has been carried out in the cyclone Aila affected area in Bangladesh. Decision makers need to know the extent of impact and the coping strategies people use to avert increased vulnerability to formulate an effective program of action in the infrastructure, socioeconomic and agriculture for household-dwellers. With a view to improve the livelihood condition of Aila affected household-dwellers, my study tries to unpack specific impact of Aila and the coping strategies. Later the recommendations are given based on empirical findings to fulfill the aim of the study. The present study contains three research questions: (a) what coping strategies are taken by household-dwellers for infrastructure development after Aila? (b) what coping strategies are determined to recover socioeconomic need?; and (c) what coping strategies are observed for agriculture?

This article structurally consists of five sections. After the introduction, the second section provides an overview of the method and materials. The third section depicts the empirical result about the impact of climate change and coping strategies of household-dwellers. Afterwards, fourth section looks at discussion where meaning of the data is presented. The final section sums up the identified impact and coping strategies in the south-western coastal area in Bangladesh and discusses the implications, recommendations, shortcomings and future agenda.

2. Methods and materials

2.1. Study Design

This is a quantitative study and descriptive in nature. This quantitative study permits to measure association between groups and subgroups of variables. In the epistemological

sense, this study shows how the variables have relationship with each other. This study provides opportunity to measure variable through determining scale to increase validity and reliability. In this phase, the study was conducted through the use of survey method in 2015. Here survey method was chosen as it would connect the information of more variables to answer research questions and to make generalization.

2.2.Samples

Ward No. 1 of Kamarkhola union at Khulna district in Bangladesh was selected purposively as it is totally cyclone Aila affected among total nine wards of this union. Afterwards, the total Aila affected households of ward No. 1 was collected from union parishad, local administrative unit, and affected households were counted 467 (Six No Kamarkhola Union Parishad 2015). Then, lottery procedure under random sampling was used to draw 120 samples from this list that represents 25 percent of the total affected households of that ward. In this study 25 percent was selected as it would reduce sampling error and correctly represent the whole population.

2.3.Variables and Measures

Variables that are used for this study are identified from different aspects of impact and coping strategies as well as the relation of specific coping strategy with specific impact of cyclone Aila in Bangladesh. With a view to maintain validity and reliability, appropriate statistical measurements are used to measure every variable for this study. Now it is first revealed the name of every subheading used in the result and followed by the variables, its measurement and coding process. H**ouse damage and coping strategies**: *coping strategies* were nominally measured and coded as 1= embankment, 2= relative house, 3= community shelter and 4= own broken house and *types of household damage* were measured nominally and coded as 1=fully damage, 2=partial damage and 3=small damage. **Coping strategies of making of house:** *coping strategies* were nominally counted and coded as 1= GO and NGO support, 2= support of relatives, 3. Own effort, 4= involvement with politics, 5= illegal connection with aid distributor and 6= taking loan. B**arriers of child education and coping strategies**: *coping strategies* were nominally measured and coded as 1=home studying, 2=boat using, 3=late schooling, 4= paying low tuition fee and 5= group sharing, and *problems of education for Aila* were typified by three categories and coded as 1=disruption of communication, 2= money shortage and 3= lack of logistic support. **Disruption of health and coping strategies:** *coping strategies* were nominally measured and coded as 1= depending on traditional medicine, 2= depending on modern medicine and 3= no treatment, and *types of health effects* were typified into four categories and coded as 1= malaria, 2= *kalazar,* 3=injury and 4= skin diseases. **Monthly income after Aila and coping strategies:** *coping strategies* were nominally measured and coded as 1= taking of daily low food, 2= stopping education of children, 3= borrowing money, 4= aid taking and 5= depends on relatives' support, and *income after Aila was* counted using scale and coded as 1= &1-$60, 2= $61-$120 and 3= $121-$180. **Coping strategies to overcome the loss of fish:** *coping Strategies* were nominally measured and coded as 1= raising pond embankment, 2= changes species, 3= pond fencing by net. **Decrease of crops yielding and coping strategies***: coping Strategies* were nominally measured and coded as 1= cultivation of hybrid crops, 2= using

traditional knowledge, 3= using modern technology, 4= receiving GO & NGOs instructions, and 4= no strategy; and *factors of no crops yielding* were counted in nominal scale and coded as 1= submerged, 2= salted, 3= lack of tools and 4=loss of land fertility. **Damage of forest and coping strategies**: *coping strategies we*re nominally measured and coded as 1=afforestation, 2= plantation of deep rooted trees, 3= plantation in highland and 4= dyke plantation, and *types of damage* were typified as 1= full and 2= partial.

2.4.Instrument and Procedure

An interview schedule as an instrument was developed to collect data from 120 samples from the village Kamarkhola. A pilot survey was conducted to check the valid scales of measurement and scrutiny of irrelevant questions before making final interview schedule. To realize the objectives of the study, data about respective concepts were collected incorporating relevant cases in the interview schedule contained both open and close ended items. Data were collected by four trained interviewers. Oral consensus of informants was ensured maintain ethical issue before gathering information. Few times were spent to build up rapport with informants and then the interview started.

2.5.Statistical Analysis

Field data were analyzed using SPSS (statistical package 20) and Excel. Both descriptive (percentage) and inferential (chi square) statistics were used for data analysis. Results on the variables were presented with cross tables and figures. The statistical analysis was conducted at 95% confidence level. P value less than 0.05 was considered statistically significant. Besides, some relevant secondary information was used for this study as well.

2.6. Why Household-Dwellers?

Here is chosen to find the coping strategies at household-dwellers as this study intends to explore the collective action of human being in response to climate change. Earlier study supports a long history within sociology of discovering multifarious results at household level (Entwisle 2007; Sampson et al. 2002). In addition, sociological theory, tools and techniques also support finding out how people respond in local settings. The prominent sociologist Emile Durkheim advocates that the social world constitutes a reality of its own, above and beyond the lives and experiences of individual persons. In view of that, macro-sociological theories have been interested in explaining collective rather than individual behavior (Siegrist and Marmot 2004). Durkheim characterized the collective conscience in the following way: “The totality of beliefs and sentiments common to average citizens of the same society forms a determinate system which has its own life; one may call it the collective or common conscience. . . . It is, thus, an entirely different thing from particular consciences, although it can be realized only through them” (Durkheim 1893/1964, pp.79–80). Both classical and contemporary sociologists have contributed emphasizing this approach to find social fact in the society. So, considering the importance of collective vision, I try to incorporate the prime concern of sociology lingers at the level of collective (social) phenomena.

3. Results

In this section, empirical results are presented that contain the information of both impact and coping strategies in the aspects of (1) infrastructure, measured in house, (2) socioeconomic, measured in child education, health and income, and (3) agriculture, assessed in fish, crops and forest.

3.1. House damage and coping strategies

House as infrastructure is the first and foremost requirement for the people to survive. Cyclone Aila in Bangladesh damaged the all houses. On the one hand, types of house damage as independent variable, divided into three types incorporating full, partial and small, are shown in rows of table 1. On the other hand, column of the similar table contains data of dependent variable-coping strategies that has been broken into four, namely embankment, relative house, community shelter and own broken house.

Tab. 1: Coping strategies of the place of dwelling by types of house damage

Types of House Damage	**Coping Strategies**				
	Embankment	Relative House	Community Shelter	Own Broken House	**N**
Full Damage	86%	6%	8%	.0%	(95)
Partial Damage	60	5	15	20	(20)
Small Damage	.0	.0	.0	100	(5)
Total	78	6	8	8	(120)

Pearson Chi-Square Value: 23.243; P<0.001

Data in table 1 indicate that the maximum 86 percent household-dwellers chose embankment as coping strategy for living place when they experienced full damage of house by Aila, by contrast nobody had scope to stay in their own house. Again, the highest 60 percent among affected people by partial damage of house preferred embankment to cope with living, with the following 20 percent for own broken house. All people of small damage type managed shelter with their own broken house. Finally, for the case of partial damage, household-dwellers adopted possible four coping strategies and it dropped to three for full damage and only one was observed for small damage. Therefore, it is clear that coping strategies of household-dwellers differ according to their types of affect of Aila. Here $p<0.001$ statistically proves that coping strategies of the places of dwelling and damages of house are significantly associated.

2.6.Coping strategies of making house

Figure 1 shows the information of six strategies taken by household-dwellers to rebuild house during post Aila. Data indicate that the maximum 28 percent of the total household-dwellers took support of their relatives. Taking loan, and GO and NGOs support were almost same

that were counted 20 percent and 19 percent respectively. Moreover, political involvement (9%) and illegal connection with aid distributor (7%) were observed as strategies to have money of household-dwellers. Finally 17 percent household-dwellers showed their own effort to rebuild house.

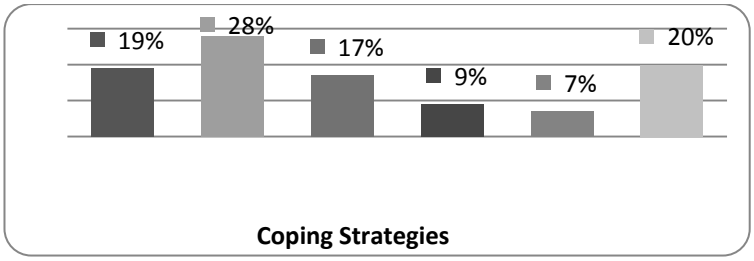


Fig. 1: Strategies of collecting money for house building (N=120)

3.3. Barriers of child education and coping strategies

Children in cyclone Aila affected 99 households of Kumarkhola experienced various barriers continuing study after cyclone Aila. So children take coping strategies against conditions after Aila so that they can overcome the loss of study. In this study, on the one hand, conditions after Aila as an independent variable divided into three categories, including barriers of communication, money deficiency, and lack of logistic support has been shown in rows of table 2. On the other hand, coping strategies as a dependent variable broken down into five criteria, namely home studying, boat using to go to school, missing year of starting school, providing lower tuition fee, and sharing study with peer group has been shown in columns of the same table. Here N represents the total number of respondents in row and Total gives information of mean percentage of column.

Tab. 2: Coping strategies for recovering the loss of education by post-Aila barriers of child education

Post-Aila Barriers of Child Education	Coping Strategies					N
	Studying Home	Using Boat	Late Schooling	Paying Lower Tuition Fee	Group Sharing	
Disruption of Communication	43%	18%	18%	15%	6%	(67)
Money Shortage	52	13	13	18	4	(23)
Lack of Logistic Support	33	11	41	5	10	(9)
Total	45	16	19	14	6	(99)

Pearson Chi-Square Value: 6.452; P<0.001

Data in table 2 illustrate that the highest 43 percent and 52 percent children in household continued study at home instead of presenting at school when they faced disruption of communication and money shortage of family respectively. Again, the highest 41 percent of households' children dropped their studies while they encountered lack of logistic support, with the following 33 percent for studying at home. Moreover, the tendency of using boat as

a traditional vehicle, paying lower tuition fee and peer group sharing about study of children were observed to recover the loss of study as well. In addition, $p<0.001$ shows the significant relationship between post-Aila barriers of child education and coping strategies.

3.4. Disruption of health and coping strategies

Another social category health has immense impact in human life. Following Aila, 113 out 120 household-dwellers experienced disruption of health were shown in various types of health effects. Types of health effects as independent variable have been shown in rows of table 3 and coping strategies as dependent variable divided into three categories, depending on traditional medicine, modern medicine and no treatment, are depicted in column of the same table. Here N represents the total number of respondents in row and Total gives information of mean percentage of column. Data contain in table 3 shows that household-dwellers having four types of health effects of cyclone Aila took three types of coping strategies, and traditional medicine was counted the highest in average among all strategies. However, for injury and skin disease, household-dwellers could not depend on all types of coping strategies. In the case of skin disease, household-dwellers depended on two strategies: traditional medicine and no treatment. Here $p<0.000$ represents the significant relationship between coping strategies to overcome the health conditions and types of health effects. Here it is also alarming that total 23 percent could not participate in any treatment.

Tab. 3: Coping strategies to overcome health conditions by types of health effects after Aila

Types of Health Effects	**Coping Strategies**			**N**
	Depending on Traditional Medicine	Depending on Modern Medicine	No Treatment	
Malaria	46%	33%	22%	(55)
Kalazar[1]	44	30	27	(34)
Injured	35	47	18	(17)
Skin Disease	71	.0	29	(7)
Total	45	24	23	(113)

Pearson Chi-Square Value: 26.344; P<0 .000

3.5. Monthly income after Aila and coping strategies

Household-dwellers took various coping strategies to maintain family according to different range of monthly income after cyclone Aila. Independent variable-monthly income- after Aila categorized into three income ranges is presented in rows of table 4 and coping strategies as dependent variable divided into five criteria, including taking daily lower food, stopping education of children, taking loan, aid taking and depends on the support of relatives

[1] *Kalazar*= One kind of fever occurred due to fear and other unexpected situations.

is presented in column in the same table. Here N represents the total number of respondents in row and Total gives information of mean percentage of column.

Tab. 4: Coping strategies for maintaining family by monthly income of household-dweller after *Aila*

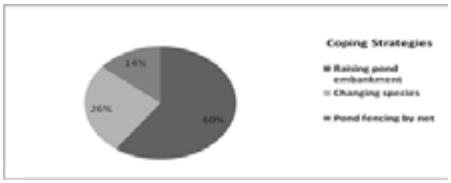
Monthly Income after *Aila* (Counted in USD)	**Coping Strategies**					**N**
	Taking Daily Low Food	Stopping Education of Children	Taking Loan	Aid Taking	Depends on Relatives' Support	
$1-$60	39%	5%	29%	24%	3%	(107)
$61-$120	45	.0	22	11	22	(9)
$121-$180	50	.0	.0	50	.0	(4)
Total	40	4	28	24	4	(120)

Pearson Chi-Square Value: 21.868; P<0.001

Table 4 illustrates that the highest 39 percent, who had income within the income group of $1- $60, took low food for daily meal as coping strategy to manage family, with the following 29 percent and 24 percent for taking loan and aid respectively. Additionally 5 percent and 3 percent people of the same income group stopped their child education and depended on relatives correspondingly. Again the maximum 45 percent respondents, who had income within the income group of $61-$120, took lower food for daily meals that was counted double compared to borrowing money and depending on the support of relatives. In the final group of income ($121a and $180), household-dwellers took only two strategies, namely, taking of daily low food and aid taking, and the percentages were equally divided. It is important that household-dwellers had to take all coping strategies when their income fall in the lowest category ($1-$60) whereas middle income group took four strategies and the highest income group was limited to only two coping strategies. So this empirical observation represents that as the income level of household-dwellers decreases, the coping strategies for maintaining family increases in the cyclone affected area in Bangladesh. Here the p<0.001 also shows the significant relationship between coping strategies for managing family and income after Aila.

3.6. Coping strategies to overcome the loss of fish

Cultivation of shrimp and common fish (Rui, Katla) were the key source of income had been fallen in damage by Aila. It was considered as a money accumulating business. All household-dwellers experienced the damage of fish mostly shrimp and other income generating fish during and after Aila. People of the Aila affected area took three coping



strategies including raising pond embankment, changing species- generating of salinity tolerant, and pond fencing by net to overcome from the loss of fish. Data in figure 2 depict that the uppermost 60 percent household-dwellers accepted to raise the embankment of pond

so that water cannot overflow during cyclone, with the following 26 percent for changing species with taste of water. Remaining 14 percent household-dwellers also used net fencing around pond to keep fish inside when water overflows.

Fig. 2: Coping Strategies for overcoming the loss of fish by Aila

3.7. Decrease of crops yielding and coping strategies

Cultivable land is important to produce crops for surviving of the household-dwellers. Data in table 5 contain information about coping strategies by factors of decreasing crops growing. Here independent variable factors of decreasing crops yielding, divided into four categories, namely submerging, salting, lacking of tools, and losing of land fertility, is presented in rows of table 5 and coping strategies as dependent variable, categorized into five strategies including cultivation of hybrid crops, using traditional knowledge, using modern technology, receiving GO and NGOs information, and no strategy, are shown in column in the similar table. Here N represents the total number of respondents in row and Total gives information of mean percentage of column. This table contains data of 86 households as the land of all households was not decreased.

Tab. 5: Coping strategies for overcoming the loss of production by factors of decreasing crops yielding

Factors of Decreasing Crops Yielding	**Coping Strategies**					**N**
	Cultivation of Hybrid Crops	Using Traditional Knowledge	Using Modern Technology	Receiving GO & NGOs Instructions	No Strategy	
Submerging	41%	6%	9%	17%	17%	(53)
Salting	54	.0	15	8	23	(13)
Lacking of Tools	18	9	46	18	9	(11)
Losing of Land Fertility	89	.0	.0	.0	11	(9)
Total	51	5	14	14	16	(86)

Pearson Chi-Square Value: 47.433; P<0.000

Table 5 depicts that household-dwellers took all four coping strategies when crops yielding was impossible in the case of submerging of land and having not enough production tools. Moreover, three coping strategies were considered when land water was salted during cyclone Aila and only one strategy was taken for reducing of land fertility. Furthermore, cultivation of hybrid crops as coping strategy was counted the maximum among all strategies against all factors of no crops yielding except in the case of lack of tools where the highest (46%) portion of household-dwellers used modern technology. Finally, a portion of household-dwellers could not take any strategy and it was observed for every factor of no crops yielding. In addition, the p< 0.000 indicates that there is significant relationship

between the variables of coping strategies for overcoming the loss of production and the factors of no crops yielding.

3.8. Damage of forest and coping strategies

Figure 3 contains information about types of damage of forest and coping strategies. Figure includes the information of all (120) household-dwellers as the forest of all households was affected by cyclone Aila. Here damage as independent variable divided into full (black color) and partial (gray color), and coping strategies as dependent variable categorized into four: afforestation, plantation of deep rooted trees, plantation in highland and dyke plantation-tree plantation in coastal area to protect tidal of water-, are depicted in figure 3. Data in figure 3 show that the highest 41 percent household-dwellers planted trees on highland when they experienced full damage of forest, with the following 39 percent for afforestation. As is observed, the coping strategies of plantation of deep rooted trees and plantation in highland were counted 30 percent for each when household-dwellers faced partial damage of forest in Kamarkhola village. Finally, dyke plantation was almost same for both types of damages of forest.

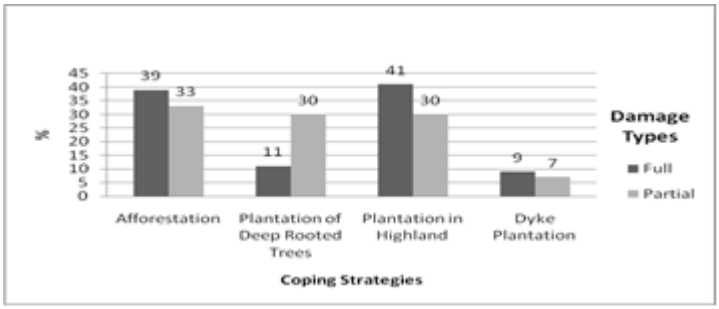


Fig. 3: Coping strategies of overcoming the damage of forest by types of damage

3. Discussion

In the section of discussion, it is presented the meaning of empirical data presented in previous section.

The impact of climate change on infrastructure is clear in Bangladesh. Maximum houses are identified fully damaged after cyclone Aila and people had very few places left for living. Very helpless condition of cyclone affected households is observed. Family members following Aila had to spend a risky life that has similarity with the concept idiosyncratic risk-risks faced by particular households (Ghorpade 2012). To rescue from the backward situation, dwellers have taken coping strategies for two collective aspects: (1) for searching shelter, and (2) for constructing house. For searching shelter, dwellers chose living on embankment, relative house, community shelter, and own broken house. Here we find the variation in the places of dwelling. And variations are observed based on their household vulnerabilities. Empirical data suffice that the greatest number (82) of people who lost all of households chose embankment than other damage groups. Moreover, household-dwellers who build their new household on embankment get support from formal and informal mechanisms. Former mechanism has exchange relation that includes taking loan especially

from bank, microcredit organization and *mahajans*[2] in the village. Latter, informal mechanism include GO and NGOs support, relative's assistance, involvement with politics and illegal connection of household-dwellers. A widespread relief intervention was initiated by the Government, NGOs and national and international humanitarian agencies in immediate aftermath of the cyclone. GO and NGOs support is considered as relief intervention and it incorporates relief materials (foods, household goods, tools, clothes, etc) were distributed for about a couple of years in order to reduce the sufferings of the Aila affected people (Masud-All-Kamal 2013). Moreover, assistance of relatives of household-dwellers is considered another informal social mechanism to recover after cyclone Aila. Societies of Bangladesh are based on a strong kinship system (Quisumbing and Maluccio 2003; Mozumder et al. 2008) and the kinship networks tend to offer support to the relatives in crisis. It is important that coping strategies of household-dwellers as collective actions are originated from the existing social structure in the study area what sociologist Blau (1964) termed 'particularistic'- integrative bonds enhancing unifying function.

In this paper, socioeconomic aspect includes three variables, namely child education, health and income. Education is a social factor for the development of any country. Being Bangladesh as a less developed country, she has to face many difficulties to build educational institutions. Unfortunately, natural disasters in different times in Bangladesh destroy this educational infrastructure. Cyclone Aila created three major barriers to education of children at Kamarkhola village of Dacope upazila. These barriers are: (1) communication barrier- the roads of the affected region are fully submerged and no public vehicles are available except boat; (2) money shortage of guardians- the parents and other head of the household do not have the sufficient money; and (3) lacking of logistic support-it includes shortage of books, pen, bag, cloth and so on. Parents in household try to overcome the barriers to train their children through taking different coping strategies. Reading at home of children is commonly identified rather than attending at school. Actually this strategy reduces the communication and interaction with teachers and classmates. A few of children is trying to use indigenous logistic supports like boat as a vehicle to arrive at school. Sometimes boat cannot reach to the destination timely due to bad weather or other disruption. Late starting of studying is also significantly observed among the affected region. 41 percent students of households, who suffered from logistic support, could not continue their studies in time. It creates discontinuity and drops out of students from school. This study has similarity with manmade disaster-war of Zimbabwe and Rwandan. Alderman et al. (2006) find that children exposed to the civil war in Zimbabwe in the 1970s had lower overall educational attainment and also entered the schooling system at later ages relative to those not affected by the conflict. Akresh and de Walque (2008) find that children exposed to conflict during the Rwandan genocide of 1994 completed on average half a year less of schooling than those who were not exposed to the genocide, and were also significantly less likely to complete primary schooling.

The second impact on socioeconomic aspect of cyclone Aila is fully an unfamiliar, serious and increasing risk to population health. Climate change affects human health both directly

[2] Money lender of village

and indirectly (Rahman 2008). Mainly four types of health impacts of cyclone Aila at Kamarkhola village are explored incorporating wounded, malaria, *kalazar* and skin diseases. Most of the identified health effects are the result of infectious and waterborne germs of post cyclone. About this World Bank (2000) suggested that Bangladesh is vulnerable to outbreaks of infectious, waterborne and other types of diseases. The damage to homes, water and sanitation facilities was particularly significant given that the population of Bangladesh are generally prone to communicable diseases, with respiratory and diarrheal diseases being the leading causes of death (GoB. 2008). Health problems increase vulnerability and reduce the capacity of individuals and groups to adapt to climate change (Rahman 2008). In Kamarkhola village, mainly two coping strategies are taken by the affected household-dwellers: (1) depend on traditional medicine given by inefficient village doctor, and (2) depend on modern medicine mainly come from floating service of NGOs and upazila health complex. Moreover, a noticeable portion of the victims for all types of health condition never took any treatment. They depended on natural setting of body as coping strategy. It could produce result of chronic health burden in future and reduced their working capability. It indicates the institutional lacking of opportunities of coping strategies. According to IPCC (2007), in order to reduce the health impacts of climate change, adaptive capacity needs to be improved everywhere in the world.

Income of household-dwellers is identified the final category of socioeconomic aspect to be affected by cyclone Aila in various ways. It is observed that most of the households belong to the lowest income group ($1-$60) after Aila. It represents the economic vulnerability in cyclone affected area as the average monthly income of day laborer in Bangladesh is around $122 (BBS 2011) that is still double than income range of $1-$60. To survive with poor income, household-dwellers reduce their daily meal to survive, stops study of their children, taking loan, taking aid and even get support from relatives. These strategies represent threatening to basic needs, and dependency. It can be explained as material deprivation and human being need to take such negative coping strategies for this deprivation comes when people do not have enough money to pay social participation as well as food (Bartley 2004).

Agriculture includes three sectors: (1) fish, (2) forest and (3) crops. Firstly, cyclone Aila devastated the cultivation of fish. Shrimp known as white gold is the key source of income in Bangladesh but now all *gher*[3] are demolished and submerged. People cannot produce white gold and other fish again until the water is removed from that area. People have made different strategies like raising pond embankment, changing species and net fencing. Secondly, reducing crops growing is observed by Aila through submerging, salinity, lacking of logistic support and loss of land fertility that has enormous economic challenge. In most of the cases land was submerged and gone under saline condition. Due to salinity 0.2 million ton of rice production is reducing. The affect of soil salinity on *Aus*[4] production would be detrimental and *Aman*[5] also suffers over two-fold yield reduction when grown under a severe climate change scenario (Habibullah et al. 2001). Such land decrease reduced the food

[3] It means a place where fish is cultivated seasonally.
[4] A name of rice grows in rainy season in Bangladesh.
[5] A name of rice grows in autumn season in Bangladesh.

production also. The affected household-dwellers of Kamarkhola village took four strategies to overcome the decreasing of crops. They started to use hybrid paddy (BR), using of traditional knowledge (using ash), using modern technology (tractor) and implications of GO and NGOs instructions. Moreover, coping strategies have relation with the factors of decreasing crops. Having the intention to gain bumper crops, household-dwellers decided to produce hybrid paddy as coping strategy when submerging, salting and loss of land fertility come into account for decreasing of land crops. Thirdly, the same impact is monitored on forest at Kamarkhola village. Considering the situation of damage, it has been divided into two types comprising (1) full and (2) partial damage. People lunched several coping strategies like afforest ration, plantation of deep rooted trees, and plantation in highland and dyke plantation. Afforestation (39%) and plantation in highland (41%) are counted more as coping strategies for full types of forest damage. These strategies reflect the usages of their traditional and scientific knowledge. It is clear that having traditional knowledge, household-dwellers make embankment or net fencing to protect fish, use ash to fertile land growing crops, and afforestation and plantation in high land to grow forest. But household-dwellers expresses scientific knowledge in practicing species changing especially nurturing new fish for salty water, cultivating hybrid paddy (BR) and use of technology, and dyke plantation after Aila. Finally, GO and NGOs intervention has been considered as social support to recover. Furthermore, in economic category, I find reciprocal relations to cope with cyclone affected society: (1) in the first case, household-dwellers cope with hazardous situation getting sense from existing structure. That is, people apparently depend on tractor to plow land quickly that is already built. (2) In second, household-dwellers invent some strategies that are not uncovered earlier and work as new element for structure. For example, changing species to adjust with saline water in the coastal area is remarkable.

4. Conclusion

The south western people of Bangladesh experienced many incredible impacts due to cyclone Aila. This impact is observed on infrastructure-house, socioeconomic issue-child education, health and income, and agriculture-fish, crops and forest. Every household-dweller depicts their collective action during and post Aila to recover from climate impact. Victims had to determine strategies for managing secured shelter and for building house to case of infrastructure. For doing these, they showed formal-exchange, and informal-non-exchange mechanism. For socioeconomic issue, practicing own studying at home of child, late starting of schooling and using boat to go school are observed to cope study barrier of children; depend on traditional and medicine are taken to cope health burden; and reducing daily food in family, cancellation of child study, loan and aid taking, and even enjoying support from relatives are observed to cope daily life in case of negligible income of family. Here reflects many negative strategies. Finally in agriculture, traditional (e.g. use ash to fertile land) and scientific knowledge (e.g. species changing with the taste of water) are used to cope with the devastation of fish, crops and forest. One important thing is that coping strategy in every aspect varies according to the nature of impact of climate change.

This empirical study has strong theoretical significance as it contains synthesis behavior of all dwellers of every household what Durkheim (1893/1964) termed common conscience.

Reciprocal relation between collective actions of victims and society are explored when new idea of victims improves the ground of existing social structure and contrary, victims enjoy the support of existing structure in case of crisis. Furthermore, the impact of climate change on house damage, poor income, loss of agriculture, and so on can be explained as material deprivation. Stopping school can reduce the knowledge and integration of children that Bourdieu (1984) categorizes as cultural and social capital.

Household-dwellers are trying to improve their post Aila condition with their collective action. Now the question why people cannot improve like the mainstream level of Bangladesh after six years of Aila? Empirical findings show that the coping strategies that household-dwellers took are the combination of both positive and negative. In positive sense, they rely on scientific mechanism like changing species and even their traditional mechanism like boat using to go school. But some strategies including reducing daily meal, stopping child education, depend on traditional healer for disease recovery etc are taken by dwellers to survive following Aila considered as negative as it reduces long term development called adaptation.

So findings of the impact and present coping strategies provide several recommendations for future to fulfill the aim of this study. Firstly, government and other active agencies need to manage proper housing facility to avoid risky life. Secondly, considering major barriers of education-communication barrier, money shortage and lacking of logistic support- it is needed to speed up schooling of children. Government, NGOs and the members of civil society can play active role in that case. Thirdly, emphasize on health should be more prioritized after disaster. Access to nearest medical and community clinic should be more than traditional healer. Fourthly, state supported financial institutions need to increase more to provide money with low interest. Victims would rather have access to those institutions than other high interest paying agencies. Finally, to get back the loss of fish, crops and forest; local agricultural institution needs to prescribe sowing more hybrid crops to get more money and provide free seeds, fertilizer, and technological facility and so on. Forest department should encourage more tree plantation to ensure ecological balance and financial support.

As this study is conducted following survey method, it might posit limitation of in-depth of every aspect. While expanding reality, one might select in-depth study to have detail picture and to include individual and community level of study. Finally this study has significance to both natural and social science as I tried to explore the collective action in existing natural settings.

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Title: An Assessment of Important Climate Change Adaptation Practices in Coastal Regions of Bangladesh

Muhammad Shahriar Shafayet Hossain and Debanjali Saha

1. Introduction

Bangladesh is a low-lying, riverine country located in South Asia from 20°34″ N to 26°38″ N and 88°01″ E to 92°41″ E. This country is an active delta having a coastline of 700 km on the northern littoral of the Bay of Bengal (Hossain and Selvanathan, 2013). The coastal region of Bangladesh which is located in the southern part is an almost level clay landscape. Unique hydro-geological and socio-economic factors are responsible for high climatic vulnerability which include geographical location in the bottom of mighty Ganges-Brahmaputra-Meghna (GBM) river basin, flat deltaic topography with very low elevation, severe climate variability , high population density and poverty incidence, agriculture based economy etc. (Ahmed, 2006). Due to these aforementioned factors, this region is highly vulnerable which makes the lives of the coastal people very difficult. Moreover, Bangladesh is one of the most vulnerable nations to the impacts of climate change though being one of the least contributors to climate change drivers. The coastal region is likely to face the major impacts of climate change in future. The sectors which have been affected by climate variability and potential climate change are crop agriculture, aquaculture, livestock, forest and vegetation, human health, settlements and infrastructure, etc. (Ahmed, 2006). Potential climate change phenomenon is expected to increase the intensity and frequency of the common natural disasters such as flood, waterlogging, low flow and salinity intrusion, cyclone and storm surge, etc. To deal with the negative impacts of climate change, adaptation is the only feasible solution as migration is pretty impossible in countries like Bangladesh where population density is very high.

Adaptation is a process of adjustment to actual or expected climate and its effects (IPCC, 2014). The coastal people of Bangladesh are associated with different climate change adaptation practices for a long time without even realizing the future expected extremity of climate change phenomenon. This is why there has been a number of adaptation measures taken in different sectors in the coastal region since long. This study is based on an inventory prepared under the project: DEltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA), funded jointly by the Department for International Development (DFID), UK and International Development Research Center (IDRC), Canada. The inventory recorded the existing adaptations in practice in the coastal region of Bangladesh according to a developed protocol by the project authorities. Adaptations from both the physical-infrastructural-technological (PIT) and socio-economic (SE) sectors have been documented in the inventory. About 110 adaptation practices have been documented in the inventory from both the sectors. In this article, five important adaptation practices from this inventory have been selected based on some criteria such as geographical location, adaption providers and beneficiaries, typicality of adaptation in the region, sustainability and gender perspectives, etc. from both the PIT and SE sectors and discussed. The article provides information about who are adapting and benefiting, what have been the major drivers of adaptations, what have been the barriers and sustainability issues of these adaptations in which sectors and geographical locations adaptations are happening, whether gender dimension is taken into

account, etc. The answering of such questions will provide information about the position of Bangladesh as a society with proper adaptation strategies and implementation of them considering climate change risks. It will also assist in identifying criteria for successful adaptations and designing better policies and actions in future in response to potential climate change.

2. Study Area

The coastal zone of Bangladesh has been selected for the study. The coastal region is mostly vulnerable in terms of climate change risks and also various reactive and anticipatory adaptation practices have been undertaken in these areas for a long period by different governmental and non-governmental organizations and in some cases individuals to communities. The coastal area of Bangladesh as defined by Integrated Coastal Zone Management Plan (ICZMP) of Water Resources Planning Organisation (WARPO) comprises 19 districts (PDO-ICZMP, 2005a). The area includes 19 districts namely: Bagerhat, Barguna, Barisal, Bhola, Chandpur, Chittagong, Cox's Bazar, Feni, Gopalganj, Jessore, Jhalokati, Khulna, Lakshmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira and Shariatpur (Figure 1). The adaptation measures analyzed in the study were selected from both the exterior and interior coastal districts to show the spatial distribution of the adaptation practices. The geographic locations of the adaptation practices analyzed in the study are Khulna, Satkhira, Bhola, Bagerhat, Barguna, Sariatpur, Jessore, Gopalganj, Madaripur, Pirojpur and Jhalkathi.

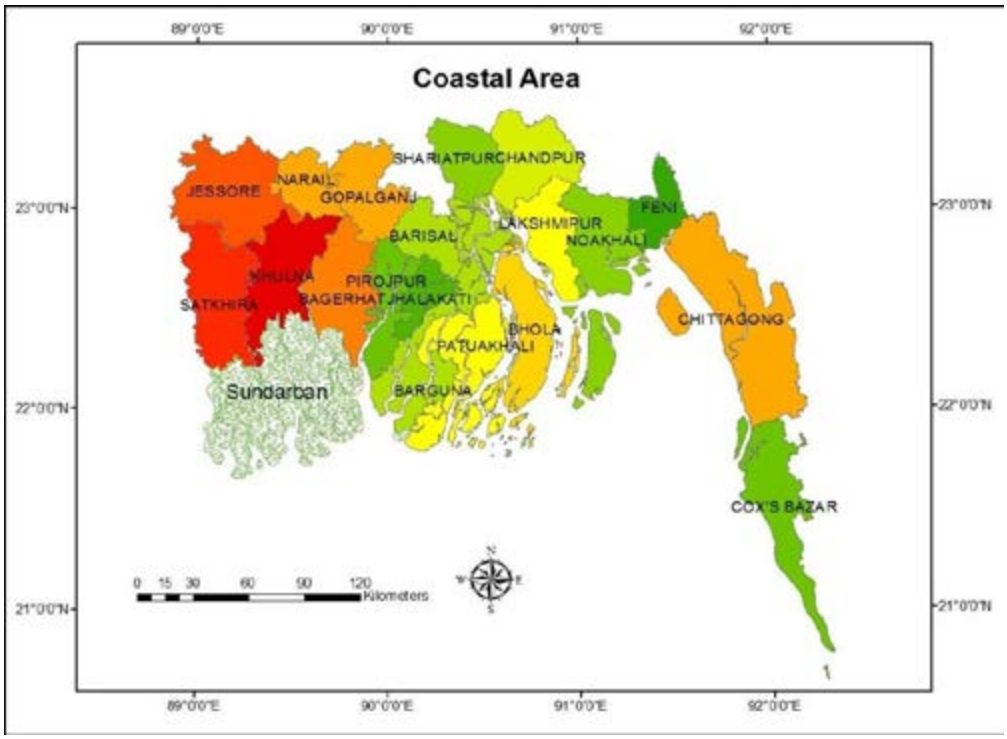

Fig 1: Location of the study area

3. Methodology

This article represents a synthesis on the climate change induced adaptation practices in the coastal areas of Bangladesh, which is a part of the inventory of practiced adaptations prepared under the DECCMA project as mentioned before. According to the protocol (Tomkins et al., 2014), the evidence of currently observed and documented adaptations were collected from different published literatures by searching in a number of sources and academic databases, national and international agencies and institutions, governmental organizations (GOs) and non-governmental organizations (NGOs), etc. These were collated in a universal spreadsheet template which has 43 different columns, namely, geographical location, provider/beneficiary, forms of adaptations, aims of adaptations, stresses and shocks, barriers to adaptations, link to migration, gender relations, sustainability and resilience factors, etc. All these adaptation practices were divided in two broad categories termed as physical-infrastructural-technological (PIT) and socio-economic (SE) adaptations. The definition of adaptation that was followed in this study was: "Adaptation refers to adjustments that reduce vulnerability to climate variability and change. These adjustments may be in response to, or in anticipation of, real or perceived climate stressors. These stressors may be exposure to sudden onset shocks, such as floods; and/or to slow-onset incremental stresses, for example in temperature and rainfall patterns, or sea level rise."

In this article, we have chosen five different adaptation practices based on different criteria such as, typicality of adaptation practices, geographic location and spatial distribution, sectors, barriers in participating, present and future damaging aspect, gender consideration, sustainability issues alongside their roles in disaster risk reduction, vulnerability reduction and increase in large scale system resilience.

4. Analysis of the Adaptation Practices

The adaptation practices which were selected according to different criteria are:

1. Multipurpose cyclone shelter
2. Saline tolerant rice cultivation
3. Pond Sand Filter (PSF)
4. Floating garden
5. Dyke cropping

These adaptation practices are being practiced throughout the coastal region for a significant time period. These practices have been described briefly and analyzed based on the criteria mentioned earlier. Multipurpose cyclone shelter, saline tolerant rice cultivation and Pond Sand Filter are mainly PIT adaptations while floating garden and dyke cropping are SE adaptation practices. The spatial distribution of these adaptation practices is shown in Figure 2.

4.1 Multipurpose Cyclone Shelter

Cyclone Shelter is one of the most important infrastructural adaptation practices in Bangladesh. Now-a-days, cyclone shelters are not only used as shelter during cyclone and post cyclone periods, but also used as school and community health center. These structures are usually termed as Multi-purpose Cyclone Shelter (MCS). In the coastal region of Bangladesh, Bangladesh Water Development Board (BWDB), Local Government Engineering Department (LGED) and Compressive Disaster Management Programme (CDMP) under the Ministry of Food and Disaster Management (MoFDM) have taken initiatives to construct cyclone shelters for the local community in different places. For example, BWDB has constructed MCSs in Bhola district which are designed to serve approximately 2000 people and also to function as schools (Rahman and Islam, 2015). Multi-purpose cyclone centers have tubewells, rainwater harvesting system, first aid room, solar panel for efficient and reliable power, sanitary facility etc. (ADB, 2013). The construction of these shelters started after the 1991 cyclone with the aim of benefiting the local communities, who are being affected by the devastation of cyclonic events for a long time. Multipurpose cyclone shelters are capable to withstand the force of water and wind speed of up to 260 km per hour (CEGIS, 2009).This adaptation measure has the potential to reduce disaster risks by protecting lives and livestock of the coastal people. This practice also increases large scale system resilience by improving DRR, increasing adaptive capacity of the local people and reducing vulnerability. High public acceptance, strong political will, cost effectiveness, absence of negative externality, easier operation and maintenance, co-benefits (literacy, education and health), are some of the major factors for which the adaptation is likely to be sustainable in the long run. However, some barriers can be identified in practicing this adaptation such as, site selection and lack of access to land for construction. Due to absence of proper maintenance, shelters may be vulnerable to earthquake, tsunami or cyclone (Ahmed et al., 2012; Dhakal and Mahmood, 2014). These shelters sometimes lack gender sensitivity as women go to these shelters at the last moment due to absence of proper women toilets (Rahman and Islam, 2015). Also, there is lack of access facility for the disabled and elderly people (CEGIS, 2009). Cyclone shelters lack of suitable storage facilities for the valuable goods of people taking shelter during the cyclone events. This shelter facility may sometimes be only confined to a specific group of people if proper governance and public participation cannot be ensured. As a result, the marginalized groups are deprived from equitable opportunities. So, along with this structural intervention, strengthening social capital, allocating maintenance funds, and encouraging participatory governance can be some non-structural measures to prevent this adaptation practice from becoming a maladaptation (Dhakal and Mahmood, 2014).

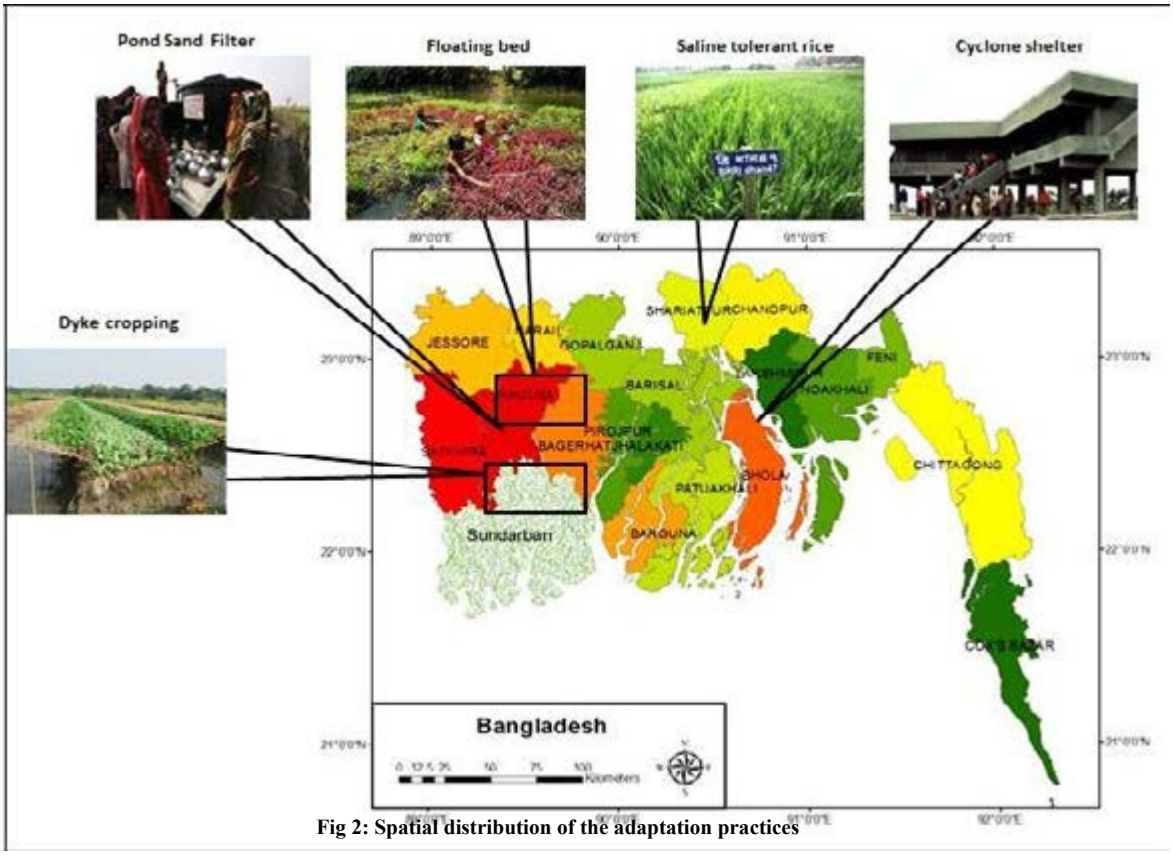

Fig 2: Spatial distribution of the adaptation practices

4.2 Pond Sand Filter (PSF)

Scarcity of drinking water is a primary concern for the local people of coastal belt. Presence of iron, salinity and arsenic in groundwater has hampered installation of regular depth deep tubewell and shallow tubewell to meet up drinking water necessity. Government and NGOs have come up with various techniques using local indigenous knowledge to solve the problem. Pond Sand Filter (PSF) is a simple, easy to use, and one of the most effective techniques in the south-western region of Bangladesh. It is made of brick, cement, sand, brick chips, net, hand tubewell, pvc pipe, filter media, etc. and is established on the edge of pond for drinking water supply (Harun and Kabir, 2013). In the high saline condition of the coastal areas, PSF is used for collecting drinking and cooking water by the community people (Abedin et al., 2014). In the coastal districts, particularly in Satkhira, Khulna, Bagerhat and some parts of Barguna, the introduction of PSF was carried out by UNICEF and Department of Public Health Engineering (DPHE) for the benefit of the community households (Alauddin and Rahman, 2013). Many national and international NGOs have promoted PSF in the coastal areas. The adaptation practice was initiated in reaction to chronic salinity stress as well as arsenic problem in groundwater.

This practice reduces the risk of unsafe drinking water, lessens time of water collection from distant sources, especially by the women so that people can use the saved time in productive activities and increase their income. It increases system resilience by providing safe water supplies and improving health and hygiene of the local communities. But, due to lack of

community involvement in operation and maintenance of PSFs, the use of this technique may be restricted (Abedin et al., 2014). Difficulties in washing the filter beds may cause water quality deterioration which can be a damaging aspect of this adaptation practice in future. Being a low cost technology, PSF can efficiently remove turbidity, color and bacteria (both general and coliform), but it may not be able to remove 100% pathogens from highly contaminated surface water (Rahman et al., 2001; Yokota et al, 2001). Another difficulty with this practice is that, women have to wait in a long queue to collect water from the filter, which hampers their daily activities including cooking, washing, taking care of children, etc. (Harun and Kabir, 2013). This practice can be sustainable if initiatives are taken to increase public acceptance, reduce operation and maintenance difficulties, and high risk of contamination. Also, it needs to be placed in a tolerable distance for the convenience of the local users. To increase the public acceptance, ensuring good quality of the pond water is the primary concern of this practice along with providing acceptable location for the PSF.

4.3 Saline Tolerant Rice Variety

Soil salinity is the primary concern for the local communities in the coastal belt of Bangladesh. During the monsoon season (June-October), tidal flooding causes salinity intrusion in groundwater and during the dry season (November-May), direct inundation by saline or brackish water causes soil salinity which results in the reduction of soil fertility (Rashid and Islam, 2007). Special type of saline tolerant crop variety is required to be cultivated in highly saline soil. Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) have invented various saline tolerant crop varieties over the last few decades. For example, cultivation of high yielding salt tolerant rice variety BRRI dhan47 is a common practice in the coastal areas (Rahman, 2011; Alauddin and Rahman, 2013). This variety of boro rice is cultivated during the dry season, which requires less water and its tolerance to dry soil is quite high (Alam et al., 2013; Sutradhar et al., 2015). It can tolerate salinity up to 12-14 dS/m during the seedling stage and 6 dS/m during the other growth stages which highly benefits the community farmers (Salam et al., 2007). Cultivation of saline tolerant rice variety is a deliberate adaptation which has occurred in reaction to the chronic salinity stress on crop agriculture in the coastal region. Also, apart from climate change, feeding the increasing population of Bangladesh is another trigger to practice this high yielding crop variety.

Cultivation of this type of saline tolerant crop in the coastal area helps in women empowerment and gender issues as most women are engaged in the post-harvest activities of these crops. This practice reduces vulnerability by increasing people's income and ensuring food security through increased crop production, thus large scale system resilience can also be increased. But, lack of knowledge of the local farmers about the variety and non-availability of seed in the local market are the common barriers of practicing this type of crop cultivation (Rahman, 2011; Alauddin and Rahman, 2013). The productivity of these type of crops is also not promising against the severe salinity stress expected to be encountered in future (MoA, 2012).With the risk of future climate change, salinity is expected to increase making saline tolerant crop varieties the only option for maintaining food availability. If local farmers are facilitated with proper training about the new improved varieties and sufficient

availability of seeds in the locality, then this practice can be brought into larger scale. Also, ensuring adequate crop yield by new innovative technologies and scale of the cultivation of these crops to cope with the increasing food demand are also necessary to uphold the sustainability of this adaptation in future.

4.4 Floating Bed/Garden

In the flood prone areas of Bangladesh, where water logging is a common issue, floating bed crop/vegetable cultivation is an age old adaptation practice. It is being highly encouraged now-a-days by many government organizations and international NGOs like Practice Action (CCC, 2009). In Khulna, Jessore, Gopalganj, Madaripur, Pirojpur and Jhalokathi districts of the coastal Bangladesh, it is a very popular practice. It is an environment-friendly technique to utilize the natural resources of wetland for growing vegetable and other crops almost all the year round (Irfanullah et al., 2011). The floating bed crop cultivation is known as 'gato', 'baira' and 'dhapchash' in the area, where, saplings of different vegetables are mainly produced and after the recession of flood water, saplings are placed in the field. Farmers then use the waste as compost in the land (Alauddin and Rahman, 2013). Farmers produce pumpkin, water gourd, turmeric, ginger, tomato, ladies finger, chichinga, lalshak, puishak, etc. in the floating garden. The growth of vegetables is very high and production from dhapchash is almost double compared to normal cultivation in land. Water hyacinth is used as the major material for preparation of the floating bed.

Floating bed crop/vegetable cultivation practice is a long term reactive adaptation in response to chronic flood and waterlogging stresses. This practice provides a growing area for the poor communities who do not have adequate access to land, as many wetlands remain waterlogged for 7-8 months in a year. Thus it reduces crop failure due to water logging and ensures food supply during the post-flooding period providing agricultural, socio-economic and disaster risk management benefits (UNFCCC, 2014). Also, it reduces vulnerability by building adaptive capacity to cultivate agro-products in the waterlogged areas, thus reducing food insecurity and generating more income. It increases large scale system resilience as it is a local knowledge based technology which would help in attaining sustainable livelihood security in vulnerable waterlogged areas. But, floating bed cultivation has been threatened due to the increase in salinity, as salinity hampers the growth of water hyacinth. Because of that, farmers are not getting enough water hyacinths for floating bed preparation which is a barrier to this easy and suitable local practice. According to the farmers, currently their floating beds have been reduced by at least 15-20 numbers each than that of the past years (Alauddin and Rahman, 2013). Though being highly effective in the waterlogged areas, this practice is being adapted without sufficient research which may lead it being a maladaptation in some ways (IPCC, 2014). Increasing trend of salinity intrusion in water, lack of proper maintenance and absence of proper material have put a question mark on the sustainability of the practice. However, by cultivating various crops on floating garden, local people are expected to be able to meet their household food requirement and earn an additional income (Rahman, 2011).

4.5 Dyke Cropping

Drainage congestion is the combined effect of higher sea levels, subsidence, siltation of estuary branches, rise of riverbed levels and sedimentation in flood-protected areas. Drainage congestion and associated inundation affect the crop production and also disrupt drinking water availability. Various adaptation measures have been taken in order to counter the problem and ease up local people's life. For example, in Satkhira district, local NGOs have taken initiatives to introduce dyke cropping practice for mixed agriculture to deal with water logging condition. A dyke is built along the boundary of the plot by digging ditch inside the dyke. The length, breadth and height of the dyke depend upon the flooding depth in the monsoon season. The ditch is used as water reservoir for fish culture and as a source of small scale irrigation (Rashid and Islam, 2007). Recently, Practical Action Bangladesh, under its 'Community Based Adaptation to Climate Change Project' has promoted dyke cropping practice in Satkhira District. Farmers of the central coastal areas mostly grow pumpkins, bitter gourds, long beans and okras on dikes (Azad et al., 2007). The improved dyke cropping system can provide high production of vegetables such as, ladies finger, chichinga, pumpkin, water gourd, bitter gourd, brinjal, etc. (Alauddin and Rahman, 2013). It is a highly preferred system by the coastal communities for rainwater harvesting, fish cultivation and irrigation of dyke vegetation during the dry season (Alam et al., 2013).This combined fish-vegetable cropping system is highly beneficial for the local farmers. It can be done with less investment cost and without spending for any additional space. This practice reduces livelihood vulnerabilities by providing multiple income opportunities from diversified crop cultivation in the dyke areas and fish farming in the ditch. Along with fish and prawn, farmers can also cultivate boro rice in the ditch during the dry season and vegetables in the dykes. This rice and vegetables can be cultivated for home consumption purposes (Barmon, 2014). The only major barrier of this practice is that, it requires improved and planned system which is sometimes unusual for local community, as they are not well trained about planning and designing of the system. This practice is likely to be sustainable in the long run as farmers can cultivate vegetable, spices and annual plants in the dyke and also can use the water of the ditch to culture fresh water fish and prawn and provide irrigation to the nearby rice field during future scarcity of irrigation water. This multiple cropping system also has positive impact on livestock and the income of the farmers from multiple cropping in the dykes has been comparatively higher than the conventional cropping system (Barmon, 2014).

5. Conclusion

Under the threat of global climate change phenomenon, Bangladesh has been considering various adaptation strategies for a long period and a lot of them have been implemented in different sectors in order to reduce the severity of climate change impacts. These practices are capable to withstand the existing difficulties and future suspected changes in the climate. This study covers an analysis of five well known adaptation practices in the coastal region of Bangladesh. Depending on some criteria, these practices have been found to be successful and effective. Though some barriers and damaging aspects of the practices have been identified, but with necessary adjustments the difficulties can be alleviated to ensure the

sustainability in future. Effective operation and maintenance, good governance, integration of technical and non-technical measures, people's participation and capacity building of the community are some pre-requisites which have been identified through this analysis. Also, implementation of existing policies and frameworks related to these adaptation practices, institution support and coordination among relevant organizations are essential along with necessary fund allocation to make the adaptations sustainable in the long run. Moreover, this study is expected to serve as a documentation of the success of these five adaptation practices in their respective sectors. It will also assist in identifying criteria for successful adaptations and design better policies and actions in future in response to potential climate change.

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Title: Climate Change Adaptation With Agriculture: A Study On Tangail District In Bangladesh

Towfiqul Islam Khan, Md. Nurul Islam and Muhammad Rezaul Rakib

1. Introduction

Climate change in Bangladesh is an extremely crucial issue now a day. Bangladesh is a nation most vulnerable to the impacts of climate change in the coming decades. Several studies indicated that climate is changing and becoming more unpredictable every year in Bangladesh (Syeda J A, 2012). Tangail district is a major part of them. Climate change in Bangladesh is an especially serious concern since agriculture is such an important sector in the country. Agriculture of Tangail district is influence by seasonal characteristics and different variables of climate such as temperature, rainfall, humidity, drought, precipitation etc. It is also often constrained by different disasters such as floods, cyclone, soil and water salinity, and storm surges. The developing world must bear a disproportionate burden of adverse impacts from these debacles. More than 80 percent of the annual precipitation of the country occurs during the southwestern summer monsoons, from June through September (Brammer H, 2012). This study feeds into these debates by considering the ways in which climate change affects agriculture in a case study of Tangail district. Bangladesh contributes roughly 20 % to gross domestic product (GDP), crops representing 11.2 %, livestock 2.7 %, fisheries 4.5 %, and forestry 1.8 % (BBS, 2014). Bangladesh is still in the bottom quintile of the nations of the world in GDP per capita, indicating that it has limited resources to adapt to climate shocks and is therefore vulnerable to even moderate changes. Climate change is urgent and adaptation to climate change is crucial, particularly in agriculture, where food security is at stake (Ahmed R, 1989). Tangail district agricultural sector plays a vital role in the economy of Bangladesh in terms of its contribution to Gross Domestic Product (GDP), employment generation, livelihoods and poverty alleviation. The sector, however, has been under increasing stress due to various natural hazards, including that of climate change. Climate change-induced extreme events such as floods, droughts, cyclones, storm surges, sea level rise and salinity intrusion are likely to occur more frequently and to become intensified in the future (Islam T, et al.2010). This will sharply affect food production, especially in vulnerable areas such as the country's central region in Tangail district. As agriculture is highly vulnerable to climate change, food security, food prices and nutrition will affected differently. Therefore, there is a strong need for decision makers to take climate change strategies adaptation in their development planning, and further explore the synergies between climate change adaptation and agricultural development. There is often limited knowledge and understanding of climate change and its implications at the local level. For these purpose this research would be helped efficiency.

1.1 Aim and Objective of the Research

The main aim of the study is to investigate how climatic variables effects on agriculture and how do farmers adapt agriculture with the climate change. The specific objectives are following:

6. To analyze, the season wise variation of Temperature of Tangail district;

7. To investigate, the season wise changing trends of Rainfall in the study area and
8. To analyze the adaptation strategies of agriculture with the climate change in the study area.

2. Data Sources and Methodology

Mainly this research has completed by secondary data sources. Secondary data is collected from the Bangladesh meteorological department to analysis the 26 year's (1987-2013) temperature and Rainfall variation in Tangail District. This Quantitative data helps for exploratory statistical analysis as a given expected outcome season wise temperature variation and dynamics of rainfall at least around 26 years. In this study used also Primary data source by observing, surveying, questioner survey, focus group discussion, team meeting etc. Primary sources provide first-hand testimony or direct evidence concerning a topic under investigation.

By the use of Geographic information system (GIS), exploratory statistical analysis, Geo statistical analysis, Trend analysis, study find out the adapted Strategies with the climate change in agriculture of Tangail district. Climate change and agriculture are interrelated processes, both of which take place on a global scale. Climate change affects agriculture in a number of ways, including through changes in average temperatures, rainfall, and climate extremes. This study finds out, Adaptation process is not easy but it can be minimize the vulnerability and impact of climate change in the agricultural sectors. Therefore, the study investigate that adaptation is a process by which individuals, communities, and country hunt to emulate with the consequences of climate change.

3. Study area

This research has performed in Tangail District of Bangladesh. Tangail is a district (zilla) in the central region of Bangladesh. It is a part of the Dhaka division. The population of Tangail zilla is about 3.6 million and its surface area is 3,414.35 km². The main town of Tangail District is the district town Tangail. It is surrounded by the several districts, such as Jamalpur district on the north, the Dhaka and Manikganj districts on the south, the Mymensingh and Gazipur districts on the east, and the Sirajganj district on the west. The main rivers that cross the Tangail district are the Jamuna, Dhaleshwari, Jhenai, Bangshi, Louhajang, Langulia, Elongjani, Jugni,Pungli, Fotikjani and the Turag. Geographically it is located 24° 01′ north to 24° 47′ north latitudes and 89° 44′ east to 90° 18′ east longitudes. Figure 1.1 shows the study area map of Tangail district. The subdivision of Tangail established in 1870. It turned into a district on December 1, 1969. The district consists of 10 municipalities, 72 wards of these municipalities, 108 Union Porishods and 2516 villages. Tangail district subdivided into 12 Upazilas.

Tangail has a tropical climate. In winter, there is much less rainfall than in summer, this climate is classified as Aw (Köppen and Geiger). The temperature here averages 25.5 °C. Tangail earn their living mainly from agriculture. Although rice and jute are the primary crops, wheat is assuming greater importance. Because of Tangail's fertile soil and normally ample water supply, rice can be grown and harvested three times a year in many areas. Agriculture has achieved steady increases in food grain production despite the often-unfavorable

weather conditions. These include better flood control and irrigation, a generally more efficient use of fertilizers, and the establishment of better distribution and rural credit networks.

Source: BCA, 2014

Fig 1.1: Study area map

The insecticides of agriculture is not only represent an environmental threat, but are a significant expenditure to poor rice farmers. The Bangladesh Rice Research Institute is working with various NGOs and international organizations to reduce insecticide use in rice. Main occupations Agriculture 49.53%, fishing 1.05%, agricultural laborers 17.28%, wage laborers 2.53%, weaving 1.68%, industry 1.71%, commerce 9.56%, transport 2.14%, service 6.67%, others 7.85%. Land use Total cultivation land 338653 hectares, fallow land 17466 hectares; forestry 11087 hectares; single crop 19%, double crop 50% and treble crop land 31%; land under irrigation 60%. Land control Among the peasants, 27% are landless, 29% small, 24% marginal, 17% intermediate and 3% rich; cultivable land per family 0.59 hectare (FAO,2013). Main crops Paddy, jute, sugarcane, wheat, mustard seed and pulse. Extinct and nearly extinct crops are Aus paddy, indigo, kaun china. Main fruits Mango, jackfruit, banana, litchi, pineapple,(BARI, 2014).

4. Result and Discussion

Climate change may refer to a change in average weather conditions, or in the time variation of weather around longer-term average conditions. Tangail has warm temperatures throughout the year, with relatively little variation from month to month. January tends to be

the coolest month and May the warmest. In Tangail the average January temperature is about 19°C (about 66°F), and the average May temperature is about 29°C (about 84°F). Agriculture related to the climate change. Agriculture must need to good weather condition growing cultivation.

This research showing season wise average Temperature and Rainfall of Tangail district around 26 years. Collected data from the Bangladesh meteorological department, analysis the changing trends of climatic variability in Tangail district. Just as weather is constantly changing and variables so is climate. It is variables on all time and special scales. This study has proved that climate change really impact on agriculture. This study capable to find out potential adaptation options available for marginal change of existing agricultural systems in Tangail district, often variations of existing climate risk management. This research shown that implementation of these options is likely to have substantial benefits under moderate climate change for some cropping systems. However, there are limits to their effectiveness under more severe climate changes. Hence, more systemic changes in resource allocation need to considered, such as targeted diversification of production systems and livelihoods. This research argue that achieving increased adaptation action will necessitate integration of climate change-related issues with other risk factors, such as climate variability and market risk, and with other policy domains, such as sustainable development.

4.1 Season wise variation of average Temperature of Tangail district (1987-2013)

A temperature is an objective comparative measure of hot or cold. It measured by a thermometer, which may work through the bulk behavior of a thermometric material, detection of thermal radiation, or particle kinetic energy. Temperature is must important for growing crops, but in a standard scale. Table 1.1 represents the twenty-six years temperature data of Tangail district. These data has collected from the Bangladesh meteorological department and used for analysis the variation of climate change impact on agriculture.

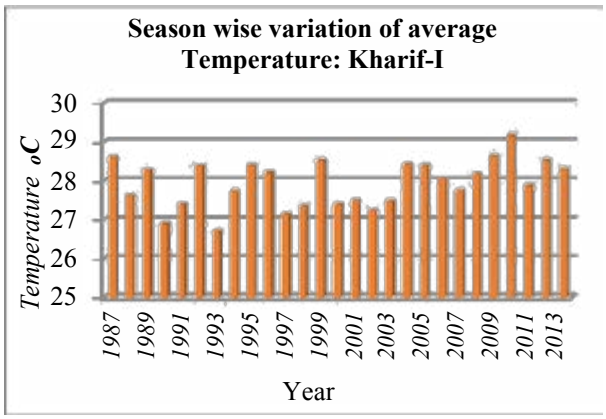
Table 1.1: Season wise Temperature data of Tangail district from 1987 to 2013

Year	Kharif-I (March to June)	Kharif-II (July to October)	Rabi (November to February)
	Average (^{o} Celsius)	Average (^{o} Celsius)	Average (^{o} Celsius)
1987	28.60	28.36	22.03
1988	27.61	28.68	21.30
1989	28.26	28.49	19.67
1990	26.89	28.24	21.05
1991	27.38	28.43	20.24
1992	28.38	28.41	19.81
1993	26.70	28.47	20.89
1994	27.72	28.63	20.33
1995	28.40	28.56	20.19
1996	28.19	28.62	20.65
1997	27.14	28.16	19.92
1998	27.33	29.25	20.83
1999	*	28.49	21.41
2000	27.38	28.72	20.34
2001	27.50	29.03	20.49
2002	27.22	28.61	20.91
2003	27.49	29.01	20.00
2004	28.41	28.33	20.42
2005	28.39	28.74	20.98
2006	28.05	29.02	21.46
2007	27.74	28.84	20.22
2008	28.16	28.69	20.29
2009	28.62	29.14	20.91
2010	29.16	29.39	20.57
2011	27.87	29.12	19.97
2012	28.52	28.97	19.87
2013	28.30	29.02	20.20

* missing data

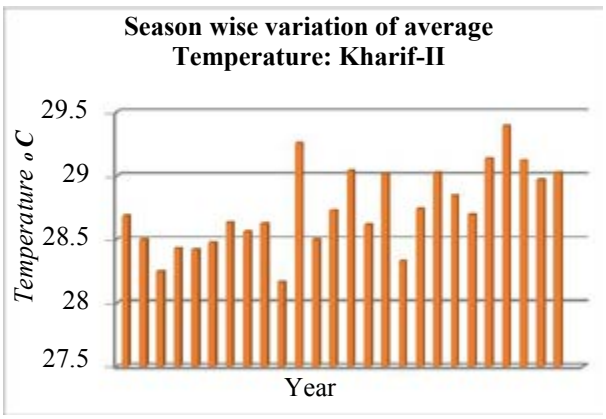
Source: BMD, 2015

Average temperature variation shows the (Fig.1.2) between 1987 to 2013 years. The lowest average temperature was 26.89 ^{o}C in 1990 in kharif-I season and highest average temperature was 29.16 ^{o}C in 2010 in the same season. For this climatic variation of 20 years, crop production has affected by the impact of climate.



Source: BMD, 2015

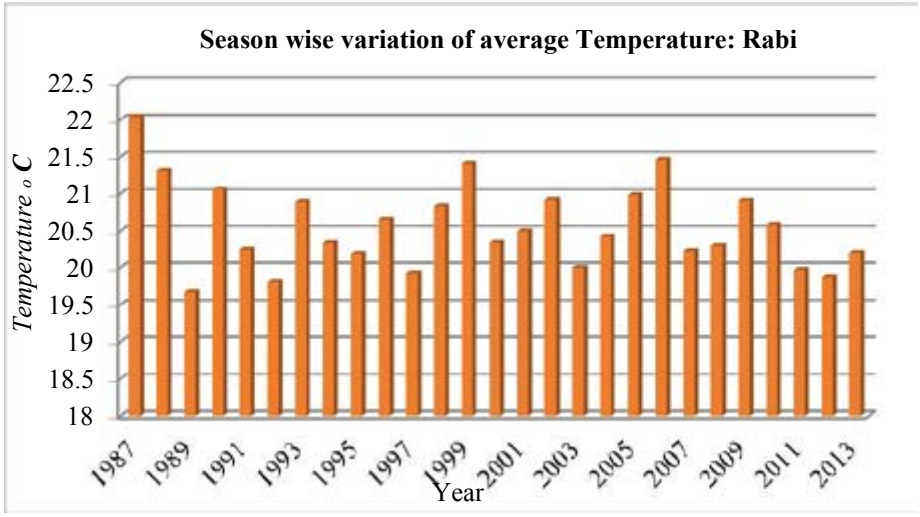
Figure 1.2: Temperature variation of Tangail district (1987-2013)



Source: BMD, 2015

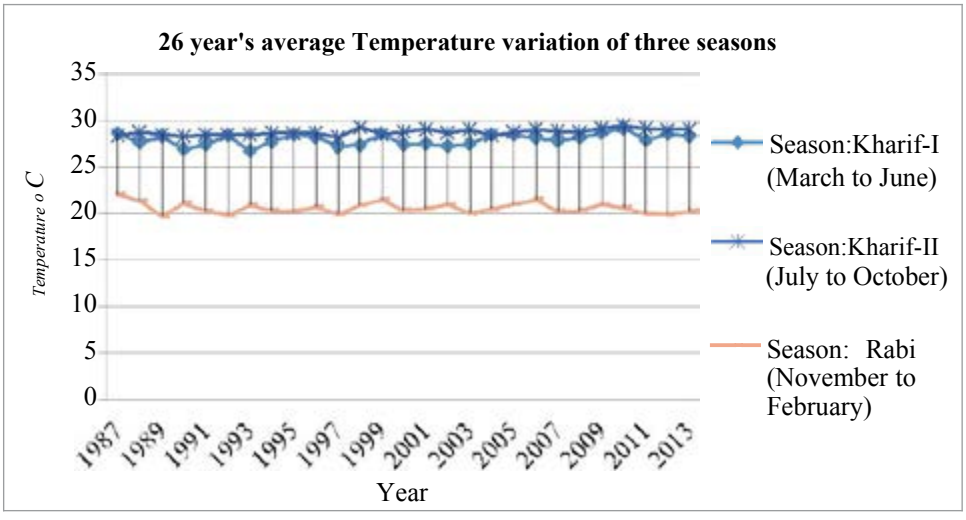
Figure 1.3: Temperature variation of Tangail district (1987-2013)

Temperature variation of kharif-II season shows on (Fig.1.3), here the lowest average temperature was in 1997 and the highest average temperature was in 2010. This changeable variation made up cropping pattern change for changing climatic variables. High temperature is unfavorable of crop production, less temperature doing the same result. So, standard temperature needed for bumper production.



Source: BMD, 2015

Figure 1.4: Temperature variation of Rabi season (1987-2013)



Source: BMD, 2015

Figure 1.5: Temperature variation trends of Kharif-I, Kharif-II, and Rabi seasons (1987-2013)

The winter or Rabi seasons average temperature represents on (Fig. 1.4). In 1987, the temperature was high in this season but gradually temperature is decreasing day by day. However, it has a stable condition and good for production last few decades. Probably climatic impact does not more effect in this period of agriculture in Rabi season. Temperature is the most important not only in agriculture but also all fields of natural science, including physics, geology, chemistry, atmospheric sciences, medicine, and biology. This diagram represents the condition and trends of average temperature about 26 years. It shows the temperature gradually increase and decrease all year round in three seasons. High temperature and rainfall is not suitable for the cultivation that we are trying to understand in (Fig.1.5).

4.2 Season wise Average Rainfall of Tangail district (1987-2013)

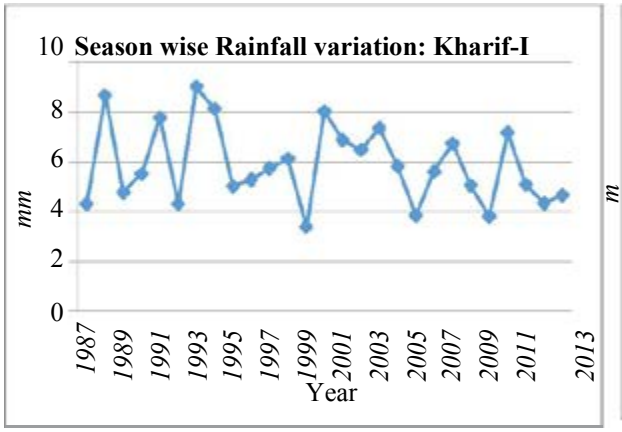
Rain is liquid water in the form of droplets that have condensed from atmospheric water vapor and then precipitated (Ahrens C D, 2009). Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth. It provides suitable conditions for many types of ecosystems, as well as water for hydroelectric power plants and crop irrigation. Among the various individual climatic parameters, which influence the growth characteristics of crops in Tangail district the most important considered water? Limitations in water availability are frequently a restrictive factor in plant development, and water is essential for the maintenance of physiological and chemical processes within the plant, acting as an energy exchanger and carrier of nutrient food supply in solution. In any regional study of agricultural production rainfall is therefore of fundamental importance. The reservoir of water from which crops draw their moisture supply through the soil derived mainly in the form of rainfall, with relatively minor contributions in Tangail district from dew, fog, and snow. Table 1.2 represents the Tangail district Rainfall data of twenty-six years that collected from the Bangladesh meteorological department and used for analysis in this study.

Table 1.2: Season wise average Rainfall data in Tangail district

Year	Kharif-I (March to June)	Kharif-II (July to October)	Rabi (November to February)
	Average (mm)	Average (mm)	Average (mm)
1987	4.31	8.98	0.60
1988	8.66	7.03	1.85
1989	4.76	7.54	0.61
1990	5.52	6.80	0.60
1991	7.77	13.69	1.01
1992	4.31	8.09	0.44
1993	9.00	11.94	0.17
1994	8.11	5.33	0.84
1995	5.00	8.8	1.37
1996	5.26	6.35	0.47
1997	5.73	10.14	0.57
1998	6.10	9.58	0.66
1999	3.38	7.75	0.29
2000	8.01	6.26	0.45
2001	6.87	5.57	0.39
2002	6.48	9.12	0.86
2003	7.35	7.01	0.30
2004	5.81	10.56	0.08
2005	3.83	12.45	0.13
2006	5.61	6.88	0
2007	6.73	10.63	1.17
2008	5.04	9.41	0.64
2009	3.79	7.53	0
2010	7.16	6.56	0.68
2011	5.07	10.37	0.02
2012	4.32	6.85	0.87
2013	4.66	*	0.23

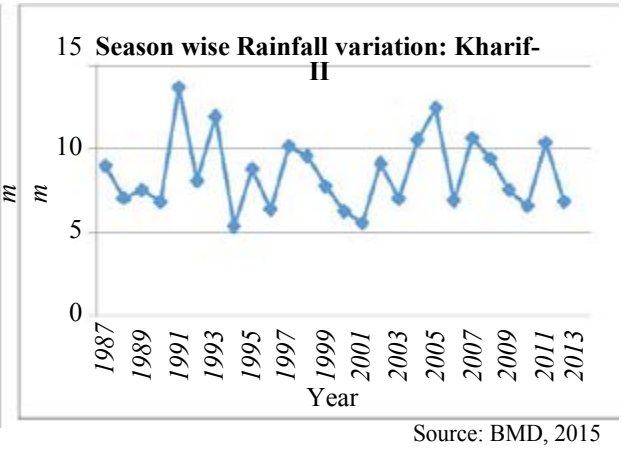
* missing data Source: BMD, 2015

An area may have high or low average rainfall, a high or relatively low variability of rainfall from one year to the next or its rainfall may be concentrated over a short rainy season or spread over a longer period. Figure 1.6 shows how was the Rainfall occurs last few decades in Tangail. The study have shown some year's rainfall was more and that year crop production must be decrease, on the other hand especially in 1987,1992,1999,2005 and 2009 season rainfall was less for various climatic reason. Therefore, the rainfall variation must be impact in crop production.



Source: BMD, 2015

Figure 1.6: Average Rainfall variation of Tangail district (1987-2013)

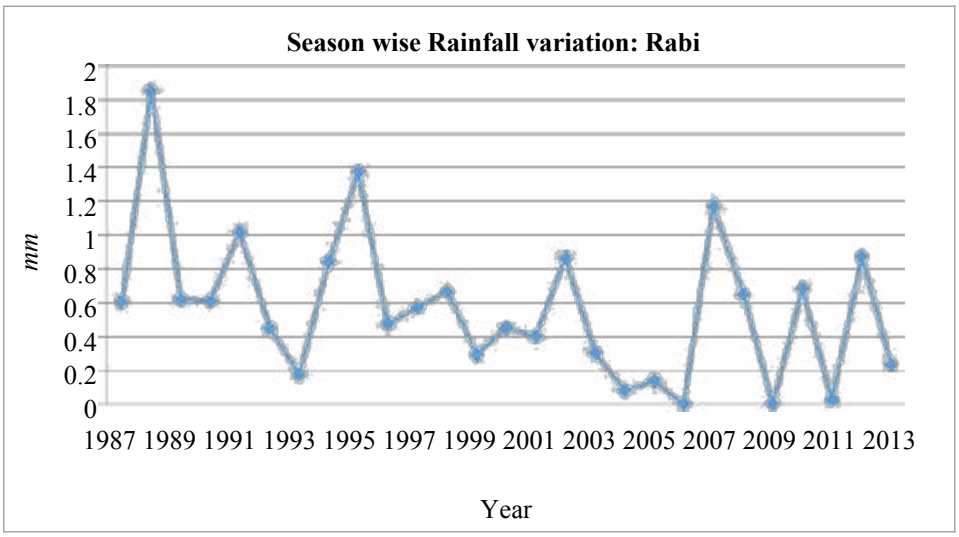


Source: BMD, 2015

Figure 1.7: Average Rainfall variation of Tangail district (1987-2013)

The major cause of rain production is moisture moving along three-dimensional zones of temperature and moisture contrasts. Figure 1.7 represents the variation of average Rainfall between 1987 to 2013 years in kharif-II season. The lowest average rainfall was 5.33 mm in 1994 in kharif-II season and highest average rainfall was 13.69 mm in 1991 in the same season. For this climatic variation of 3 years, crop production has affected more above two years by the impact of climate.

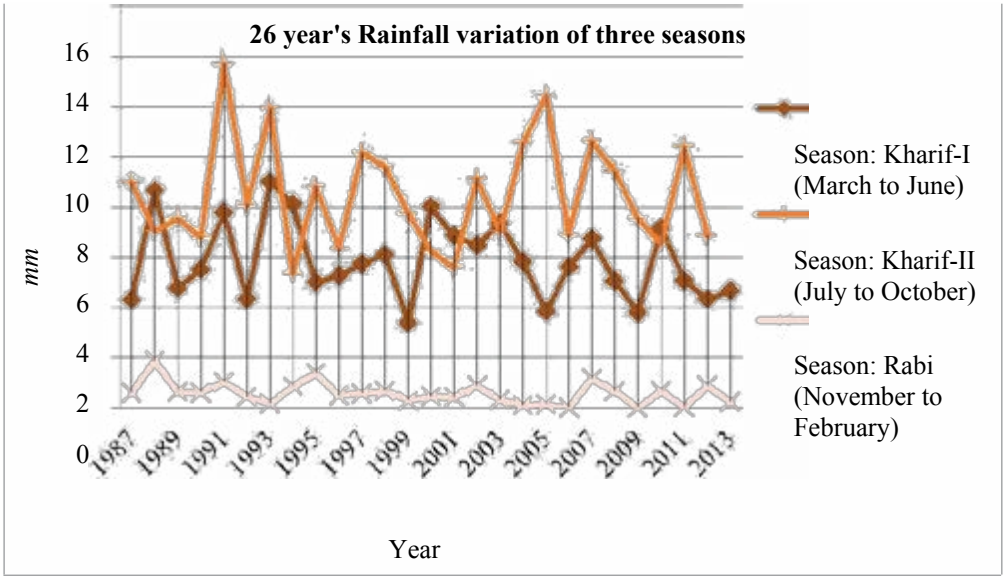
The distribution and selection of crops or the sustainability of veld or the period in which most runoff generated, depend not only on annual amounts, variability, or seasonality, but also on the duration of the rainy season. Figure 1.8 showing the more climatic impact season was Rabi season among the three. Crop production falls in decrease in the years of 1993, 1999, 2004, 2005, 2006, 2009, 2011, and 2013 in Rabi season. On the other hand, high rainfall is harmful for the crop production, for this reason in 1988, 1995, and 2007 Rabi season was highly hampered by the climatic change. This research proved that rainfall is not same every year it is changing by time in rabi season. Variation of rainfall is responsible for the cropping pattern of agriculture. So rainfall variation must impact on agriculture every year in Tangail district region.



Source: BMD, 2015

Figure 1.8: Average Rainfall variation of Tangail district (1987-2013)

The average amount of precipitation need not necessarily be a constraint to successfully carrying out an agricultural. Figure 1.9 showing the dynamics of average rainfall among the three seasons of 26 years. More rainfall occur in kharif-I season, little more rainfall occur in kharif-II season, and less rainfall in Rabi season. However, some year rainfall falls and some year it occurs more by the impact of climate change, and that is the main fact and effect in agricultural crop production.



Source: BMD, 2015

Figure 1.9: Average Rainfall Dynamics of Kharif-I, Kharif-II and Rabi seasons (1987-2013)

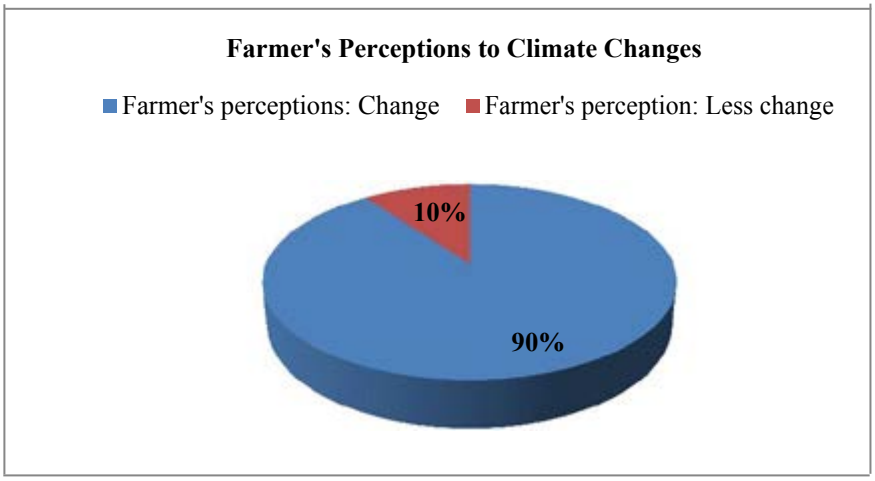
4.3 Agricultural Crop Calendar

A cropping calendar is a schedule of the crop-growing season from the fallow period and land preparation, to crop establishment and maintenance, to harvest and storage. The crop calendar allows a farmer to plan for input purchase and use, develop cash flow budget for year, determine need credit and period requirement, determine labor requirements and plan for peak usage times, organize contractors for land preparation and harvesting. Using a crop calendar allows better planning of all farm activities and the cost of production. Tangail region agricultural crop calendar presents in (Table 1.3) that represent the season wise variation of agricultural cultivation.

Table 1.3: Agricultural crop calendar of Tangail region

Kharif-I crops (March-June)	Kharif-II crops (July-Oct.)	Rabi crops (Nov.-Feb.)
Boro	Fallow	Mustard
Boro/Fallow	B. Aman	Mustard/Boro
Fal./Dhaincha	Fallow	Boro
Jute/Fallow	Fal./B.Aman	Wheat
Jute/Vegetable	Fal./B.Aman	Vegetables
Vegetables	Fallow	Maize
Jute	Fallow	Maize
Dhaincha	Dhaincha	Maize
Sugarcane	Sugarcane	Sugarcane
Maize	Fallow	Tobaco
Fallow	T. Aman	Boro
Fallow	B. Aman	Pulses
Vegetables	Vegetables	Pulses
Sesame	Fallow	Pulses
Jute	Fallow	Vegetables
Jute	Fallow	Tobacco
Fallow	B. Aman	Spices
Fallow	Vegetables	vegetables
Vegetables	Fallow	Spices

Source: BARC



Source: Field Survey, 2015

Figure 1.10: Farmer's perceptions of changes in climate

4.5 Adaptation strategies with the climate change

Climate change impact on agricultural. In this study climatic variables especially temperature and rainfall are more responsible these kinds of impact. Tangail district is a central district of Bangladesh. They provide lots of production of agriculture and contribute continuously to GDP and GNP. But sometimes Tangail district crop productions are really hampered by climate change. For this reason, they need to Adaptation strategies with the climate change. Some strategies are integrated below that would be able to help in Tangail district agricultural sector to provide more crops from the barrier of climatic hazard and probably it will be enriched our country economy and national policy.

a) Adaptation plans should prioritize helping people, places, and infrastructure that are most vulnerable to climate impacts and be designed and implemented with meaningful involvement from all parts of society.
b) Adaptation should incorporate into core policies, planning, practices, and programs whenever possible.
c) It should ground in the best-available scientific understanding of climate change risks, impacts and vulnerabilities.
d) It may require coordination across multiple sectors and scales and should build on the existing efforts and knowledge of a wide range of public and private stakeholders.
e) Adaptation planning should incorporate risk-management methods and tools to help identify, assess and prioritize options to reduce vulnerability to potential environmental, social and economic implications of climate change.
f) Adaptation plans may include measureable goals and performance metrics to assess whether adaptive actions are achieving desired outcomes.
g) Adaptation should, take into account strategies to increase ecosystem resilience and protect critical ecosystem services on which humans depend to reduce vulnerability of human and natural systems to climate change.
h) In which place possible Adaptation, it should use strategies that complement or directly support other related climatic condition or environmental initiatives, such as efforts to improve disaster all preparedness, promote sustainable resource management, and reduce greenhouse gas emissions including the development of cost-effective technologies.

5. Conclusion

This study has remarked some crucial findings after the useful research. The process of adaptation is not new, people have been adapting to changing conditions, including natural long-term changes in climate. This investigation are capable to climate change adaptation, but in a very small scale. Due to unplanned work, Lack of high cost, Scarcity of high Technology, over population, uncertain forces of natural calamity, Absence of proper distribution of Industry, more unemployment, don't appropriate preparedness for adaptation yet,

Government unable to carry right track, People do not have decent awareness etc. Agricultural crops can be destroyed by flood, not only flood but also some climate change related factors through, high temperature, Rainfall, tropical cyclone, storm surge, erosion, back water effect etc. Although we are developing country, but with the process of adaptation with climate change gradually we will touch develop as European country. This research would be best help to enlighten the Tangail district agricultural sector and enrich our local government and national government policy.

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Title: Organic Farming Prospects and Constraints in Bangladesh: a case study of Daynna Union of Tangail Sadar Upazila

Md. Sariful Islam, Md. Nasir Uddin, Mizanur Rahman, Tazwar Muttaqi

1. Introduction

Bangladesh is one of the most densely populated countries in the world with more than 160 million people. Due to its very small territory (147,570 square kilometers), the amount of additional land available to be brought into cultivation is very limited (BBS, 2006). The country has 8.20 million hectare arable land against the huge population (Hassan, 2011). The land area is steadily decreasing due to its population growth, rapid industrialization and infrastructural development. As a result, the amount of per capita land declined from 0.13 hectare in 1960 to 0.06 hectare in 2000. However, agriculture plays a pivotal role in overall economic development of the country. More than 70% of the population depends on agriculture (Jensen, 2000). Thus, the agriculture sector in Bangladesh is the most important sector in terms of sustaining growth and reducing poverty. However, a lack of adequate nutrient supply, the depletion of organic matter in soils, and soil erosion are major obstacles to sustainable improvements in agricultural production (MoA, 2008). The total amount of fertilizer used in Bangladesh has increased by about 1.55 million tons from 1994–95 to 2006–07, although the use of urea fertilizer has only increased by about 0.95 million tons over this period (BER, 2008). The use of pesticides increased from 7,350 metric tons in 1991 to 16,200 metric tons in 2001 (MoA, 2005), more than doubling over the course of a decade. Among this huge amount of pesticides, insecticides accounted for about 90%, and are generally used for vegetables and Boro rice (UNDP, 2006). This huge consumption of chemical fertilizers and pesticides applied to 7.32 million hectares of cultivated land (BBS, 2008) represents an over-use of agro-chemicals and a waste of foreign currency reserves, as the country imports most of the applied agro-chemicals, except for urea fertilizers. Given the challenges that arise from the over-use of agro-chemicals, a key policy intervention for sustainable agriculture is to encourage the adoption of agricultural technologies that rely to a greater extent on local or renewable resources. Organic farming (OF) is one such technology that can reduce the harmful impacts of agro-chemicals, and is considered by many scientists to be the best form of agriculture in terms of maximizing cost-effectiveness and minimizing pollution (Christian et al. 2005).

1.1 Statement of the problem

Before the introduction of chemicals, Bangladesh agriculture was fully dependent on the organic sources of fertilizers (animal manure, crop residues and domestic wastes) to fertile the land. In 1960s, with the introduction of green revolution, to follow former agricultural policy - to meet the demand of food for increasing population, some farmers started to use chemical fertilizers. Some of them used both chemical and organic fertilizers and some of them didn't adopt chemicals fertilizers due to conservativeness or lack of infrastructural facility (Hossain, 2001). The objectives of the organic farming are mainly to protect natural and agricultural resource bases from further degradation and to ensure long term

sustainability in agricultural system. Therefore, the understanding of organic farming status in Daynna union of Tangail Sadar Upazila, Bangladesh is necessary and also necessary to identify Constraints of organic farming in Daynna Union for visualize the overall status of organic farming in our country.

1.2 Objectives

The objectives of this research are mainly to protect natural and agricultural resource bases from further degradation and to ensure long term sustainability in agricultural system. Based on the above mentioned situation, the specific objectives of the study are:

1. To identify the present status of organic farming in Daynna Union of Tangail Sadar Upazila.
2. To look for the constraints of organic farming in Daynna Union of Tangail Sadar Upazila.
3. To know about the awareness status of organic farming in Daynna Union of Tangail Sadar Upazila.

1. Material and Methods

2.1 Study area

The studies were carried out in Daynna Union of Tangail Sadar Upazila under Tangail district of Bangladesh. Daynna Union is located within 24° 16' N latitude to 24° 14' N latitude and 89° 53' E longitude to 89° 51' E longitude.

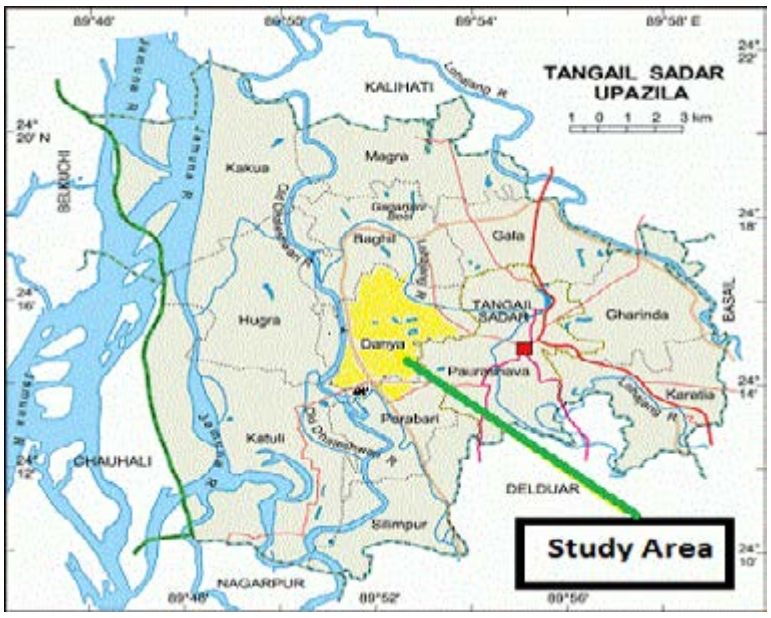

Fig. 2.1 Map showing Daynna Union at Tangail Sadar Upazila (Source: Banglapedia, 2008)

2.2 Study materials

The research carried out on the bases of primary and secondary information's. In this research, for collecting primary data, different methodologies were used including key informant interview, semi structured questionnaire survey, Focus Group Discussion (FGD) and other participatory rural appraisal (PRA) tools for the data collection. Secondary data were collected from different books, journals, different reports and websites. The key informants were Government officials, NGO officials and influential farmers.

Photo 1: Cow dung uses in organic farming system

Photo 2: Pest Management

2.2 Sample collection

The following data were collected by making a farmer questionnaire on independent variables for the individual (age, sex, education) and family (size and land holding) with dependent variables (awareness, available technology, opportunities and constraints). In contrast, a consumer questionnaire was created based on independent variables for individuals (age, sex, education, social status) with dependent variables (awareness and intention to buy production of organic farming). For collecting primary data, two types of questionnaire were created and used.

2.2.1 Questionnaire for farmer

Through a purposive random sampling technique, 20 farmers were selected. In addition, farm size and existing resources, number and area of interventions, awareness of the farmers, resource base and management capability of the farmers and other aspects were considered in selecting the participating farm households. The results of this questionnaire produced a view of each farmer's awareness and understanding regarding organic farming.

2.2.2 Questionnaire for consumer

Our objectives were to discover the awareness-level of consumers about organic production. We collected data from 20 consumers in the Tangail Sadar Upazila, Tangail. Consumers were randomly selected (interviewed the consumers in the open places as random basis) for this study.

2. Results and Discussions

3.1 Farmer's data analysis

3.1.1 Local concepts of organic farming in Daynna Union

The meaning of organic farming to farmers of Daynna Union is a practice in which farmers manage their farm based on natural resources and avoiding synthetic compounds.

3.1.1.1 Practice as Fertilizers

In the organic management system to supply essential plant nutrients, farmers of Daynna Union usually use, cow dung, different composts, green manure, crop residues, ash Rice barn, poultry litter etc.

3.1.1.2 Practice as Pesticides

For controlling insects and diseases, they use different non-chemical measures such as: Integrated Pest Management (IPM), Mechanical measures (e.g. Hand net, light trap etc.), Biological control (e.g. rearing of beneficial insects and pathogens).

3.1.1.3 Practice as Preservatives

Organic farmers and consumers in Daynna Union rely on different natural inputs rather than toxic hormones and preservatives for ripening fruits and storing their seeds and other harvested crops.

3.1.2 Present cultivation pattern in Daynna Union:

According to field survey the Figure 4.1.2 shows that 50% farmers are practicing inorganic farming, 20% farmers are practicing organic farming and 30% farmers are practicing mixed (organic farming and inorganic farming)

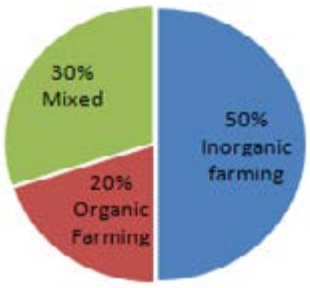

Fig. 3.1: Present cultivation pattern in Daynna Union.

3.1.3 Level of awareness of farmers about the harmful effects of pesticides

The Figure 2 shows that 77% of the farmers, agreed with the proposition that Chemical fertilizers and pesticides have harmful effect on soil, human and environment and 23% farmers have no idea about the proposition that Chemical fertilizers and pesticides have harmful effect on soil, human and environment` due to the lack of knowledge.

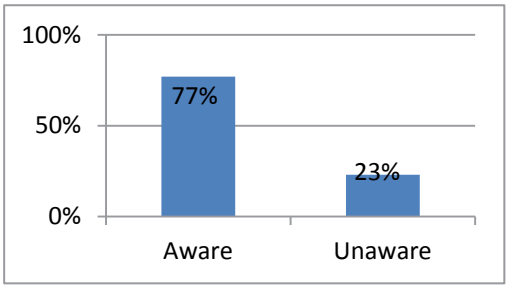

Fig. 3.2: Level of awareness among farmers about the harmful effects of pesticides in Daynna Union.

3.1.4 Interest in conversion from inorganic to organic farming among farmers

The Findings show that 20% of the farmers are interesting in conversion from inorganic to organic farming and rest are uninterested in conversion from inorganic to organic farming.

3.2 Consumers data analysis

3.2.1 Level of awareness of consumers about the harmful effects of fertilizers and pesticides

It is observed that 75% of the consumers are aware of the `harmful effects of pesticides or chemical fertilizer on human body and environment. Due to the lack of knowledge about organic farming only 25% of the consumers have no idea about the harmful effects of pesticides or chemical fertilizer on human body and environment.

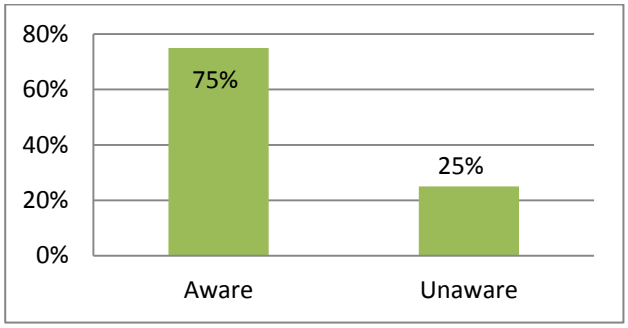

Fig. 3.3: Level of awareness about the harmful effects of pesticides or chemical fertilizer on human body and environment.

3.2.2 Interest in buying production of organic farming

It is observed that 80% of the consumers are interest in buying production of organic farming due to the purity, tasty and aesthetic value of these products. On the other hand 20% consumers have no interest in buying production of organic farming due to the lack of knowledge and the high rate of organic product.

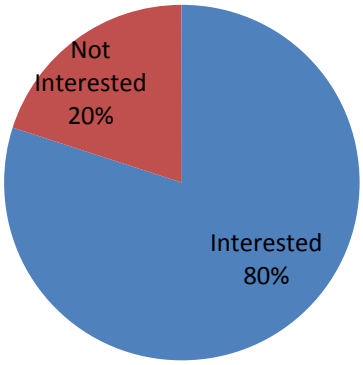

Fig. 3.4: Interest in buying products produced by organic farming

3.3 Constraints of organic farming in Daynna Union

To identify the core problems for organic farming in Daynna Union, a problem analysis was conducted. All the problems mentioned by the farmers and consumers, as well as personal observations and summarized these in Table no.3.1 and Table no. 3.2 Organic farming has four core problems poor farmers, poor farmer knowledge of organic farming and its benefits, insufficiency of organic inputs, and poor marketing of organic foods and summarized in the following tables.

Table 3.1 Problems faced by organic farmers in Daynna Union

Problems	Percentage (%)
Lack of technical support	35%
Marketing problems	15%
Lack of technical knowledge	20%
Lack of training	5%
Price problems	25%

Table 3.2 Problems faced by the consumers of buying organic food in Daynna Union

Problems	Percentage (%)
Organic produce not being certified	45%
Lack of trust of producers and sales personnel	25%
Insufficient supply of organic production	20%
Organic foods areavailable in a limited number of shops	10%

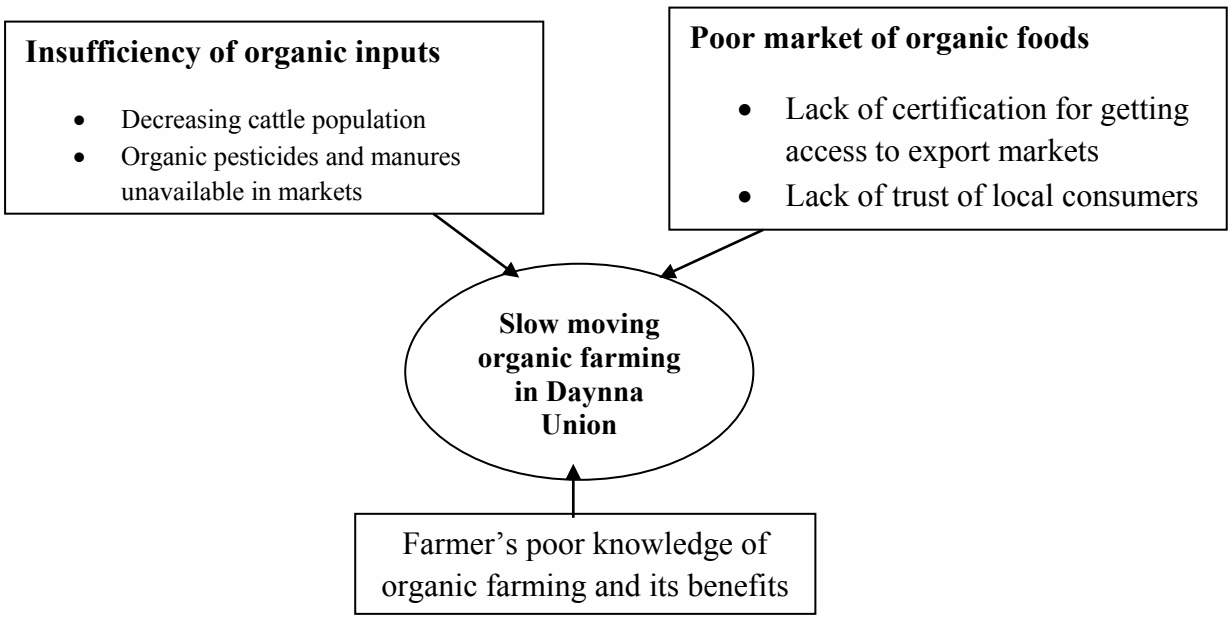

Fig. 3.5 Constraints of organic farming in Daynna Union

3. Conclusion

The current study, although the level of awareness about organic farming is low, did reveal that both farmers and consumers are aware of the toxic effect of chemical fertilizers and pesticides. With the introduction of organic farming and the assurance of some relevant factors (like price and quality), we expect an increase in the marketing of the production of organic farming in both domestic and overseas market. Results also indicate the constraints of organic farming in Daynna Union. Some major problems faced by organic farmers in Daynna Union such as lack of technical support, marketing problems, lack of technical knowledge, lack of training, price problems etc. Consumers also faced some Problems in Daynna Union such as organic produce not being certified, lack of trust of producers and sales personnel, insufficient supply of organic production, organic foods are available in a limited number of shops etc.

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Coastal Zone Management

Title: Canal Re-excavation: A viable approach for agricultural productivity enhancement in a coastal region of Bangladesh

Md. Gulam Kibria, Debanjali Saha, M. Shahjahan Mondal

1. Introduction

Bangladesh is an agrarian country and about 80% of her total population is dependent on agriculture (Rahman, 2004). According to Land and Soil Statistical Appraisal Book of SRDI (2010), agricultural land covers 9.5 million hectares (ha) area in Bangladesh. Crop agriculture accounts for about 60% of the agricultural GDP of this country (BBS, 2011). In the south-western coastal region of Bangladesh, agriculture is one of the major livelihoods of the local community. In most of the areas, one or two seasons' crop cultivation is the general practice. In many areas, crops can be cultivated only during one season, i.e., during the monsoon season. Aman rice is the dominant crop in the coastal region during the monsoon with small and medium scale crop cultivation in the dry season. Aman rice occupies more than 30% of the net cultivable area during the monsoon (Mishu and Zaman, 2013). Farmers get sufficient water supply from seasonal rainfall and salinity of the river water is comparatively lower during this season. However, boro rice cultivation during the dry season is very low and it covers less than 14% of the coastal area (Mishu and Zaman, 2013). This low cultivation is mainly due to the fact that salinity in the soil and water is comparatively higher during the months of April and May. So, unavailability of fresh water for irrigation and high salinity restrict the cultivation of boro rice. Other dry season crop cultivation, which includes sunflower, sesame, mustard, watermelon, vegetables, etc., is also hampered by high salinity of the south-west coastal area, variability of climatic parameters and climate change induced natural disasters. But to improve the socio-economic condition and standard of living, local people are now trying different agricultural adaptation Kibria, Saha and Mondal practices during the dry season to cope with the changing environment. These crops have varying requirements of resources and inputs, and their production also varies depending on the field condition and availability of input resources such as quality seeds, irrigation water, fertilizers, labor activities, etc. Cultivation of dry season crops can be increased if the supply of sufficient irrigation water is ensured. Coastal areas are characterized by a wide network of canals and other internal water bodies. These water bodies have high potential to supply irrigation water during the dry season under proper management. This specific study focused on the role of the canal re-excavation in agricultural productivity enhancement in a selected polder of the south-west coastal region of Bangladesh. This study will help the policy makers to design a better agricultural adaptation measures for the coastal region of Bangladesh.

2. Literature Review

The south-west coastal region of Bangladesh consists of unique environmental and geographical characteristics and a complex network of rivers, canals and beels. According to several studies, this region has been identified as one of the climatically challenged areas with fragile ecological settings, which are likely to increase livelihood vulnerability

in changing future climatic conditions (IPCC, 2007; Dasgupta et al, 2010). Coastal livelihoods are frequently affected by various natural and anthropogenic events which include cyclones, cyclonic storm surges, floods, river erosion, salinity intrusion, ecosystem degradation, etc. (Oxfam International, 2009). On the other hand, climate change and associated impacts pose a serious threat to the coastal livelihoods and in achieving food security and thus make the reduction of poverty even more difficult (Kibria et al., 2015).

Agriculture is one of the major livelihood options for the coastal people of Bangladesh (GoB and UNDP, 2009). About 40 million people in the coastal areas of Bangladesh directly or indirectly depend on agricultural activities (BBS, 2011). The amount of gross and net-cropped area in the coastal zone of Bangladesh is 144085 hectares and 83416 hectares (Islam, 2004). The trend of traditional agricultural practices is continually changing (Islam, 2006). Traditionally, local farmers used to cultivate both local and HYV aman rice during the monsoon season. During the pre-monsoon and the dry season, water used to be more saline which limited the crop production. People cultivated only some homestead vegetables during those seasons for their personal consumptions. Unavailability of fresh water during the dry season, high soil and water salinity, intrusion of saline water during natural disasters and regular tidal cycles resulted in the lowering of agricultural productivity during the dry season. As a result, poor and marginal coastal people became more vulnerable due to loss in agricultural productions. Food shortage became prevalent and subsequent price hike restricted the purchasing capacity of the local people (Nasreen et al, 2008).

Since the past few years, the net cropped area has been showing a decreasing trend due to a combination of factors. Local farmers were compelled to switch to shrimp farming to maintain their livelihoods and to incur more benefits (Karim, 1986). According to Gowing *et al*. (2006) and NAPA (2005) degradation of soil quality due to salinity (which was exacerbated by shrimp cultivation) is the main reason for the reduction of crop production and subsequent crop land. Researchers have recently identified several other problems which put the coastal agriculture at stake. Overuse of lands due to continuous pressure from increasing food demands and contamination of soil and water quality are the major problems. According to Sarwar and Khan (2007), Sea level rise affects coastal agriculture in two ways. Salinity intrusion degrades soil quality which in turn reduces rice production. Cropping intensity in the coastal region of Bangladesh is also unsatisfactory. Compared to the national cropping intensity of 175%, the intensity in the coastal area is about 162.74% (BBS, 2010). From the year of 1996 to 2008, where there is a 5.87% increase in net cultivable land of Bangladesh, there has been a loss of 5.89% net cultivable land in the coastal areas (Mishu and Zaman, 2013). In recent years, salinity has increased from 6% to 25.6% in the coastal area, depending on the location (SRDI, 2010). The salinity situation of the south-west coastal region had become worse after the cyclone Aila of 2009, as short and long term inundation degraded the soil and water quality up to a damaging extent. The traditional practice of aman rice cultivation during the monsoon season and rabi crop cultivation during the dry season often experience impacts of such natural disasters and their production vary with the situation.

Due to increasing population and decreasing agricultural land, farmers now have to

produce more rice from the limited land resources by adopting improved management practices and potential input supply. However, crop agriculture is constrained by a variety of challenges every year. Due to high population density and increasing food demand, the effects of any natural disaster on agricultural production of this country are alarming to the national food security. Climate change is another driving factor which contributes to the livelihood diversification of the coastal inhabitants. Dry season crops are under the threat of future changed climate as the event is likely to reduce the availability of suitable irrigation water. Very few studies have been conducted so far to assess the production and yield performance of the dry season crops under proper adaptation measures. This specific study focuses on the canal re-excavation as a potential agricultural adaptation measure and investigates its prospects in agricultural productivity enhancement.

3. Study Area

There are 139 polders in the coastal region of Bangladesh (Khan, 2014). This study has been performed in a selected polder of Dacope upazila, Khulna district of south-west coastal region of Bangladesh. There are three polders in Dacope upazila namely, Polder 31, 32 and 33. Among them, Polder 31 has been selected for this specific study (Figure 1). There are two unions and one pourashava in Polder 31. They are Pankhali and Tildanga unions and Chalna pourashava. This polder is characterized by a wide network of rivers, canals and internal water bodies. The polder is bordered by the Sibsa river on the north and the west, the Rupsa and the Bhadra rivers on the east and the Dhaki river on the south. The major canals in the polder are Moukhali Doani khal, Baruikhali khal, Batbunia khal, Chalna khal, Mora Bhadra khal, etc., which act as the sources of dry season irrigation water and monsoon season drainage channels. Livelihood pattern includes crop agriculture, fishery, wage labor, small business, Sundarbans dependent work, etc. Major livehood option is agriculture and major agricultural crops are rice (aman and boro), sunflower, sesame, pulses, vegetables, etc.

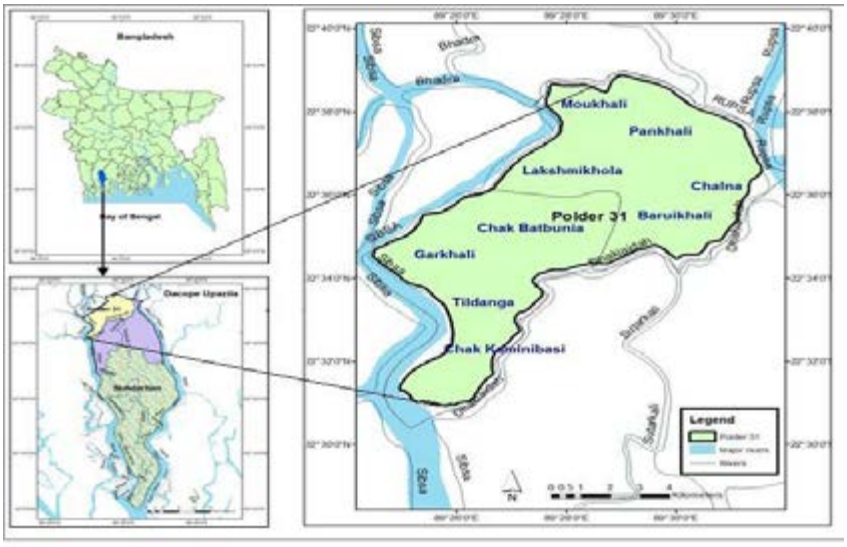

Fig. 1: Location of the study area

Net cultivable land in the area is 5395 hectares (ha). Usually there are two crop seasons in

the study area. During the monsoon season, aman rice is cultivated with natural water supply from monsoonal rainfall. During the dry season, boro rice and some non-rice crops are cultivated in small scale. Boro rice cultivation ranges from mid-November/December to April. Other non-rice crops are cultivated between January to May. During this time of the year, both soil and water salinity reaches to the peak. Soil salinity ranges from 8-22 dS/m while water salinity ranges from 6-18 dS/m.

4. Methodology and Data Collection

For the study, primary and secondary data were collected using some Participatory Rural Appraisal (PRA) tools including individual interviews, Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). The major canals in the study area were identified and then the length and width were measured using the 'Google Earth'. Then a map of the canal network system was prepared and taken in the field for verification. Using local people's perception and field knowledge, and discussions with informants from relevant organizations, depth and other canal properties were verified. Technical analyses for crop water requirement, canal storage and profit estimation for various types of crop cultivation have been performed using the collected data. Relevant primary and secondary data were collected from several field visits to the study area. Data on crop types and canal properties were collected from local farmers, personnel from Bangladesh Water Development Board (BWDB), Dacope Agriculture Office, etc. Relevant literatures were reviewed in the context of the coastal region of Bangladesh for previous cropping history, crop types, existing cropping pattern, etc.

5. Results

During our study, it was found that dry season crop cultivation has been limited due to unavailability of suitable irrigation water. There are a good number of canals and internal water bodies in the study area which can be used as potential sources of irrigation during the dry season. But most of the canals have been silted up due to lack of proper management. We have identified the major canals in Polder 31 (Figure 2) using the Google map and then verified those canals in the field during our visits to the area (Table 1). The length, width and depth were measured integrating data from the field and the satellite. According to the local people, the average water depth in the canals is 1.0-1.5 m during the dry season. With this small amount of water, the local people do not feel interested to cultivate any dry season crops.

Fig. 2: Existing major canals in Polder 31

Tab. 1: Dimensions of major canals in Polder 31

Name	Length (m)	Width (m)	Water depth during dry season (m)
Kaminibashia khal	2740	15	1
Mora Bhadra khal	7100	95	1.5
Gorkhali khal	7350	21	1.1
Kironkhali khal	2000	8	0.6
Tetultola khal	3560	8	0.4
Batbunia khal	5490	10	1.5
Kakrabunia khal	2870	9	1.25
Nishenkhali khal	2640	10	1.4
Deloti khal	4170	14	1.2
Chalna khal	5490	15	1.7
Baruikhali khal	3450	9	0.5
Moukhali Doani khal	8500	40	2
Kholisha khal	3000	10	1
Katakhali khal	1870	13	1.2
Hetalbunia khal	3490	9	1.1
Shatgoria khal	3280	9	0.6

Source: Length and width data have been taken from Google Earth and depth data from local people and BWDB authority

It was found that, BWDB re-excavated Chalna khal, Baruikhali khal and Moukhali Doani khal (Table 2). After re-excavation of these three canals, local farmers are cultivating the surrounding lands with the stored water during the dry season. Farmers are cultivating boro rice, sunflower and sesame during the dry season. Other farmers are being inspired by the beneficiary farmers. Officials from BWDB informed that, if the canals are re-excavated by 1.2 m then about 2.0-2.5 m depth of water will be available during the dry season. For subsistence use of the local communities, 0.45 m depth of water will be needed to be kept in the canals. The additional water can be used for irrigation purpose during the dry season.

Tab. 2: List of previously re-excavated canals

Canal Name	Previous depth (m)	Depth after re-excavation (m)
Chalna	1.50	1.70
Baruikhali	0.60	1.10
Moukhali Doani	1.20	2.00

Source: Field visits and BWDB, Khulna office

We have calculated the volume of water available for dry season irrigation (Table 3). Based on the information provided by the local farmers and satellite information on the canal dimensions, the volume of available water for irrigation has been calculated. Keeping 0.45 m water for the domestic purposes, the remaining water has been assumed to be used for irrigation purposes.

Tab. 3: Volume of available irrigation water in the re-excavated canals

Name	Depth after re-excavation during the dry season (m)	Water available for irrigation (m)	Volume of irrigation water (m^3)
Kaminibashia khal	2.20	1.75	71925
Mora Bhadra khal	2.70	2.25	1517625
Gorkhali khal	2.30	1.85	285547
Kironkhali khal	1.80	1.35	21600
Tetultola khal	1.60	1.15	32752
Batbunia khal	2.70	2.25	123525
Kakrabunia khal	2.45	2.00	51660
Nishenkhali khal	2.60	2.15	56760
Deloti khal	2.40	1.95	113841
Chalna khal	2.90	2.45	201757
Baruikhali khal	1.70	1.25	38812
Moukhali Doani khal	3.20	2.75	935000
Kholisha khal	2.20	1.75	52500
Katakhali khal	2.40	1.95	47404
Hetalbunia khal	2.30	1.85	58108
Shatgoria khal	1.80	1.35	39852
Total			3648670

Recently practiced crop types such as boro rice, sunflower and sesame have been taken into consideration during the technical analysis. The number of irrigation and the amount of water for each irrigation event have been used in the calculations as collected from field visits. Irrigation water requirement for boro rice, sunflower and sesame have been found as 900 mm, 120 mm and 40 mm respectively. Calculations were done for various combinations of dry season crop production for the above amount of available irrigation water mentioned in Table 3. Economic analysis based on the local people's information shows that, profit from boro rice cultivation is BDT 50000/ha while it is BDT 45000/ha from sunflower and BDT 20000/ha from sesame. Profit analysis included the cost in land preparation, seed and fertilizer cost, irrigation cost, all kinds of labor cost, selling price of harvested crops, etc. Detailed comparison of net profit from three major dry season crops is shown in Table 4. If all the available water for irrigation is spent in sesame cultivation, then maximum area can be brought under irrigation. But, in this case, the profit is found to be comparatively low. If all the available water for irrigation is spent equally in cultivating two crops, namely sunflower and sesame, then the profit will be maximum and the amount of land use will also be maximized. This maximum land use indicates that number of beneficiary farmers will also be maximized. But, as rice is the staple food in Bangladesh, so farmers are interested to include rice cultivation in their crop schedule during the dry season to meet their food requirement. Including rice in the crop schedule, it has been found that, if the combination of rice, sunflower and sesame cultivation using equal amount of water is chosen by the farmers, then the area coverage under irrigation will be almost 80% of the net cultivable area with a profit of about BDT 110 million.

Tab. 4: Comparison of profit from three major dry season crops in Polder 31

Crop type	Rice		Sunflower		Sesame		Total area under irrigation (ha)	Total profit (million, BDT)
	Land area (ha)	Profit (million, BDT)	Land area (ha)	Profit (million, BDT)	Land area (ha)	Profit (million, BDT)		
Rice	405	20	0	0	0	0	405	20
Sunflower	0	0	3040	137	0	0	3040	137
Sesame	0	0	0	0	5380	105	5380	105
50% rice + 50% sunflower	203	10	1520	68	0	0	1723	78
50% rice + 50% sesame	203	10	0	0	4561	91	4763	101
50% sunflower + 50% sesame	0	0	2690	121	2690	54	5380	175
50% rice + 25% sunflower + 25% sesame	203	10	760	34	2280	46	3243	90
25% rice + 50% sunflower + 25% sesame	101	5	1520	68	2280	46	3902	119
33% rice + 33% sunflower + 33% sesame	134	7	1003	45	3010	60	4147	112

Previously, in the study area, only aman rice during the monsoon was practiced and during the dry season due to high salinity and unavailability of fresh water, the lands were kept fallow in most of the cases. Re-excavation of the canals will result in availability of irrigation water and subsequent increase in land coverage under cultivation during the dry season. It has been found that, with the water available in some internal water bodies in some areas, local farmers are getting irrigation supply in less than 10% of the net cultivable land (Land Zoning Report, 2011). If major canals in the study area are re-excavated, with the additional water supply from the re-excavated canals, rice can be cultivated in 8% of the net cultivable land area. Whereas, if the additional water is used in sesame cultivation, then it will cover 56% of the net cultivable land area. The land coverage for various crop types with available irrigation water after canal re-excavation is provided in Table 5. It has been found that, for some combinations of dry season crop cultivation, there is a potential to irrigate all the net cultivable land. The above stated irrigation facility will increase the local farmers' agricultural activities, increase their economic return and improve their socio-economic condition.

Tab. 5: Comparison of irrigation coverage for different dry season crop cultivation

		Irrigation coverage as percentage of net cultivable land
Before canal re-excavation		10
After canal re-excavation	Rice	8
	Sunflower	56
	Sesame	100
	50% rice + 50% sunflower	32
	50% rice + 50% sesame	88
	50% sunflower + 50% sesame	100
	50% rice + 25% sunflower + 25% sesame	60
	25% rice + 50% sunflower + 25% sesame	72
	33% rice + 33% sunflower + 33% sesame	77

6. Discussion

There are more than 30 canals of varying sizes in the study area. Most of the canals have become narrower and shallower with time due to lack of proper management. Siltation and human interventions have transformed the canals into dying canals. The community people and local government organizations were not much interested in the re-excavation process of these canals as it was very costly. So these canals remained unattended for a long period. In the recent past, some canals were excavated by BWDB and some farmers started storing rainwater in them. Using this water for irrigation, they started some sunflower cultivation along with small scale boro rice during the dry season. In that year, they earned some profit from the crops and other farmers were inspired from this practice. They realized that, if they keep their lands fallow, then there will be no improvement of their living condition neither the soil salinity will reduce. This fact has made them think about cultivating dry season crops to get some profit and also food supply for the rest of the year, which they were not getting adequately with only aman rice cultivation. Now-a-days, they are trying to store some fresh water in some ponds and on-farm reservoirs at or nearby their fields. They are also interested in storing more water, which make them demand re-excavation of the existing canals.

The canal re-excavation includes slope development, increase in width and depth to increase storage capacity (Figure 3). It has been found that, storage capacity of most of the canals has reduced due to siltation. If the canals are rehabilitated through proper earth cutting, then it will be able to store a considerable amount of water.

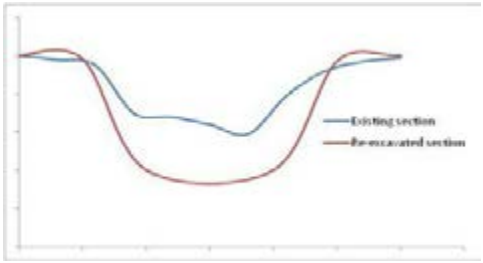

Fig. 3: Typical existing and re-excavated canal sections

BWDB is the government organization which usually carries out the task of re-excavating the canals. But, once the canal is re-excavated, local people will have to come forward to keep the canal operational. For this purpose, canal management groups will have to be structured. A committee to manage the proper functioning of a canal will have to be formed. Regular supervision of the canals by selected committee members will be done. Any problems or conflicts related to the canals or canal water will be resolved by the committee. A sub-assistant engineer from BWDB, Khulna informed that, a few years back some canals were re-excavated in the study area. But, due to the carelessness of the local people and conflicts of different livelihood groups these canals silted up with time. Along with BWDB, other non-governmental organizations need to be involved actively in canal re-excavation work. Training and workshop program should be arranged by governmental and non-governmental organizations to build the management capacity of the local people.

During several visits to the study area, a number of problems and barriers were identified that hinder the task of canal re-excavation. Insufficient government fund is one of the major barriers. Re-excavation of the canals requires a huge amount of money. Per cubic meter of earth cutting (manually) requires 113.76 taka (BWDB office, Khulna). A hypothetical rectangular canal of 20 m width and 2000 m length requires almost BDT 45 Kibria, Saha and Mondal lacs to re-excavate it up to 1 m. Dacope agriculture office and BWDB office of Khulna informed that, in spite of the dirge public demand, they cannot re-excavate the canals due to huge cost and insufficient government fund.

Despite a number of barriers, the canal re-excavation is a burning demand in the agriculture dominant coastal polder. If all the governmental and non-governmental organizations come forward to re-excavate the canals and local community actively participate in management of the canals, then it will play a vital role in agricultural productivity enhancement in the study area.

7. Conclusion

This study identified the major canals in Polder 31 and their dimensions (length, width and depth) from satellite and field visits. This study found that, if the major canals are re-excavated by 1.2 m then they will act as a potential source for dry season crop production. The available irrigation water after canal re-excavation can be utilized in various ways for different kinds of dry season crops, which are likely to benefit the farmers. The amount of profit may vary depending on the cultivated crop types. This study also found that, if the available water in the re-excavated canals are used equally in sunflower and sesame cultivation, then the best utilization can be achieved in terms of land use and profit. It has been found that, irrigation coverage for up to 100% of the net cultivable land is possible under some combination of crop cultivation, whereas less than 10% of the net cultivable land is under dry season irrigation at present. Water utilization for rice cultivation combined with other crops has also been investigated in this study as for the food consumption of local people, rice cultivation is of paramount importance. Success of the canal re-excavation work largely depend on the proper management of the re-excavated canals. The increased irrigation facility will result in an increased crop production, which will lead to a better socio-economic condition and provide agricultural sustainability.

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Title: Variation of Morphological Characteristics with Varying Hydraulic Regime for the Estuaries of the Ganges-Brahmaputra-Megha Delta

Md. Wasif-E-Elahi, Fatin Nihal, Anisul Haque, Munsur Rahman

1. Introduction

Deltas are important dynamic environments that are constantly reshaped and reformed (Brown and Nicholls, 2015). The GBM delta, situated in Bangladesh and India (West Bengal), covers approximately 100,000 km^2 of lowland flood and delta plains (Goodbred and Kuehl, 2000). Main drivers that affect the characteristics of hydraulic regime of estuaries are tide, discharge of the rivers, waves, lateral sediment transport, density difference of water and climatic factors (Savenije, 2012). Tide and river floods are the two most important factors in determining estuarine shape. However, it is the combination of all these drivers that leads to the wide range of estuarine shapes and behaviors, each with a different aquatic environment. Several ways to classify estuaries are according to shape, tidal influence, river influence, geology and salinity. Alluvial estuaries are estuaries that have movable beds, consisting of sediments of both riverine and marine origin, in which there is a measurable influence of fresh water inflow. The water moving in the estuary can either erode the estuary bed (by deepening or widening) or it can deposit sediments and, in doing so, make the estuary narrower or shallower. Hence, the shape of an alluvial estuary is directly related to the hydraulics of the estuary, or as Wright et al. (1973) put it: "the simultaneous co-adjustment of both process and form has yielded an equilibrium situation". In this paper, relation between flow velocity and width-depth ratio (WDR) is developed.

2. Study area

To assess the variation of morphological characteristics of estuaries of GBM delta, seven estuaries are selected from the different estuarine systems. Rupsa and Sibsa estuary from Western Estuarine System (WES); Baleswar, Bishkhali and Buriswar estuary from Central Estuarine System (CES) and Tentulia and Lower Meghna estuary from Eastern Estuarine System (EES) (Haque et al, 2015) are selected and is shown in Figure 1. In this study, Width-Depth-Ratio (WDR) of each estuary is calculated from the Google Earth image. Flow velocity of each of the estuaries in different locations is computed from a calibrated and validated morphology model (Delft-3D) for the average year condition (2000). Locations are shown in Figure 2. An average flood year is defined as the year when 20% - 24% of the entire country is flooded (BWDB, 2012). Relation between WDR and flow velocity is developed for each of the estuarine systems.

Md. Wasif-E-Elahi

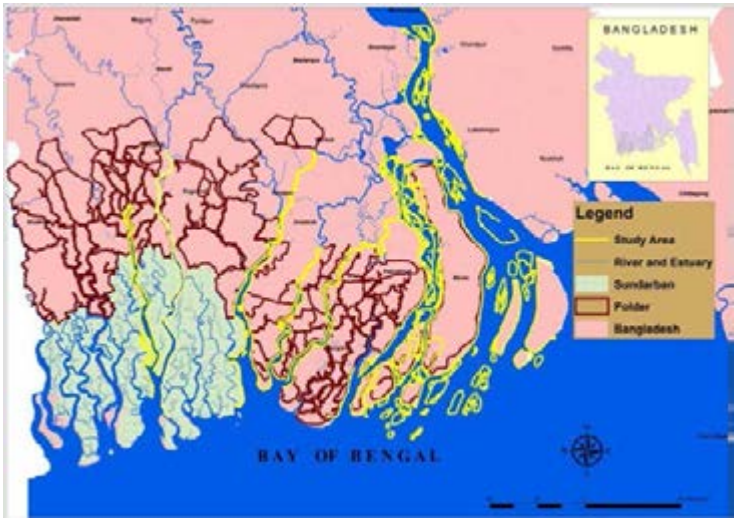

Fig. 1: Map of study area

Fig. 2: Locations of computed B/D and model velocity point

3. Model description

Open source Delft3D Morphology model, which is well-verified and widely applied in different parts of the world, is applied in the study region to compute the hydraulic parameters. The model is applied using a single-layer spherical coordinate system. Curvilinear grid is used for spatial discretization. In the ocean, grid size was approximately 500 m X 600 m and in estuaries the grid size was approximately 200 X 300 m. Constant roughness value, 0.025 is used over the study area. Figure 2 shows the Model domain with boundary locations.

Time series of discharge is specified as the upstream boundary condition, with a time series of water level in the downstream boundary condition. Discharge data is used from the measurement of the Bangladesh Water Development Board (BWDB) for the year 2000. As downstream water level boundaries in ocean, tides at the sea boundary are generated by using Nao 99b tidal prediction system (Matsumoto et al, 2000).Bathymetries of the rivers/ estuaries are specified by using measured cross sections collected within the ESPA-delta project of BUET. The inland ground elevation data are collected from the Centre for Environmental and Geographic Information Services (CEGIS), Bangladesh which is generated from FINNMAP Land Survey 1991, National DEM from FAP19 (CDMP, 2009).The ocean bathymetry is specified by using the open access data from General Bathymetric Chart of the Oceans (GEBCO) and can be found at http://www.gebco.net/.

For the sediment boundary condition, sediment concentrations are used from the measured data of BWDB at Hardinge bridge station, Bahadurabad transit and Bhairab Bazar station for the year 2000.

Fig. 3: Morphology model validation location

Location of the stations is shown in the Figure 3. Model reliability is calculated for each estuarine system by computing the reliability indicator described by Haque et al (in preparation) as:

$$\frac{\sum |\quad\quad|}{\sqrt{\sum (\quad\quad)}}$$

Here, Reliability is a new model reliability measure indicator introduced by Haque et al [10] and is shown to quantify performance of a dynamic model realistically. Reliability = 100 % means the model is 100% reliable with respect to measured values. Here and are the measured and the model values at any instant of time t, is the average of the measured values, t is any time instant, T is total duration for both the measured and model values and n is the total number of values.

4. Model validation

Model parameters are determined from an exhaustive calibration exercises. Calibrated model is validated using long term (more than 10 years) data. The validation results are shown in Table 1.

Tab. 1: Model validation results

River name	Station name	Measured erosion/deposition rate (cm/month) (For a long Period of data which is more than 10 years)	Model erosion/deposition rate (cm/month) (Only for the base year condition)	Reliability %
Bishkhali (CES)	BIS16	-0.0122	0.1912	49.26
	BIS15	-0.1426	-0.1504	
	BIS14	-0.4637	-0.4430	
	BIS12	0.3157	0	
	BIS11	0.0083	-0.0837	
Lower Meghna (EES)	ML2	-0.7832	0	41.80
	ML5	0.2265	-0.0023	
	ML12	-0.2471	-0.0010	
Rupsa (WES)	RP10	-0.9200	-0.2532	50.86
	RP13	-0.6169	-0.3153	
	RP14	(n/a)	-0.3492	
Overall Model reliability over the estuarine systems				**47.30**

*** The negative sign means erosion and the positive sign means deposition.

5. Result and discussion

Computed WDR with distance from mouth of selected rivers are shown in Figure 4. Distance from mouth is presented as Non-Dimensional Distance factor (NDF) where NDF is the ratio of distance from the mouth to the total length of the river. Higher correlations values between the variables of the regression model are found for all the estuaries except the Buriswar River. As shown in Figure 4, correlations between WDR and NDF show increasing trend from the Sibsa to the Baleswar estuary (as we move from WES to EES). In general estuaries of CES (Baleswar and Buriswar) show lower correlation compare to estuaries of EES (Tetulia and Lower Meghna).

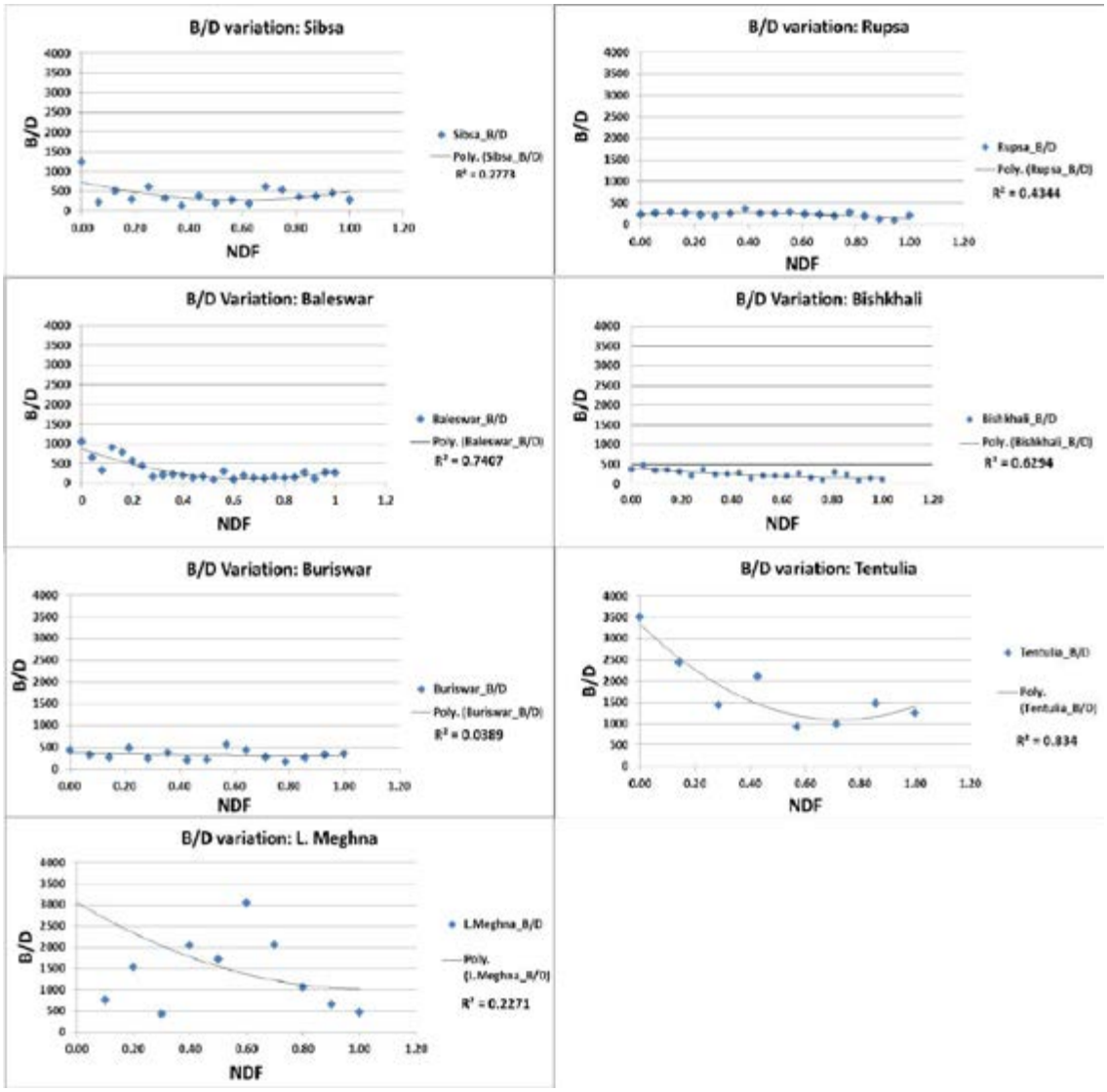

Fig. 4: Width-depth ratio of different rivers over the GBM delta

Depth average flow velocity for different estuaries are computed from the Delft-3D morphology model. Velocity variations along the estuary from the mouth to head are plotted for differnt estuaries and are shown in Figure 5. The highest velocity is found at the mouth of Lower Meghna estuary and the lowest velocity is found near the head (NDF-0.75) of Sibsa estuary . In general, velocities are higher at the mouth (NDF=0.0) than the head (NDF=1.0) for all the estuaries except Rupsa, Buriswar and Tentulia . This may be

due to meandering pattern of these estuaries, presence of Chars and relatively high discharge.

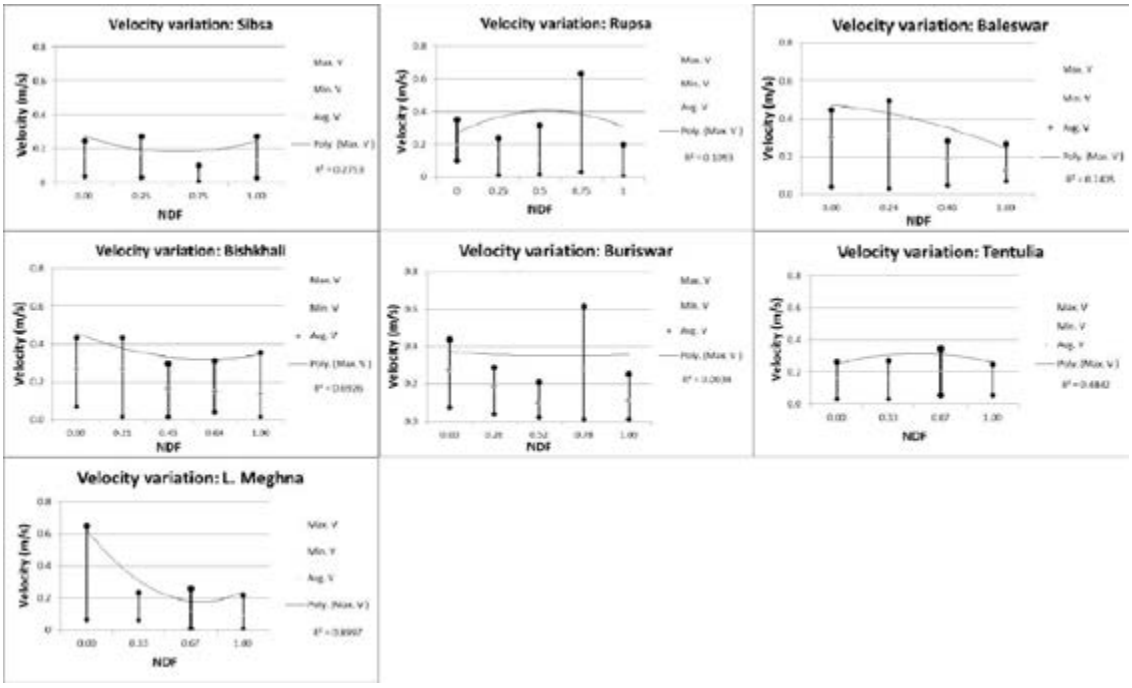

Fig. 5: Velocity variation of different rivers with distance from mouth

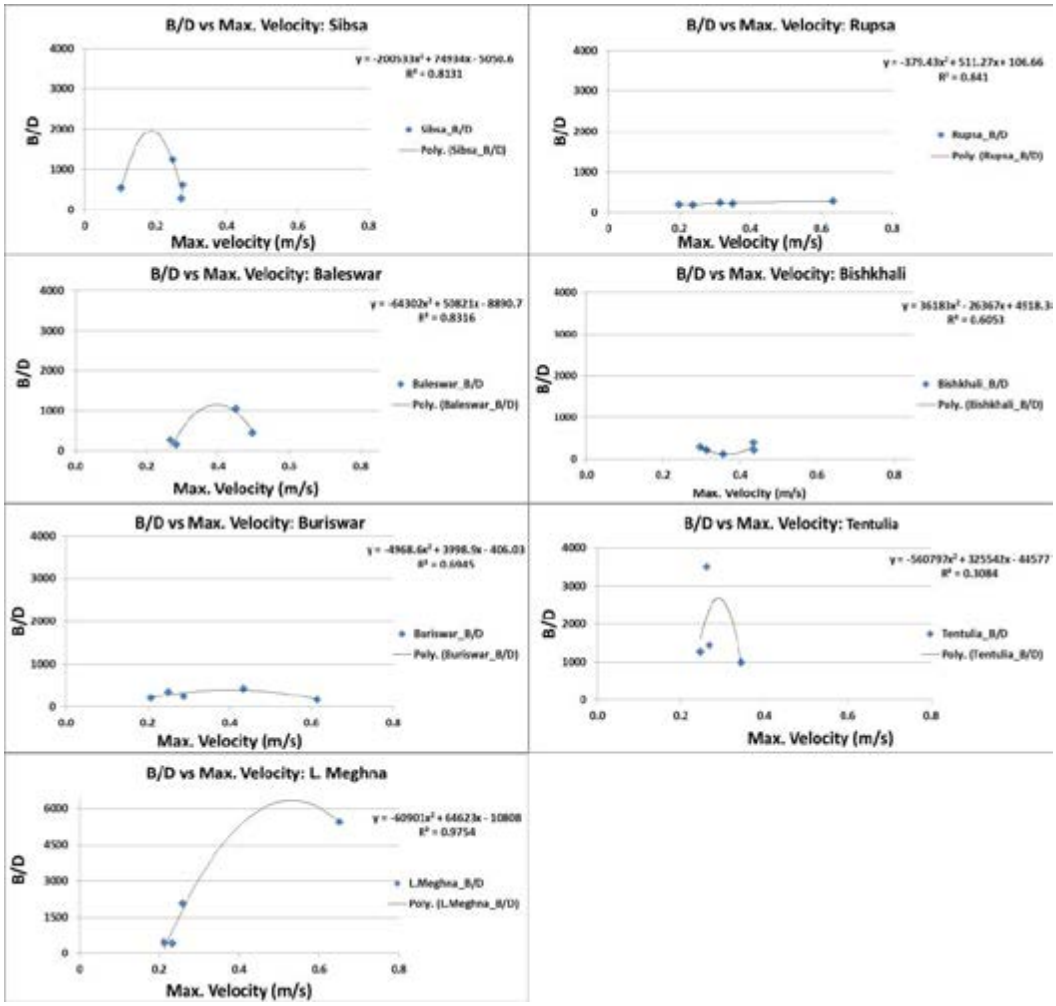

Fig. 6: Width-depth ratio variation with maximum flow velocity of different rivers

In Figure 6, WDR and maximum flow velocity are plotted for the same NDF location for each of the estuaries. The general relation between WDR and NDF is polynomial with correlations varying from 0.31 (for Tetulia estuary) to 0.98 (Lower Meghna estuary). The regression equations along with correlations are shown in Table 2.

Tab. 2: Model for different estuary

Estuarine system	River name	Equation y = B/D and x = Max. flow velocity (m/s)	R^2 value
WES	Sibsa	$y = -200533\ x^2 + 74934x - 5050.6$	0.81
	Rupsa	$y = -379.43\ x^2 + 511.27\ x + 106.66$	0.84
CES	Baleswar	$y = -64302\ x^2 + 50821\ x - 8890.7$	0.83
	Bishkhali	$y = 36183\ x^2 - 26367\ x + 4918.3$	0.61
	Buriswar	$y = -4968.6\ x^2 + 3998.9\ x - 406.03$	0.69
EES	Tentulia	$y = -560797x^2 + 325542x - 44577$	0.31
	Lower Meghna	$y = -60901\ x^2 + 64623\ x - 10808$	0.98

6. Conclusion

Using Delft 3D model results – regression models are developed relating morphological variables with the hydraulic drivers for the estuaries of the GBM delta. The general regression trend is found to be polynomial with correlations varying from 0.31 to 0.98. These regression models can be used to compute morphological variables (width/depth ratio) once hydraulic variables (instantaneous tidal velocity) are known or vice versa.

7. Acknowledgment

The authors would like to acknowledge to NERC, ESRC, UK DFID, ESPA for funding this work as part of the ESPA Deltas project (Grant Reference Code : NEJ0027551). We would like to acknowledge the contribution of all the members associated with the research team who has direct and indirect input to this article.

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Haque A, Sumaiya, Salehin, M Rahman M Reliability analysis of dynamic models, in preparation

Title: Storm Surge Flooding due to SIDR-AILA and SIDR-AILA-LIKE Cyclones along the Bangladesh Coast

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Rabeya Akter, Mashrekur Rahman, Rifath Ara Rimi and Meer Ahemed Tariqul Omar

1. Introduction

The Bay of Bengal is a potentially energetic region for the development of cyclonic storms and around 7% of all these cyclones hit the coast of Bangladesh (Gray, 1968).) Inundation due to cyclone induced storm surges causes significant loss in the coastal livelihood (Gonnert et al., 2001), that leads to long term damage to coastal eco-systems and landscape (Dietrich et al., 2013). Bangladesh coast is infamous for the negative impact that storm surge flooding (De Angelis, 1976). From 1877 to 1995, about 154 cyclone, including 43 severe cyclonic storms, 68 tropical depression hit Bangladesh coast (Dasgupta et al., 2010). Since 1995, 5 severe cyclones hit the country's coast. On average, a severe cyclone strikes the country every three years (GoB, 2009), and more than 14 severe cyclones are generated in Bay of Bengal in every ten years (IWM, 2002). Historical cyclones such as Barisal cyclone in 1584, Bakergonj cyclone in 1876, 1970 cyclone, 1985 Urirchor cyclone, April 1991, Sidr in 2007, Aila in 2009 have brought Bangladesh into global attention as a disaster-prone country. Among them, cyclone SIDR is notable for its strength and cyclone AILA is famous for its severe after-effects. Cyclone SIDR that devastated the coastal zone of Bangladesh in 2007, was one of the most catastrophic natural disaster, causing nearly 2,388 human casualties and $2,300 billion property damage. Whereas AILA caused nearly 190 human casualties and property damages amounting to $270 billion (World Bank, 2010).Inundations generated by both of these cyclone are influenced by their landfall locations. This study is mainly focused on the actual inundation characteristics (surge depth and areal extent of flood) of SIDR-AILA cyclones and possible inundation characteristics of these cyclones if their landfall locations are different than the actual ones (SIDR-AILA-LIKE cyclones).

2. Study Area

Bangladesh coastal region is divided into eastern, central and western region (ESCAP/UN, 1987). The study area selected comprises the south-western and south-central region of Bangladesh including the Sundarban
(Fig. 1). Western part is known as Ganges tidal plain and consists of semi-active delta and has a very low and flat topography. The area lies about 0.9 to 2.1m above the mean sea-level (Iftekhar et al, 2004). The combined flow of the mighty Ganges, Brahmaputra and Meghna rivers drains out to Bay of Bengal in this region through the very active Lower Meghna river estuary.

Fig. 1: Study Area

3. Model Description

Delft 3D flow model coupled with cyclone generating Dashboard model are applied to simulate the land inundationdue to storm surge. Time series of discharge is specified as the upstream boundary condition, with a timeseries of water level for the downstream boundary condition. Discharge data is used from the measurement ofBangladesh Water Development Board (BWDB) for the year (2007 and 2009). For downstream water level boundaries,tides are generated by using GCOMS (Matsumoto K et al, 2000) data for the year (2007and 2009).

Cross sectional data for each of the estuarine systems of the GBM delta are measured under the ESPA deltaproject (http://www.espa.ac.uk). The domain of the measurements covers the entire study area. Open accessGeneral Bathymetric chart of the Oceans (GEBCO) data is used as the bathymetry of the Bay of Bengal. The inlandground elevation data is collected from Centre for Environmental and Geographic Information Services(CEGIS), Bangladesh.

4. Model Calibration and Validation

The storm surge model is calibrated and validated with cyclone “SIDR”. Calibration and validation locations are shown in Fig. 1. Performances of the model during the calibration exercises are evaluated by computing the model reliability as described by Haque *et al*. (unpublished). Using this indicator, model reliability for the stormsurge model for the “most acceptable model parameters” is obtained approximately 60%. The calibrated model is then validated where measured tidal water level was available during the time of landfall of the cyclone. The calibration and validation performances of the model are shown in (Fig. 2).

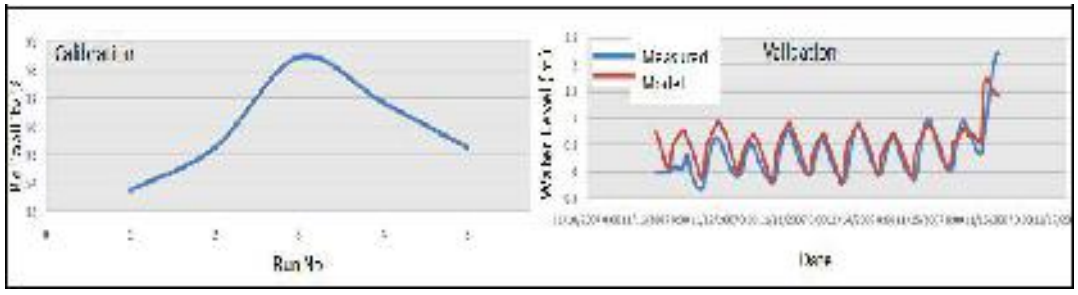


Fig. 2: Model Calibration and Validation

5. Result

5.1 Inundation

In the SIDR-ACTUAL case, the maximum inundation area (1710 km^2) is around its landfall location (Fig. 4). The total inundation area for SIDR-LIKE cyclones (variable landfall locations) is much less compared to the SIDR-ACTUAL case (Fig. 3 and Fig. 4). Among different landfall locations of SIDR-LIKE cyclones, the maximum inundation area (813 km^2) is found when cyclone makes landfall at Sundarban; and the minimum inundation area (340 km^2) is found when landfall location is at Bhola (Figure 4). Reason behind the minimum inundation for SIDR-LIKE cyclone at Bhola is because of its landfall location; which is far away from Meghna Estuary. The spatial extent of inundation, due to landfall at Bishkhali & Rupsa-Sibsa estuaries is greater compared to the other landfall locations (Fig. 3 and Fig. 4).

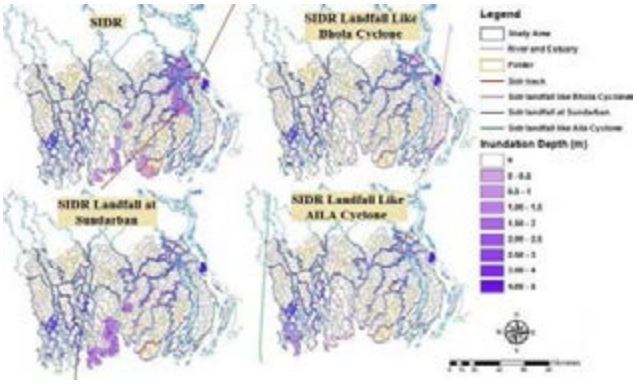


Fig. 3: Inundation map for SIDR and SIDR-like cyclones at different landfall locations

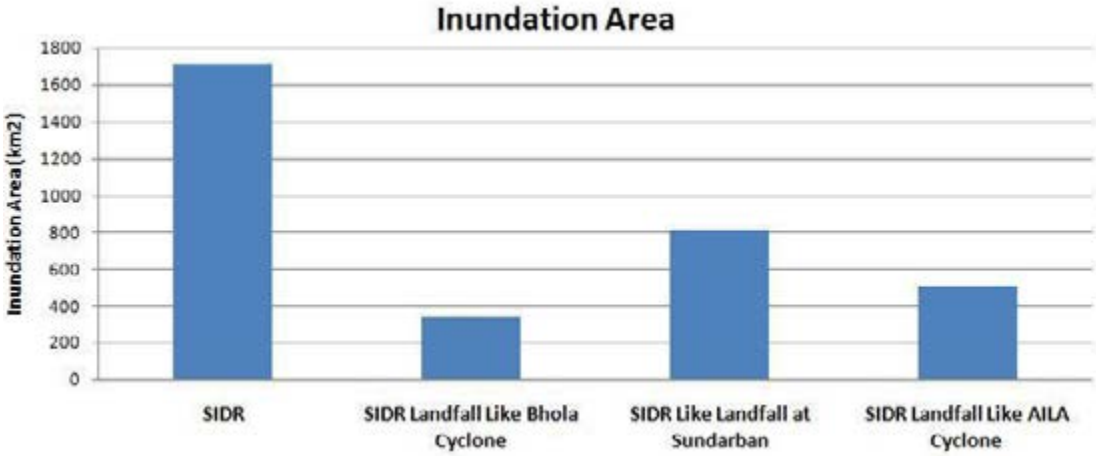
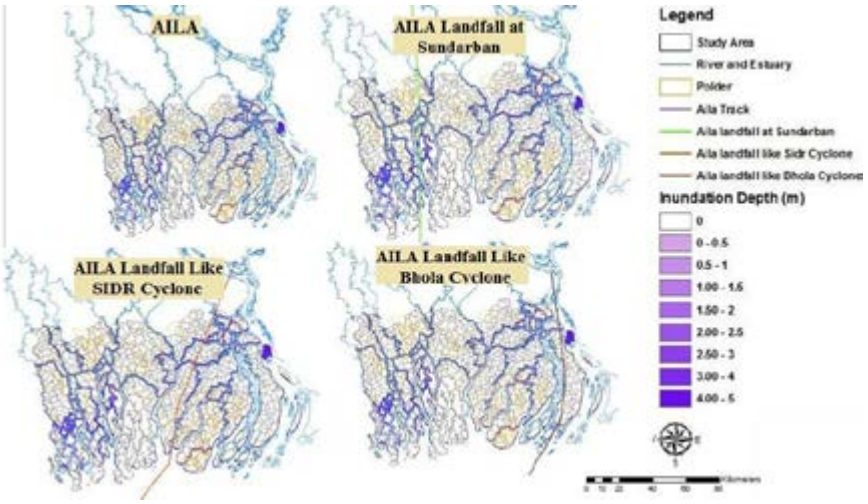


Fig. 4: Inundation area for SIDR and SIDR-like cyclones at different landfall locations

For the AILA-ACTUAL case, inundation area of 390 km^2 is found around its landfall location (Fig.6). The maximum spatial inundation (490 km^2) occurs when AILA makes landfall at SIDR location i.e. Bishkhali estuary (Fig. 5 and Fig. 6). Whereas, the minimum inundation (200 km^2) occurs when AILA-LIKE cyclone makes landfall at Bhola (Fig. 6).When AILA-LIKE cyclone hits Sundarban at Rupsa-Sibsa estuary, it inundates an area of 250 km^2 (Fig. 6).



ig. 5: Inundation map for AILA and AILA-like cyclones at different landfall locations

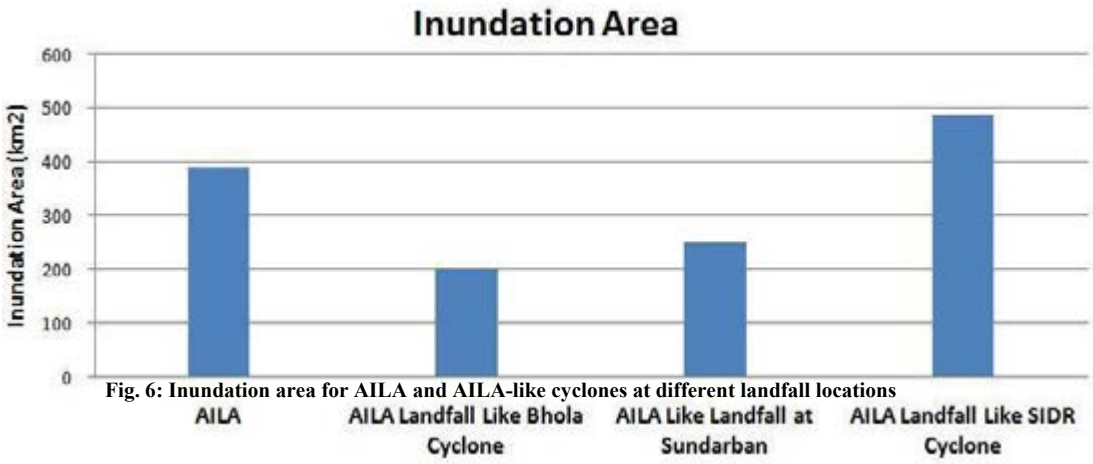


Fig. 6: Inundation area for AILA and AILA-like cyclones at different landfall locations

5.2 Polder Overtopping

Polders (a kind of encircled embankment) play an important role in protecting the region from flooding (either fluvial or storm surge). The maximum, minimum and average polder heights in the study region are 5.75m, 4.5m and4.79m respectively (Source: Bangladesh Water Development Board and Center for Environmental and Geographic Information Services data archives). If the flood water elevation is lower than the polder height,the regions inside the polders are not flooded during a storm surge. Although the polders are not designed to protect against the storm surges, in certain limits they can also protect the enclosed area from storm surges. There is only one incident where poldershave been breached or overtopped (during cyclone SIDR), but no such incident occurs for AILA and SIDR-AILA-LIKE cyclones (Fig. 7 and Fig. 8).

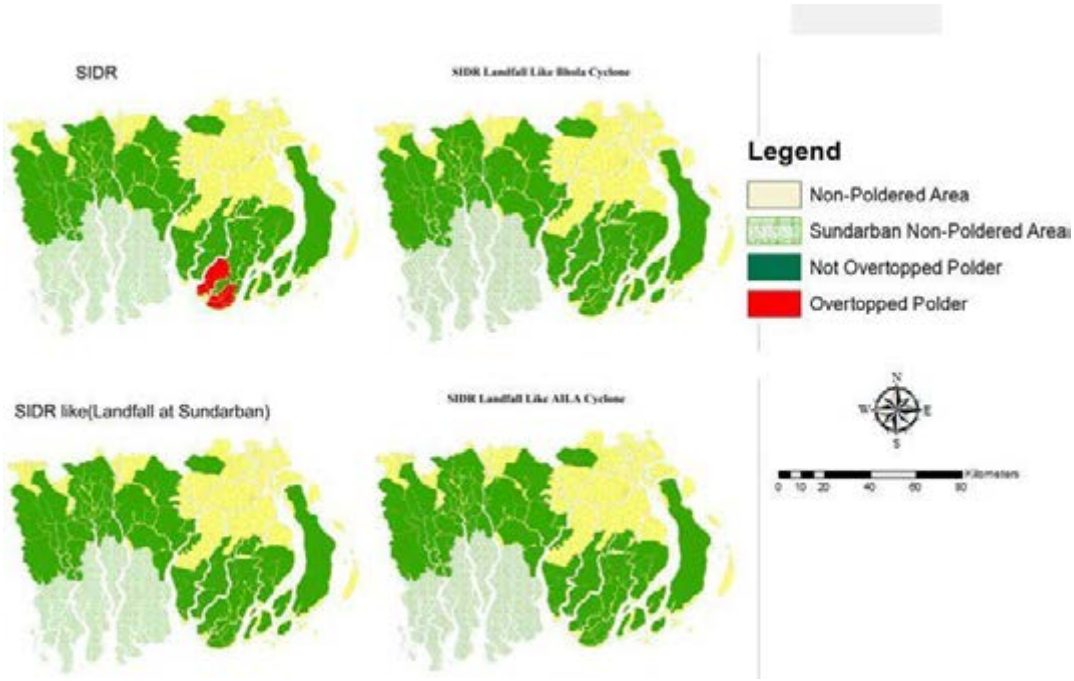


Fig. 7: Polder overtopped maps for SIDR and SIDR-LIKE cyclones at different landfall locations

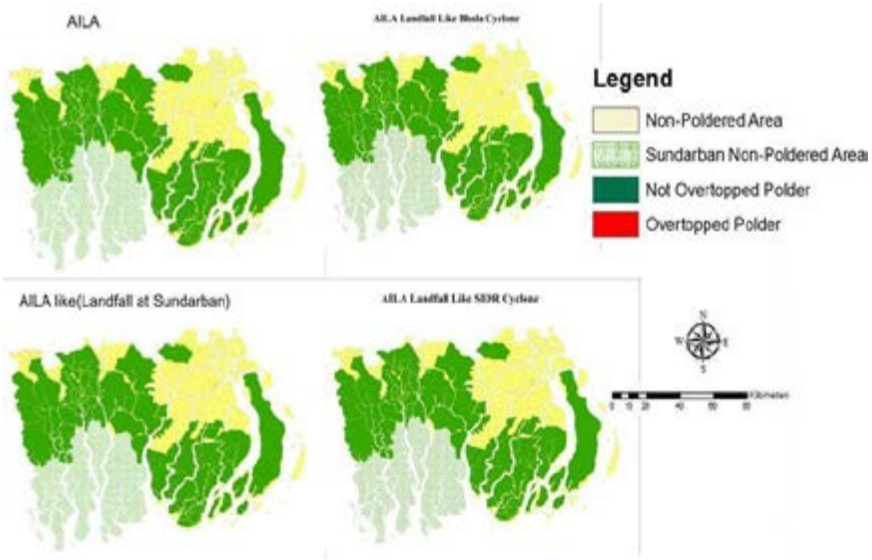


Fig. 8: Polder overtopped maps AILA and AILA-LIKE cyclones at different landfall locations

6. Conclusion

Severity of land inundation due to storm surge generated by cyclones in Bangladesh coast is largely influenced by its landfall location.The spatial extent of inundation is more when a cyclone makes landfall at estuary mouth (for example mouth of Lower Meghna estuary) compared to land locations. This makes estuary mouths as vulnerable locations when cyclone landfalls are considered.

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Title: Contribution of Vocational Education and Training (VET) to Enhance Disaster Resilience: A case study through Human Capital Lens in Coastal Area of Bangladesh.
Abdullah Al-Maruf. Boris Braun

1. Introduction

Human, social, natural, financial and physical capitals are the main factors that affect household livelihoods (DFID, 1999; Ungar, 2011) which are needed in order to cope with stresses and shocks and for the pursuit of livelihood strategies (IDS,1998). Almost every year, these household capitals are affected by the cyclone and storm surges in the coastal area of Bangladesh (Fakhruddin& Rahman, 2013). As a result, different livelihood vulnerabilities (less income, poor housing condition, crisis of drinking water, lack of sanitation) are increasing with regard to different forms of household capitals (Kulatunga, et al. 2014). However, it is very difficult to handle all forms of capitals by households before, during and after disasters (Speranza et al. 2013). Despite the remarkable initiatives of disaster management taken by the governmental and non-governmental organizations (NGO), vulnerability to disaster is still a big challenge in the context of coastal Bangladesh. Hence, resilience through household's capital, especially which capital is predominant to enhance household resilience to cyclone and storm surges is an urgent question to the academics, policy makers and practitioners. This research aims to examine how the components of human capital (HC) relate to the components of resilience to mitigate or adapt to cyclone and storm surges. This papers particularly explores how vocational education and training contribute to enhance household resilience to cyclone and storm surges in the coastal area of Bangladesh. The empirical findings are based on a household survey (sample size 1200) in nine coastal villages within the districts of Khulna, Bagherhat, Pataukhali, Lakshmipur and Noakhaliof Bangladesh that was conducted from 15th October 2014 to mid of February 2015.

Vocational education and training (VET) is an important component of human capital (HC). VET plays a significant role on households during, after and before disasters. During the cyclone and storm surges, the first responders are the local residents because disaster response organizations usually takes a minimum 48-72 h to go to the affected areas-sometimes longer due to communication and access difficulties (Islam and Walkerden, 2014). Institutional relief goods and can take four to five days to reach the devastated areas (Khalil, 1993; Haque, 1997; Alam and Collins, 2010). For this reason, households have to use their own skills and knowledges to minimize their loss and damages of household assets in this crucial moment. After disasters, affected households are responsible to manage this adverse situation by their vocational skills and knowledge particularly to find a new job, fixing houses, sanitation and try to increase income and savings which also key components for probable next disasters or before disasters. In addition, affected residents exchange expertise among neighbors and relatives. So the contribution of vocational education and training in the three stages of disasters is a key point to understand disasters resilience to cyclone and storm surges. This study uses the experiences with Cyclone Aila (On 25 May 2009, 3.9 million people were affected when Aila slammed into southern Bangladesh killing 190 and injuring more than 7,000; reported by IRIN, 2009) and Sidr (On 15 November 2007, 3,400 people were killed and millions more rendered homeless by Sidr – now described as the most powerful cyclone to strike the

impoverished low-lying nation in just over 15 years; reported by IRIN, 2009), in nine affected coastal villages, to reveal how vocational education and training contribute to enhance household resilience to cyclones and storm surges.

Resilience through different forms of capital is gradually being recognized as vital issue in the disaster management domain. A number of studies have focused on resilience through sum of human, social, physical, natural and financial capitals. A large number of studies have focused on a particular capital for building resilience to disasters, for example social capital (Bourdieu 1986; Putnam 1995, 2000; Coleman 1988; Lin 2001; Adger 2003; Aldrich 2006, 2012; Murphy 2007; Islam et al. 2010; OECD 2010; Braun &Aßheuer 2011; Islam &Walkerden 2014, 2015; Shimada 2015;) financial capital (THULSTRUP 2015; Huggins et al. 2015; Hudner& Kurtz 2014; Speranza et al. 2014; Mayunga 2007; Cutter et al. 2008; DFID 1999; Mayunga 2007; Cutter et al. 2008) natural capital (Dominati et al. 2014; Sherrieb et al. 2010; Brand 2009), physical capital (Islam et al. 2010; Ungar 2011; DFID 1999; Institute for Development Studies 1998). Severalearlier studies have been executed on the component of human capital to the different economic production oriented e.g. formal education, school enrollment, income, wage of labor (Unger et al. 1998; DFID, 1999; Grossman, 2000; OECD, 2008; Cuaresma 2010; Fleisher et al., 2011; Ng et al., 2005; Singh et al.,2009; Baron, 2011; WEF, 2013) , job training and production of organization (Mincer, 1962; Singh et al., 2009; Unger et al., 2011), health and labor force(Grossman, 1972, 2000; Bartel&Taubman, 1979; Anson & Anson, 1987; World Bank, 1993; Ross & Mirowsky, 1995; Olson &Pavetti, 1996; Jayakody et al., 1998; DFID, 1999; Pindius et al., 2000; Nerdrum& Erikson, 2001; Bloom & Canning, 2003; WEF, 2013), individual knowledge and skills and economic value (Snell & Dean, 1992; Becker, 1993; Bontis, 1999, 2001; Finkelstein and Hambrick, 1996; Huselid, 1995; Pennings et al., 1998; Wright et al., 1995; Sullivan, 1999; Mayo, 2000; OECD, 2001; Nerdrum& Erikson, 2001; Walker, 2001; Youndt&SnelSheffin, 2003, 2004; Wiig, 2004; Abeysekera& Guthrie, 2005; Bozbura et al., 2007; Isaac et al., 2009; Gates &Langevin, 2010; Santos-Rodrigues et al., 2010; Choudhury & Mishra, 2010; Baron, 2011; Unger et al., 2011), leadership ability(Bozbura et al., 2007), geographical migration (Hicks 1932, Sjaastad 1962; Harris & Todaro, 1970; Glaeser et al., 2001), job experiences (Hudson, 1993; Baron 2011; CDIP, 2006; Gates &Langevin, 2010). However, a few of them have been carried out in resilience through human capital regards to cyclone and storm surges in the coastal area Bangladesh.There is much less scholarship addressing the details of vocational education and training,in particular, the role of VET for enhancing resilience. In addition, in the most existing literature, resilience addressed for community level (Flora & Flora 2013; Ashwill et al. 2011; Pigg et al. 2013; Gasteyer & Araj 2009; Cannon, 2008; Siles et al. 2013; Gomez et al. 2008; Flora & Bregendahl 2012; Flora & Delaey, 2012) whereas the resilience at households level is more effective for policy making for reducing conflicts within community (Das, 2009; Dasgupta, 2014). The household level or micro level disparities are slightly reflected in the present studies on resilience to cyclone and storm surges. This study addresses this gap.

Therefore, this study aims to fill that gap. The present study investigates how coastal households use knowledges which obtained through vocational education and training as a component of human capital for enhancing resilience to cyclone and storm surges. The objective of the study is to mushroom the understanding of research scholars, development practitioners, and policy makers about the strength of vocational education and training, and how it foster the household resilience. This empirical affirmation fabricates a significant contribution to the literature on human capital and disaster resilience.

2. Key concepts

2.1. Human capital

The theory of human capital emerges in the underlying research done by Nobel laureate and economist Theodore Schultz (1961), Gary Becker (1964), and Jacob Mincer (1962) as they argue that individuals and
their families construct parallel decision regarding human capital investment with the objective of increasing his or her future productivity and earnings (Hong and Pandey, 2007). Schultz (1961) and Becker (1964) have emphasized on formal education whereas Mincer (1962) focused on technical and job training. OECD (2001) and WEF (2013) noted human capital as knowledge, skills, competencies and other attributes embodied in individuals that facilitate the creation of personal, social and economic well-being. A group of scholars (Griliches & Regev, 1995; Rosen 1999; Youndt& Snell 2004; Abeysekera& Guthrie 2005; Choudhury & Mishra 2010; Santos-Rodrigues 2010; Unger et al 2011) draw attention to technical ability and training. Frank & Bemanke (2007) define that human capital is 'an amalgam of factors such as education, experience, training, intelligence, energy, work habits, trustworthiness, and initiative that affect the value of a worker's marginal product.

2.2. Measurement of human capital

Human capital measurement is gradually being recognized a vital issue in the social science. However, despite the increasing use of the HC, it is difficult to find any complete measurement approach as how to measure it (Han et al. 2008). Numerous scholars and organizations measured human capital through different indicators on the basis of different approach (Afiouni, 2013).

Table.1: Different measurement approach of human capital
Source: Compiled by the author through existence literature, 2015

Used indicators	**Justification**
Formal education/Year of schooling or school attainment	Schultz, 1961; Becker, 1964; Unger et al.,2011; DFID, 1999; Grossman, 2000; OECD, 2008; Fleisher et al., 2011; Ng et al., 2005; Singh et al.,2009; Braun & Aßheuer, 2011; Baron, 2011; WEF, 2013
Job training	Mincer, 1962; Singh et al., 2009; Unger et al., 2011
Individual knowledge and skills	Snell & Dean, 1992; Becker, 1993; Bontis, 1999, 2001; Finkelstein and Hambrick, 1996; Huselid, 1995; Pennings et al., 1998; Wright et al., 1995; Sullivan, 1999; Mayo, 2000; OECD, 2001; Nerdrum& Erikson, 2001; Walker, 2001; Youndt & SnelSheffin, 2003, 2004; Wiig, 2004; Abeysekera& Guthrie, 2005; Bozbura et al., 2007; Isaac et al., 2009; Gates &Langevin, 2010; Santos-Rodrigues et al., 2010; Choudhury & Mishra, 2010; Baron, 2011; Unger et al., 2011
Geographical migration	Hicks 1932, Sjaastad 1962; Harris &Todaro, 1970; Glaeser et al., 200)
Health	Grossman, 1972, 2000; Bartel &Taubman, 1979; Anson & Anson, 1987; World Bank, 1993; Ross & Mirowsky, 1995; Olson & Pavetti, 1996; Jayakody et al., 1998; DFID, 1999; Pindius et al., 2000; Nerdrum& Erikson, 2001; Bloom & Canning, 2003; WEF, 2013)
Leadership ability	Bozbura et al., 2007; Paul, 2009
Experiences	Hudson, 1993; Baron 2011; CDIP, 2006; Gates &Langevin, 2010

Although many researchers have explored and measured human capital, some problems still exist in its measurement. As Bukh et al. (2001) argued, hardly any human capital literature traits a comprehensive perspective and discussion of the indicators. Harpan and Draghici (2013) mentioned the three approach of human capital measurement; the first approach is based on the individual aspects. According to Schultz (1961), human capital as 'something akin to property' against the concept of labor force in the classical perspective… (as cited in KWON and DAE-BONG 2009, p.3). Alan, Altman &Roussel (2008) points out that a far more effective second approaches as HC is understand and explained in association with the accumulation process of individuals. This approach focused on knowledge and skills (competencies, expertise and wisdom) obtained throughout education activities such as compulsory education, postsecondary education, and vocational education. The third approach is linked to the production-oriented view point of human capital. 'Human capital as an amalgam of factors such as education, experience, training, intelligence, energy, work habits, trustworthiness, and initiative that affect the value of a worker's marginal product' (Frank &Bemanke 2007). According to the similar point of view, Sheffrin (2003) stated, human capital is the stock of skills and knowledge embodied in the ability to perform labor so as to produce economic value. Taking the position of the three approaches, we developed a new framework for measuring human capital. We have considered that there are six pillars of human capital such as: knowledge obtained through formal school, college and university education; knowledge obtained through vocational education and training; knowledge obtained through learning by doing; knowledge obtained through interaction and participation; knowledge obtained through experiences and indigenous activities and ability to work. The paper is based on the second pillar (knowledge obtained through vocational education and training) and test its significance in adapting with cyclone disaster.

2.3. Vocational education and training (VET)

OECD (2009), Asian development Bank (2008), ILO (2008), World Bank (2007), DFID (2007), European Training Foundation (2006a), BundesministeriumfürwirtschaftlicheZusammenarbeit und Entwicklung (2006) stresses on vocational education and training for particularly three point of view in their main agenda, for example 1) how to promote employability among secondary education graduates 2) better skilled labour force is essential precondition for sustainable development, based on coping with ecological issues using appropriate technologies and maintaining infrastructures which minimize negative shocks, and 3) human capital necessary for socio economic development. Although, knowledge-based economies are foreseeable to enhance employment opportunities for non-academic post-secondary and university graduates, but developing countries apparently need another type of human capital stock, with rising industries and the modern crafts sectordemanding the kind of professional qualifications that cannot be acquired ingeneral secondary education (Wallenborn 2010). According to these points of views, vocational education and training (VET) is should be a priority sector for coastal area of Bangladesh. There are various technical education programs under the Bangladesh Technical Education Board (BTEB), which are encompassing a large number of variations of level and methods (Newaz et al. 2013). In our investigation, we focused on vocational education and training related with 'basic trade' (1 to 6 months) within BTEB curriculum or others (NGO) with minimum duration is one months. We emphasized certain sectors of vocational education and training such as e.g. livestock and crop cultivation, fishing and aquaculture, bee keeping, business and trade, tailoring and boutique, talacabi, bicle, rickshaw/van repairing, general electric and mechanic repairs, house wiring, construction work (building and roads) sanitary latrine making, medical training, ayurvedic (Kobiraji), swimming and climbing (trees). A large number of residents are dropping out from primary to below secondary level education in our study area. However, those resident who are gained specific skills and knowledge through vocational

education and training, they are keeping contribution on components of household resilience such as income, ability to use mechineries, improve housing condition, and sanitation.

2.4. Resilience to disasters

Resilience is one of the most cardinal research topic with respective to sustainability (Kates et al. 2001; Foley et al. 2005; Brand & Jax, 2007). First Holling (1973) bring as descriptive ecological term, however resilience frequently redefined and extended by different dimension in various level (Holling, 2001; Pickett et al. 2004; Zhou et al.2009). A group of researchers (Pelling 2003; Cardona 2003; Zhou et al 2009; Buckle et al 2003) pointed out resilience as the ability of an actor to cope with or adapt to disaster stress. A few of scholars (Folke et al. 2002; Wildavsky 1988; Paton et al.2000; Pelling 2003; Cardona 2003) stressed three characteristics of capacity such as capacity to absorb disturbances, self-organization capacity of learning and adaptation. DFID (2011), OECD (2013b,1) defined resilience as the ability of individuals, household and states to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term changes and uncertainty. Although, the concept of resilience is becoming the *de facto* framework for enhancing disaster preparedness, response, and recovery in the short term and long term (Cutter et al. 2014), many discussion remains on framework for measuring resilience on household level. The reviewed existence literature on resilience addressed two types of framework for measuring resilience. Firstly, resilience is sum of households or community capitals (human, social, natural, physical and financial capital(Institute of development studies, 1998; DFID, 1999; Mayunga, 2007; Cutter et al., 2008a & 2010; Kulig et al., 2013; Mowbray, 2011; Norris et all., 2008; Flora &Flora, 2013; Ashwill et al., 2011; Pigg et al., 2013; Gasteyer&Araj, 2009; Siles et al, 2013; Cepeda Gomez et all., 2008; Flora and Bregendahl, 2012; Flora and Delaney, 2012; Thulstrup, 2015), secondly resilience is a output or results of some particular indicators for example age, language competency, learning, housing, income, savings, health access, sanitation so on (Paton, 2001;Tobin & Cutter, 2003, 2010, 2014; Norris et al., 2008; Morrow, 2008; Akter&Mallick, 2013; Forgette and Boening, 2010; Tierny et al., 2001; Enemark 2006; Aldrich, 2012; Islam &Walkerden, 2014; Maguire & Hagan, 2007; Breton, 2007; Ruitenbeek, 1996; Adger, 2000; Zhou, 2010; Holling et al., 1995; Folke et al., 2004). On the basis of second view point, this study explored the indicators for measuring resilience to cyclone and storm surges at the household level in coastal Bangladesh. These indicators justified by existence literature and our filed work as we conducted March 2014 and 15th October 2014 to mid of February 2015 through informal discussion.

Table. 2: Indicators to measure household resilience to disasters

Source: Compiled by the author through existence literature and informal discussion during field in March 2014 and 15th October 2014 to mid of February 2015

Indicators	Justification
Income	Norris et al. 2008; Wendy Merritt, 2015; Ranjan & Abenayake, 2014; Tobin, 1999; Enarson, 2012; Sherrieb et al, 2010; THULSTRUP; 2015; Akter & Mallick, 2013; Burton, 2012; UNDP, 2014; Cutter et al. 2003 & 2014; March 2014 and 15th October 2014 to mid of February 2015
Housing type	Cutter et al. 2003 & 2014; Sutter & Simmons, 2010; Tierney March 2014 and 15th October 2014 to mid of February 2015, 2009; Akter & Mallick, 2013; Twigg, 2009; World Bank, 2013; March 2014 and 15th October 2014 to mid of February 2015
Sanitation	Akter & Mallick, 2013; Kusumastuti et al. 2014; World Bank, 2013; March 2014 and 15th October 2014 to mid of February 2015
Using ability of machineries	Twigg, 2009; Burton 2012; Bhinge, 2014; UNFCCC, 2013; Grubb, 2004; March 2014 and 15th October 2014 to mid of February 2015

3. Study area and methods

This study conducted in nine coastal villages such as Amadi, Bagali, Jhonjonia/Gabbunia, Itabaria, Latachapli, Deulisubedkhali, Char Alexander, Tamaruddin, Char Ishwar under the five coastal districts Khulna, Patuakhali, Bagherhat, Lakshmipur and Noakhali in the southern part of Bangladesh during October 2014 to February 2015 (Table 2). Historically all nine villages are located in cyclone and storm surge affected regions in the high risk zones of the country. The regions are close to the sea; frequently falling victim to cyclone, storm surges, tornado and tidal bore. Last ten years (2004-2013), the six recurrent cyclones e.g., Sidr 15 November 2007, Rashmi 26 October2008, Bijli 19April 2009, Nisha 28 November 2008, Aila25 May 2009 and Mahasen16 May2013attacked the study area, and caused a lot of damage and loss (Alam& Rahman 2014; Bangladesh Meteorological Department-BMD 2014). In addition, selected villages under the mentioning five districts are geographically different characterized as located in the inland (Khulna), shore land (Patuakhali, Bagherhat, Lakshmipur) and Island (Hatiya under Noakhali) area. Therefore, it is believed that selected unions will be ideal representatives to examine the various components of human capital and resilience to cyclone and storm surges.

Table. 3: Description of the study area.
Source: Compiled by the author, 2015

Case of study	Location of the study villages			Main criteria of selection	Level
BANGLADESH	**Districts**	**Upazilas**	**Villages**	1. Located in coastal zone 2. Historically cyclone and storm surges affected area 3. Villages with different level of capitals due to location (villages in the inland, shore land and island	**HOUSEHOLD**[1]
	Khulna	Koyra	1. Amadi		
			2. Bagali		
	Bagherhat	Rampal	3. Jhonjonia/Gabbunia		
	Patuakhali	Patuakhali sadar	4. Itabaria		
		Kalapara	5. Latachapli		
		Mirzaganj	6. Deuli subedkhali		
	Lakshmipur	Ramgati	7. Char Alexander		
	Noakhali	Hatiya (island)	8. Tamaruddin		
			9. Char Ishwar		

[1]'A group of people who are generally but not necessarily relatives, who live under the same roof and normally eat together, including individuals who live for part of the year or the entire year elsewhere without having established their own family (with spouse and /or children) in that other place' (De Haas 2003, p415 area)

Both primary and secondary sources of data used in this study. However, the study mostly based on primary data and information. Primary data was collected through standardized and structured questionnaires at the household level by face to face interviews duringOctober 2014 to February 2015. Few data collected from key informants too in first phase of field survey in March 2014 regarding the components of household resilience. In addition, observations and informal discussions also conducted in order to gather additional and supplementary information on cyclone and storm surge disasters, their impact on livelihood activities of residents, and their ability to cope with disaster and GO and NGO support services.

Fig.1: Location of the study area. Source: Bernzen.A, 2015

This survey carried out on household level in the study villages. Households are the principle unit of analysis of the study because households are firmly combine in coastal area of Bangladesh and work together in the three phases (during, after, before) disasters (Paul B. K 1998; Islam &Walkerden 2014). To collect primary data from study villages in household level, a coordination schema were prepared and a standard structured questionnaire were developed (partly based on the questionnaire used by Braun and Aßheuer 2011). The questionnaire formulated by mainly three sections such as demographic characteristics, land use changes, forms of household's capital, resilience as well. We conducted household survey through face-to-face interviews with households head by using a standardized questionnaire. Because household heads as the person who making major economic, social and household decisions and able to represents information of others members of the family (Paul B.K 1996).In few instances, other members of the household were participated in the discussion and given the deeper insights. To ensure the reliability of data, questionnaire was pre-tested in the study area and necessary modifications were made before conducting final survey. Sample size has been determined selectively within the nine villages under the seven upazilas(second lowest administrative unite). Total number of sample size was 1200 (from Koyra and Rampal 300; from Kalapara, Patuakhalisader and Mirjaganj 450; from Ramgati and Hatiya 450. We interviewed 1200 household heads through standardized questionnaire and secured 1189 valid responses. Moreover, we observed the physical settings and the daily livelihood strategies that contributed to understand the actual components of resilience. Our interviews with household head were accompanied by 9 informal discussions with the local residents and chairman and members of the Union parishad (lowest administrative unite of Bangladesh) in the study villages for achieving the significant component of resilience to cyclone and storm surges. In addition, we gathered their understanding about the contribution of vocational education and training in their income, using technology, sanitation, housing conditions.

Secondary data was collected from different government bodies, nongovernmental organizations, voluntary and social organizations as well as from several published sources such as satellite image, reports, books, documents, journals, maps and papers from different libraries. The secondary data required for the study includes historical data of

cyclone and storm surges, frequency, and damage. Data on forecasting and relief operation was collected from the Ministry of Food and Disaster Management and the Disaster Management Bureau. Besides, upazila maps, data on topography, drainage systems and communication networks will be collected from the Local Government Engineering Department (LGDE). These data was used primarily to understand and identify the cyclone and storm surge prone areas and provide background information on cyclone disasters for the country as a whole.

In our investigation, resilience is our dependent and vocational education and training is independent variables. In this paper, household resilience was defined with a composite variables which developed by four most suitable components of resilience on the basis of secondary literature and informal discussion in two phases of our fields work in March 2014 and October 2014 to February 2015. This resilience components are household income, using ability of particular machineries (tractor, harvester, boat for fishing, net for fishing, rickshaw/van, motorbike, and bicycle) sanitation, and housing condition and vocational education and training assessed through certain attributes (Table. 4). Collected data has been checked and verified before coding process by EXCEL. Moreover, SPSS 22 software used for quantitative analysis. Different descriptive statistical methods like frequency, percentage, mean, standard deviation were used for analyzing data in terms of general information such as demographic profile, condition of vocational education and training, household income, sanitation, housing condition, using ability of machineries.To assess the weight of resilience and vocational education and training, this investigation applied subjective scoring (Guilford &Wilson 1957; Harrington 1975) and on responses of variables from 1 to 3 as low to high quality (Table 4).

Table. 4: Measuring weight of the each variables
Source: Formulated by the author, 2015

Variables	Description of variables	Scoring
Vocational education and training	Yes	2
	No	1
Household monthly income (BDT)	500-9,999	1
	10,000-19,999	2
	20,000+	3
Housing condition	*Kaccha*	1
	Semi *pacca*	2
	Pacca	3
Sanitation	Open field/other	1
	Kaccha	2
	Sanitary	3
Ability to use machineries	Yes	2
	No	1

Household resilience categorized into three category (low, medium, and high/resilience) on the basis of Connor-Davidson Resilience Scale-CD-RISC (2003) as higher score represents greater resilience in combination with a three point Likert scale. Three category of household resilience defined on the basis of summation of scores such as score 4 -7 low, 8-9 medium, and 10-12 high or resilient. Chi-Square test has been used to understand the association between resilience and vocational training. Besides, comparison of mean applied to justify the contribution of vocational education and training on household.

4. Result and discussions

Cross tabulation were developed to examine the associations among the study variables and to investigate the influence of vocational education and training on different level (low, medium, high) household resilience to cyclone and storm surges. As can be seen in Table

5, household resilience is positively associated with the vocational education and training, reveals that those household heads gained vocational education and training tend to have higher level of resilience. In addition, results indicates the significant association between different level of household resilience and vocational education and training of household heads. The study found that 35.5% households are low level resilient who have no vocational education and training however only 12.7% low level of resilience those who gained vocational education and training. Results also shows that 49.4% households highly and 38.0% moderately resilience who have vocational education and training whereas this number is very low (12.8%) who have no vocational education and training.

Table. 5: Contribution of vocational education and training on household resilience

Source: Household survey 2014/2015

Status of vocational education and training	Categories of household resilience to cyclone and storm surges								
	Responses	Low	%	Moderate	%	High	%	Total	%
	Yes	10	12.7	30	38.0	39	49.4	79	100.0
	No	377	35.5	549	51.7	136	12.8	1062	100.0
	Total	387	33.9	579	50.7	175	15.3	1141	100.0

χ^2-test: χ^2=78.12, df= 2 , Sig. value .0000

To identify the actual impact of vocational education and training on household income, we also compared mean value between two group (with vocational education and training and without vocational education training). As shown table 6, there is significant difference of mean monthly household income between two groups. Those residents who have no VET, their monthly mean income 14992.99 B.D.T (apx. 190 USD) whereas those who achieved, their monthly mean income 24010.00B.D.T (apx. 300 USD), which is more than 60% higher (Table 6). Earlier several study probed the impact of education (Sanaz et al. 2015; Nazir, 2015; UNICEF-East Asia and Pacific Regional Office 2015; Carol, 2014; Haigh, 2014; Zhoua et al. 2014) on disaster resilience however, what types of education particularly need is less highlighted. Our results suggested the distinct contribution of vocational education and training on household resilience to disaster.

Table. 6: Effect of vocational education and training on household average monthly income

Source: Source: Household survey 2014/2015

Household income in BDT (Monthly)	Responses	N	Mean	SD
Vocational education and training	Yes	80	24010.00	27471.051
	No	1104	14992.99	13625.017
t = 5.207, Sig: value .000				

Low educated households are low level resilience (Tatebe and Mutch 2015; Theron & Theron, 2014; Paul & Routray, 2011). According to our household survey[1], 35.5% households never attended school and 50.1% dropped out before secondary school level of education. This large number of households might acquire vocational education and training as it needs a minimum level of entry qualifications. During our informal discussion, local key informants, NGO workers, media personnel advised that households should be enhanced their technical skills and knowledge, because this skills contributes during response, recovery and preparedness phases. 'After dropping out form class eight, I was unemployed which was a pressure for my family. In 2005, I achieved 3 months short courses on carpenter under the basic trade of vocational training from a vocational institute in Pataukhali Sadar. Now I am earning money; even I repaired our own houses after the devastated Sidr (2007) through this expertize' said the 24 years old local resident Liakot Ali in Deuli Subedkhali, Mirzaganj, Patuakhali. This statement indicates the contribution of VET during two phages (recovery and preparedness) of disaster. Finally our results probed that vocational education and training (VET) has a significant positive role on enhancing resilience to cyclone and storm surges at household level in coastal area in Bangladesh that had main objective of this paper.

5. Policy implications and conclusions

From this investigation we can formulated various recommendation to strengthen the role of vocational education and training to enhance household resilience to disasters. These are applicable both to local government and non-government organization who have direct contributions, and to central government, national and non-government agencies, who support local actors by developing policies, donating and delineating new agenda. Three major policy implications can be drawn from the case study. First, the number of existing vocational institute is not enough and most of them located district level which is far away from costal household level. It seems to be costly to bear of expenditures for the study from long distance by poor family and reduced their interest. The adequacy and effectiveness vocational institutes can be established by GO and NGOs in local level for poorer households, enhancing the opportunity to achieve VET, especially for those residents who early left out from school and unemployed. Second, the dissemination of information about the positive impact of vocational education and training to be reached to the households to enhance their interests. Moreover, institute can presents success story of VET from succeed individuals within their community. Finally, the government and non-government organization can increase the number of VET program on some specialized field such as livestock and crop cultivation, fishing and aquaculture, bee keeping, business and trade, tailoring and boutique with study scholarship which is very urgent for coastal residents in Bangladesh.

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Title: Preliminary Assessment Of Socio-Economic Vulnerability In The Coastal Region: A Case Study Of Barguna District

Momtaz Jahan, Rubaiya Kabir, Noor-E-Ashmaul Husna, Anisul Haque and Md. Munsur Rahman

1. Introduction

Coastal zones are the interfaces of land and ocean balancing geosphere, atmosphere and biosphere; major biological activity centers favorable for easy living and about 3 billion people are living in the coastal zones. The coastal area of Bangladesh is very unique and diversified with variety of resources and activities. Coastline is 710 km along the north and north-east part of the Bay of Bengal. The coast can be broadly divided into three regions: the deltaic eastern region (Pacific type), the deltaic central region, and the stable deltaic western region (Atlantic type). The zone constitutes 32 percent of the area and 28 percent of the population of Bangladesh (Islam, 2004).

Coastal area is a hub of diversified activities and functions that create or comes to the people as resources. It has biodiversity, marine ecology, fishery, estuary and lots of other things that are called resources. However, some problems often create disasters and make the lives hard and the whole coastal ecosystem is being disturbed. Coastal area is vulnerable to several natural disasters like Cyclone, storm surge, river bank erosion, salinity intrusion etc. In case of climate change scenario, it is already predicted that the situation will be worsen. The severity of climate change impacts or any natural or manmade disaster depends not only on the nature of climate hazards and the resilience of natural ecosystems, but also on factors such as the degree of socio-economic development, social inequalities, human adaptive capacities, health status and health services, demographic characteristics, economic livelihood alternatives etc. Therefore, socio-economic information is an integral part of assessing impacts and vulnerability to disaster or climate change, as well as in adaptation planning. Socio-economic information can highlight the differential exposure to climate threats of coastal regions and communities with different socio-economic endowments. It is also a crucial ingredient for any assessment of vulnerabilities and adaptive capacities of different economic sectors and communities
of the coastal region and for understanding how they will be affected by threat of disaster or climate change. For identifying the intense of vulnerability, the demand for socio-economic information is wide-ranging and includes economic and demographic data, such as GDP and population distribution, analyses of land use and land-use changes, etc. Socio-economic information is assessed for vulnerability assessments mainly through the construction of indicators. These indicators together represent a simple assessment that describes the resultant socio-economic vulnerability for particular region of coastal area. Prior going to the main study it is essential to have a view of what this socio-economic vulnerability is and what does it means.

Environmental disasters are the combined result of stress and exposure on one hand, and the fragility and vulnerability of the human society on the other hand (Weichselgartner, 2001; Turner et al., 2003; Adger et al., 2004; UN/ISDR, 2004; Downing and Patwardhan, 2004; Kasperson and Kasperson, 2005; Birkmann, 2006b). As the amount of losses from disasters increases at a striking pace, to understand and to define socio-economic

vulnerability becomes highly important, especially concerning present degrading situation. The common understanding of social vulnerability and economic vulnerability and the ability to measure it become keys to addressing disasters through managing the consequences and setting targets (Kasperson and Kasperson, 2005; Birkmann, 2006a).

According to the study of Cutter, Boruff and Shirley (2003) "There is a general consensus within the social science community about some of the major factors that influence social vulnerability. These include lack of access to resources (including information, knowledge, and technology); limited access to political power and representation; social capital, including social networks and connections; beliefs and customs; building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines (Cutter et al, 2001). Disagreements arise in the selection of specific variables to represent these broader concepts." These factors were considered when developing and selecting the indices.

This research attempts to construct a picture of socioeconomic context of vulnerability by focusing on indicators that measure both the state of development of the study area as well as its capacity to progress further. It also indicates current potential socio-economic vulnerability of the study area. This also attempts to suggest strategies of intervention and mitigation strategies in the context of current socio-economic condition.

2. Study Area

About 710 km long coast of Bangladesh comprising the complex delta of the Ganges Brahmaputra-Meghna river system has immense resources for development. Bangladesh has an area of about 144,000 square kilometres and a population of more than 140 million, of which 23% of the total population lives in the coastal region. It is situated in the north-eastern part of the South Asian subcontinent and has a vast sea area to the south in the Bay of Bengal (a northern, extended arm of Indian Ocean, covering about 510,000 square kilometres).

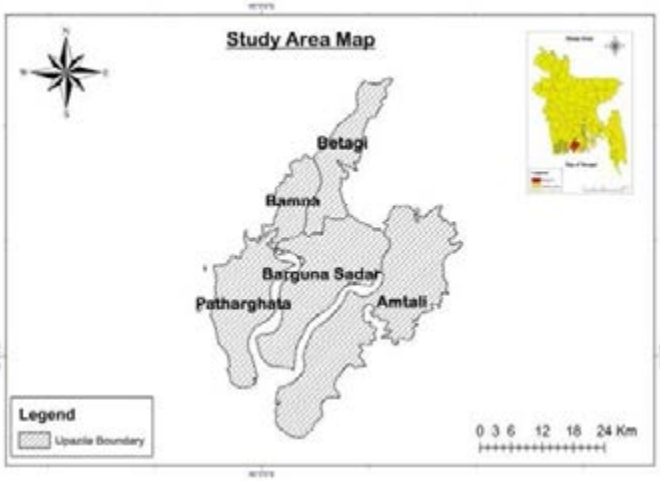


Fig. 1: Study Area

Barguna (Fig. 1), an exterior coastal district of Bangladesh was previously a sub-division

of Patuakhali district which was upgraded to district in 1984. Barguna district is bounded on the north by Barisal, Jhalokati and Patuakhali districts, on the east by Patuakhali district, on the south by the Bay of Bengal and on the west by Pirojpur district and a part of Sundarbans under Bagerhat district. It lies between 21º48′ and 22º29′ north latitudes and between 89º52′ and 90º22′ east longitudes. The total area of the district is 1,831.31 sq.km. (707.07 sq.miles) of which 399.74 sq.km. is riverine and 97.18 sq.km. is under forest. The maximum and minimum temperature of Barguna district varies from 33.3°C to 12.1°C. The annual average rainfall of the district is recorded as 2506 mm.

3. Methodology

Vulnerability is the combination of exposure, sensitivity and adaptive capacity. Exposure and sensitivity are also termed as potential impact for any hazard event. Adaptive capacity is the ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters. Vulnerability is the degree to which a system, subsystem, or system component is likely to experience harm due to exposure and sensitivity to a hazard, either a perturbation of stress/stressor. In calculative terms, Potential Impact – Adaptive Capacity = Vulnerability.

For analysis of Socio-Economic vulnerability, based on literature review and socio-economic conditions of the study area six social indicators and six economic indicators were selected. The social indicators are (a) Population density (b) Literacy rate, (c) Male/Female ratio, (d) Social dependence, (e) Water Supply and (f) Cyclone shelter. The economic indicators are (a) Poverty rate, (b) GDP, (c) Type of household, (d) Proportion of crop land, (e) Cropping intensity and (f) Road density. Related data for the selected indicators were collected from the Census Data 2011. (BBS, 2011)

For vulnerability assessment, as social indicator for potential impact, where population density is higher, vulnerability is also higher and same perception consider for male/female ratio, social dependency(no. of women, children and elderly) and water supply condition. For adaptive capacity, where literacy rate is higher, vulnerability lowers and where there is large number of cyclone shelter established, it also lowers vulnerability.

As economic indicator for potential impact, where poverty rate is higher, vulnerability is also higher and same perception consider for GDP, type of Kucha household and proportion of crop land. For adaptive capacity, where cropping intensity and road density are higher, vulnerability lowers.

Each indicator value was normalized using equation (1) and scored in the scale of 0 to 100.

$$\text{Score} = \frac{\text{Actual} - \text{Wor st}}{\text{Best} - \text{Worst}} \qquad (1)$$

Individual indicator map was prepared using ArcGIS. The individual indicator maps are then combined using weighted sum tool of ArcGIS to prepared social and economic vulnerability maps. All the indicators were given equal preference as they are equally important to determine the vulnerability condition of the study area. Then the combined Socio-Economic Vulnerability map was prepared.

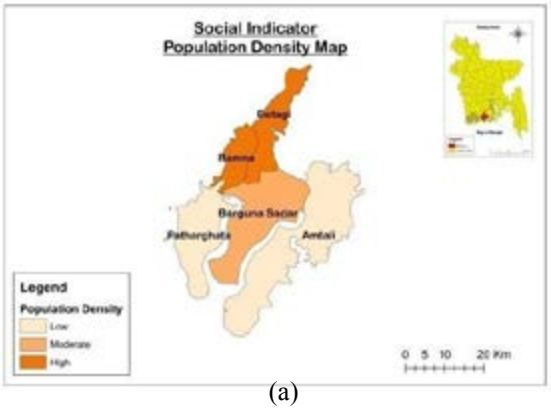
Tab 1: Weights for socio-economic vulnerability

Information type	Weight
Social Vulnerability	0.4
Economic Vulnerability	0.6

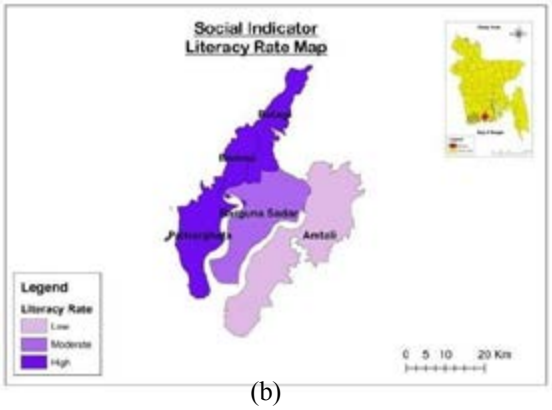
Based on expert opinion economic vulnerability was given higher preferences over social vulnerability as economic vulnerability is dominant in determining the resiliency. A comparative map was also prepared to show the comparison of the social and economic vulnerability of the study area.

4. Results and Discussion

The individual social indicator maps are shown in the figure 2.



(a)



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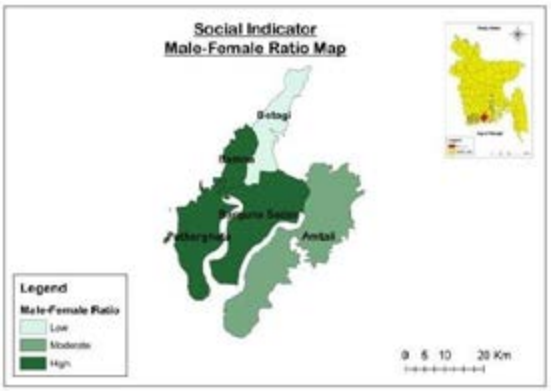

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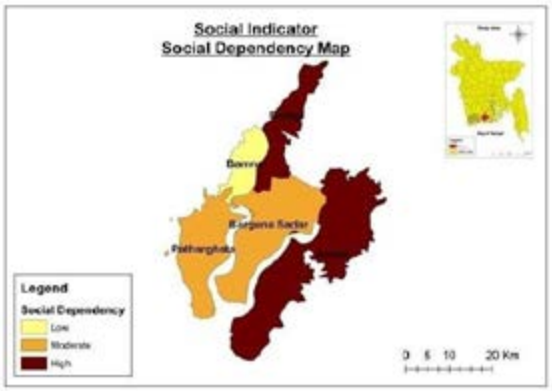

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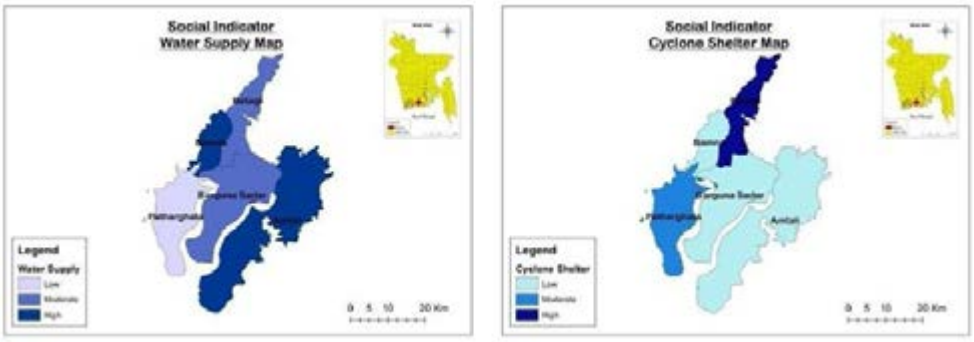
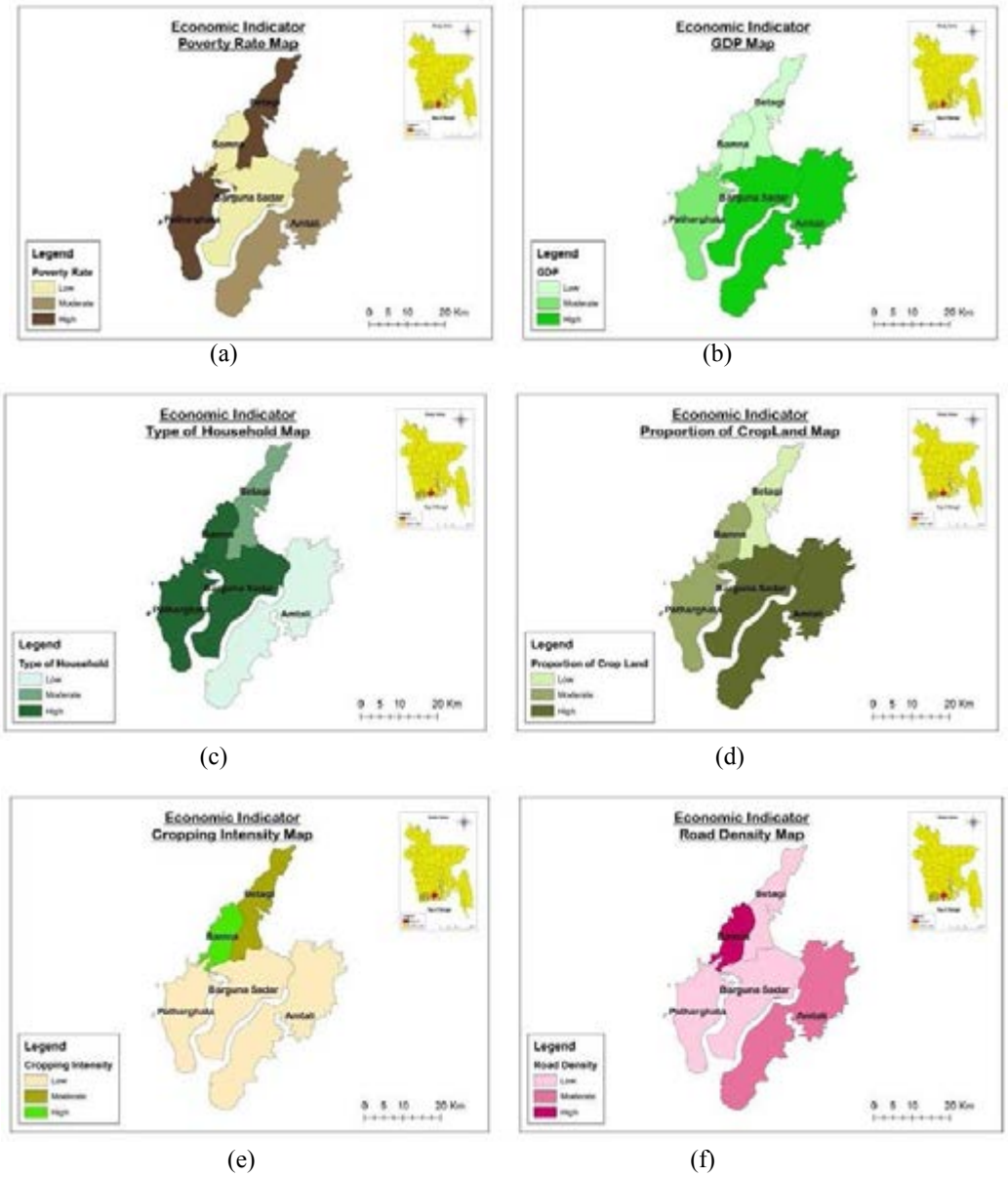


(e) (f)

Figure 2: Social Indicators (a) Population density, (b) Literacy rate, (c) Male/Female ratio, (d) Social dependence, (e) Water Supply and (f) Cyclone shelter Maps

The individual economic indicator maps are shown in the figure 3.



(a) (b)

(c) (d)

(e) (f)

Figure 3: Economic Indicators (a) Poverty rate, (b) GDP, (c) Type of household, (d) Proportion of crop land, (e) Cropping intensity and (f) Road density Maps

Based on the actual value of each indicator, scoring was done in a scale of 0 to 100 which is shown in Table 2. From the analysis, in Barguna district, Bamna upazila got all the five social indicators maximum score but social dependence zero where Amtali upazila is the most vulnerable because of high vulnerable score in social dependence and water supply and Patharghata is the least vulnerable because of its higher adaptive capacity.

Table 2: Social Vulnerability Calculation

Upazila	Social Indicators						
	Potential Impact				Adaptive Capacity		Vulnerability
	Population Density	Male/Female ratio	Social Dependence	Water Supply	Literacy Rate	Cyclone Shelter	
Amtali	0	25	98.958	97.921	0	20.678	201.201
Bamna	100	100	0	100	100	12.786	187.214
Barguna Sadar	48.418	75	9.895	92.723	69.880	0	156.158
Betagi	78.345	0	100	93.971	87.952	100	84.364
Patharghata	11.436	75	9.993	0	92.771	53.765	0.000

The Social Vulnerability map of the study area is shown in figure 4.

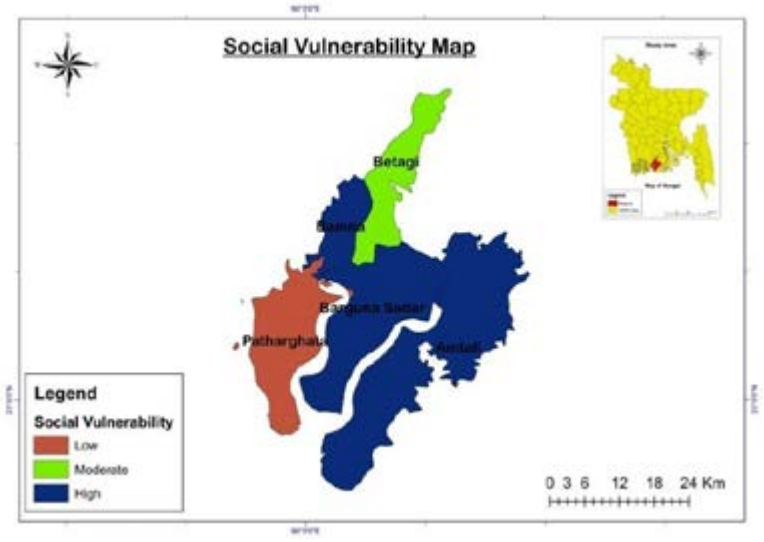


Figure 4: Social Vulnerability Map

In terms of economic vulnerability, Barguna Sadar is the most vulnerable in Barguna district. Higher poverty rate indicates the people are more vulnerable to any disaster while road density is considered as the coping capacity because it increases the mobility of people during any hazardous event. The economic vulnerability calculation is shown in table 3 following the economic vulnerability map in the figure 5.

Table 3: Economic Vulnerability Calculation

Upazila	Economic Indicators						
	Potential Impact				Adaptive Capacity		Vulnerability
	Poverty Rate	GDP	Type of household	Prop. Of crop land	Cropping Intensity	Road Density	
Amtali	7	100	0	100	0	13.442	193.979
Bamna	0	0	100	27	100	17.066	9.582
Barguna Sadar	1	95	91	93	17.649	11.144	251.632
Betagi	100	20	65	0	47.856	100	36.389
Patharghata	95	44	84	40	16.041	0	246.938

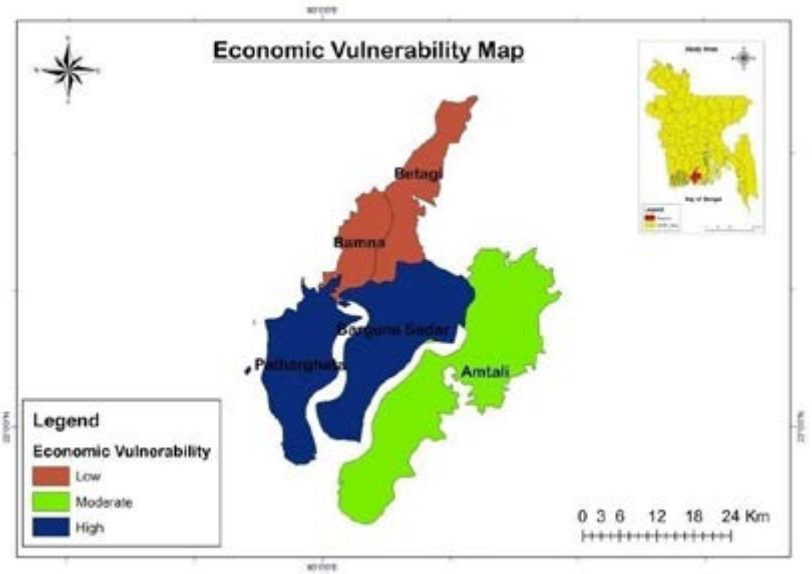


Figure 5: Economic Vulnerability Map

The calculation for Socio-Economic Vulnerability is shown in Table 4.

Table 4: Socio-Economic Vulnerability Calculation

Upazila Name	Social Vulnerability	Economic Vulnerability	Socio-Economic Vulnerability
Amtali	201.201	193.979	196.868
Bamna	187.214	9.582	80.635
BargunaSadar	156.158	251.632	213.442
Betagi	84.364	36.389	55.579
Patharghata	0	246.938	148.163

The final Socio-Economic Vulnerability map is shown in figure 6.

Figure 6: Socio-Economic Vulnerability Map

With the above assessment, it can be said that Amtali Upazila and Barguna Sadar Upazila are vulnerable in socio-economic analysis respect. This result shows the higher vulnerability of exposed coastal areas as exposed coasts are mainly susceptible to cyclones and storm surge and subjected to severe damages frequently which generally impact on socio-economic conditions. This result also indicates the economic vulnerability higher than social vulnerability of Barguna district.

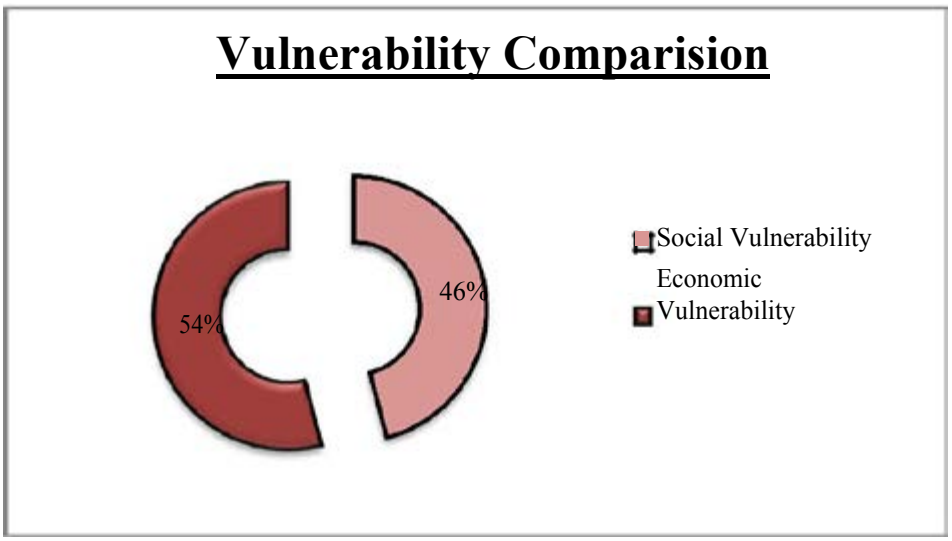


Figure 7: Comparative Socio-Economic Vulnerability of Barguna District

4. Conclusion

The social and economical quantitative analyses provide an empirical basis upon which the objectives of the study can be addressed. First, the coastal unions of Barguna district are identified as geophysical risk zone. The results of the socio-economic vulnerability analysis have important implications for emergency management and planning. However,

because of the scarcity of resources, special needs for emergency assistance in the form of early warning, mobility assistance or both should be given the highest priority in those areas which are highly socioeconomically vulnerable. For example, Barguna Sadar upazila requires the highest priority. In recapitulation, it can be said that the results of this analysis demonstrate the importance of evaluating vulnerability from socio-economic perspectives of emergency management purposes. However, much more considerations to be made if we are to develop dynamic, effective, and efficient evacuation plans.

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Disaster Management

Title: Adaptation and learning to riverbank erosion: Jamuna char land experience on Kazipur sadar union, Sirajganj.

H.M. Shahid Hassan and Dr. Md. Shamshul Alam

1. Introduction

Bangladesh is a riverine country having 230 rivers with their abundant tributaries and distributaries with an uneven distribution. As a result riverbank erosion is the common scenario in the various part of Bangladesh. Sirajganj district has been considered as the most disaster prone area to bank erosion. Many studies were conducted on this study area to analyses the vulnerability. Many government interventions (both structural and non-structural measures) were initiated in this area. Bishurigacha village of Kashrajbari Union is a mid-island char and the old Meghai village of Kazipur Union, Sirajganj District, is severely prone to bank erosion. The village was formed by the deposit of land. The age of this char land is almost 14 years. It is in a constant condition to practice all kinds of agricultural activities. Once the erosion starts, it is very likely to erode the whole village within a short period, as there is no protection measures like embankment, dam etc. to protect it from further erosion. People of erosion prone area survived with such miserable condition from the last few decades. As we know, river bank erosion is resultant from a very frequent and uncertain behavior of nature. At the time of collapse of bank during erosion it wash away the agricultural land, homesteads, various infrastructures as well as cattles also. So from this point we can see that a huge loss occur due to erosion of any area. Various measures must be taken to get rid out of such problem. In my present study trying to focus on such strategies which taken usually to reduce the impact of river bank erosion by the local people of erosion prone area. Beside explaining their coping strategy also trying to realize what are more necessary steps to decline the impact of erosion on life and properties as well as what are the leanings for the survival and to live in an erosion prone area. It is expected that, present research will helpful for the well-being of erosion as well as to enable to work out appropriate plan for diverse setting.

1. Aim and Objectives

The aim of the research is to observe and learn the way people adapt with riverbank erosion. The objectives of the current research are:

To find out the nature and intensity of erosion in Kazipur sadar union.

To document the adaptation process of local people to river bank erosion.

To document the leanings for surviving with riverbank erosion in Kazipur sadar union.

2. Literature review

For conducting current research I have to take help from various papers written on the context of river bank erosion. In this section, I describe the summary of my relevant literature review very shortly.

Mohammad Nazim Uddin and Md. Munsur Rahman (2011) in their report 'Socio - Economic Impact of Erosion along the Right Bank of the Jamuna River in Bangladesh' stated that, Due to riverbank erosion, many farmers become poor overnight. They lose homestead, houses, cultivable land, trees and other properties. Some of the respondents of the said, they have lost their loom factory due to erosion. Before erosion, when they can

guess that there is a possibility of erosion of their homestead, they follow a strategy that first they cut their big trees. They keep only the small tress and wait for erosion. Some of the respondents have also lost their pond, dug well, tube well and latrine. Many of the victims migrated to the nearest town or big city like Dhaka. On an average, seventy percent of the respondents opined that the cropping pattern is changed as a result of bank erosion. It also affects the crop diversity. Rice growing fertile cultivable land is becoming unsuitable for rice cultivation due to sand deposition.

Md. Hossain Bellal, Toshinori Sakaiand and Md. Zakaria Hossain in Their Report (2010) "River Embankment and Bank Failure in Bangladesh: A Study on Geotechnical Characteristics and Stability

Analysis" stated that the failure of embankments and riverbank erosion are common problem in Bangladesh.

Devastating flood and excessive rainfall are accelerating the failure process which results immense damage to agriculture and infrastructures every year. M R Rahman (2010) in his report "Impact of riverbank erosion hazard in the jamuna floodplain areas in Bangladesh" stated that Riverbank Erosion an endemic and recurrent natural hazard in Bangladesh. Every year, millions of people are affected by erosion that destroys standing crops, farmland and homestead land. It affects the crop income of vulnerable groups. The big farmers are the worst affected, followed by medium farmers, and marginal groups. A large proportion of the victims remain unemployed due to lack of work opportunities. Moreover, women head many of these families. The female-headed households displaced by riverbank erosion and residing on embankments are the most deprived group.

A.t.m. abdullahel baki (2014) in his report "socio-economic impacts of gorai riverbank erosionon people: a case study of kumarkhali, kushtia" stated that, the two principal resources of our country are its land and people. Maximum of the people are solely dependent upon small holdings as owner- occupiers, tenants, sharecroppers, or as landless laborers. As the socio-economic impact on people due to bank erosion is heavy it demands extra attention at the time of policy making.

Biswajit Nath, Sultana N. Naznin and Paul Alak Bangladesh (2013) in their article "Trends analysis of river bank erosion at Chandpur, Bangladesh: A remote sensing and GIS approach" stated that, Landsat TM & MSS Satellite image from 1980-1990 and Google Earth high resolution satellite imagery from 2002-2010 were used to delineate the historical changes of the river especially to The present study examines the trends of left bank line the left bank alignment of the river course.

Rawadee Jarungrattanapong and Areeya Manasboonphempool (2009) in their aricle "Adaptation Strategies to Address Coastal Erosion/Flooding A Case Study of the Communities in Bang Khun Thian District,

Bangkok, Thailand " stated that Adaptations to impacts of coastal erosion take multiple forms. Empirical studies of how individuals or communities actually adapt to coastal erosion and flooding show that choice of adaptation measures or initiatives depend on particular impacts and geographical factors in each country. Adaptation options are also constrained by economic, social, technological, and political conditions.

A.F.M Azim Uddin and Jayanta Kumar Basak in their article stated "Effects of Riverbank Erosion on Livelihood" that The study was conducted in the most vulnerable regions of Bangladesh (i.e., Kapasia Union of Gaibandha District, and Kazipur and Khasrajbari Union of Sirajganj District) due to riverbank erosion. A very little loss in cultivable lands put the marginalized people in more vulnerable situation. Due to bank erosion, a vast area of agricultural land goes into the river. When erosion strikes, people have no option left behind them except bearing the losses. They never change location of their homestead before the erosion takes place. The main reason behind such behavior is that they have

little earnings that never allow them to replace their homesteads before it totally collapses.

4. Methodology

Mainly I have done my research by using various data collection techniques like field observations, questionnaire, photograph taking, documentation etc., mainly I collect primary data by using these techniques. I collect secondary data from various books and journals. I use both primary and secondary data to fulfill my research. I Analysis collected data by Microsoft office, excel, Arc gis then present it in chart, table etc. To analyze the trend and intensity of erosion I have to calculate the area of river area and the total bank area as well as the main land area of different years. For this purpose I use Google earth and Arc map 10.1 for the area calculation of different specific year. Mainly I use the satellite image of Google earth of 2010, 2012 and 2014 for the analysis. The detail of various procedures of data collection, analysis, and methods are discussed below. Here mainly discuss the methodology according to objectives.

- First objective of current research is to find out the nature and intensity of erosion in study area. To complete the tasks of this objective, primary data collected by field observation and documentation and secondary data collected from books, journals and Google earth image. Data of total area collapse in erosion at various time, record of Past River bank erosion, and timing of erosion are collected which are analyzed by critical analysis, MS excel, word, Arc. GIS and Presented in table, flow chart, graph and Image.
- Second Objective of present research is to document the adaptation process of local people to river bank erosion. For this objective primary data collected by Physical observation, Measurement, Questionnaire survey, Photo taking, Recording and interviewing whereas secondary data collected from various books and journal. Data of various process relevant to adaptation like agricultural practice, household patterns, assets, migration, food security, occupation etc. collected and analyzed by Microsoft word and excel and presented in table, chart and graph.
- Third objective of the research is to Document the leanings for surviving with riverbank erosion in Kazipur sadar union. For this objective primary data collected by Physical observation, Measurement, Recording and interviewing whereas secondary data collected from various books and journal. Data of various process relevant to adaptation like agricultural practice, household patterns, assets, migration, food security, occupation etc. collected and analyzed by Microsoft word and excel and presented in table, chart and graph.
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5. Study area

Kazipur Upazila (sirajganj district) with an area of 368.63 sq km, is bounded by dhunat, sariakandi and sarishabari upazilas and the jamuna river on the north, sirajganj sadar upazila on the south, Sarishabari upazila and the Jamuna river on the east, Dhunat upazila on the west. Many old inhabitation including Mallickpara, Dhulaura, Maijbari, Manik Patal, Kazipur, Meghai, Tarakandi, Tengalahata are gradually getting extinct by river erosions. Jamuna-Bhramaputra Flood Protection Dam known as WAPDA Dam, built in the 1960 on the west side of the Jamuna could help much neither to resist river erosion nor flood control. Of course it helped much in irrigation. Main rivers are Jamuna and ichamati. Kazipur (Town) consists of 9 wards and 9 mahallas. The area of the town is 10.84 sq km. The town has a population of 14800; male 50.01% and female 49.99%. The density of population is 1365 per sq km. Literacy rate among the town people is 27.2%. (BBS Population census 2011)

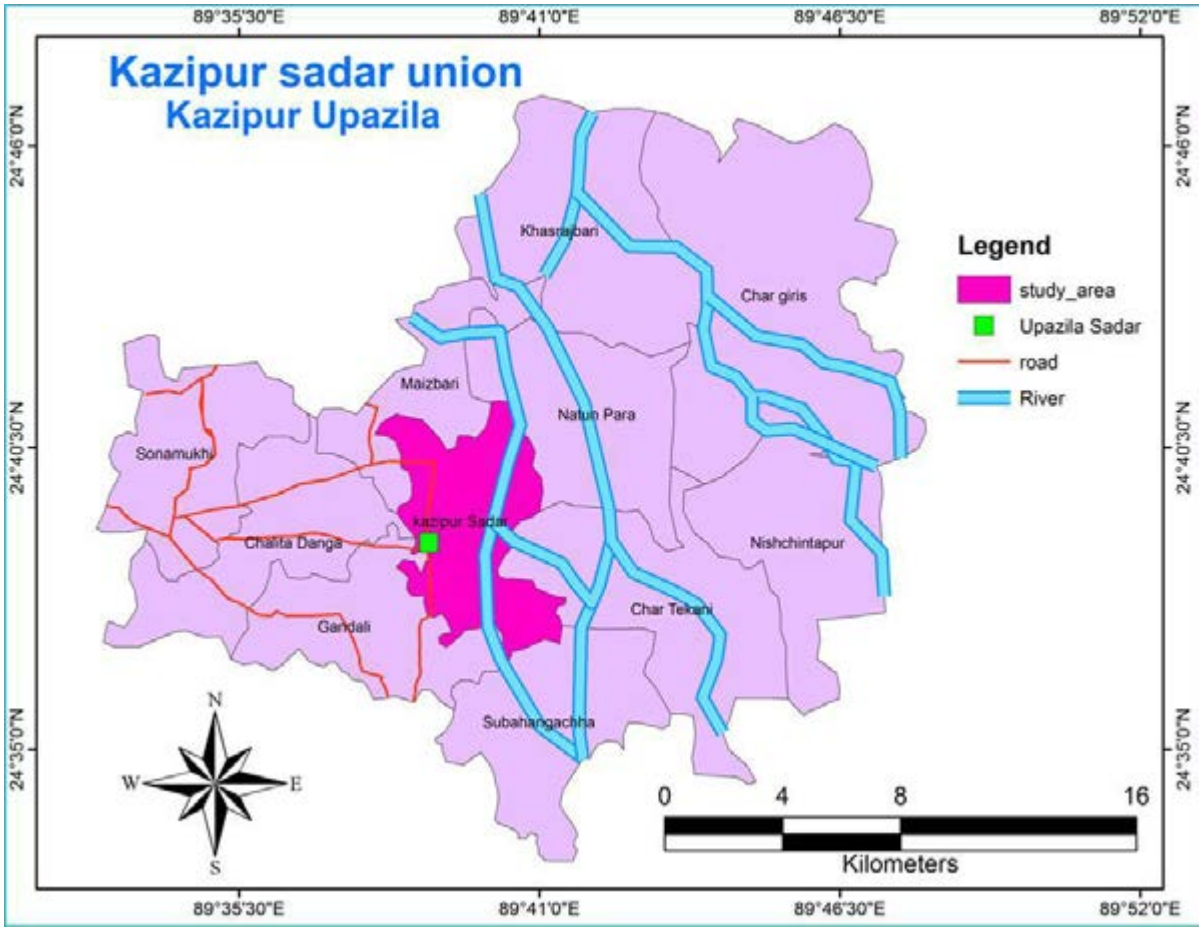

Figure 5.1 - Location Map (Study area) **Source-Author**

6. Result and Discussion:

*6.1 Nature and Intensity of erosion***:** Main aim of our study is to find out the adaptation strategies of the people whose are living in the erosion prone area from many years. Before start discussion about this matter, we should have an idea about some basic characteristics of riverbank erosion as like as nature, intensity, or area collapse in the river of recent time. Bank erosion is the wearing away of the banks of a stream or river. This is distinguished from erosion of the bed of the watercourse, which is referred to as scour. The two types of riverbank erosion are:

- Undercut: Involves the removal of bank material by flowing water and carried sediment. Look for undercutting of the bank toe as a sign of scour and mass failure.
- Mass Failure: Characterized by sections of the bank sliding or toppling into the stream. Look for bare and near-vertical banks as a sign of collapse.

In my study area there is mainly riverbank erosion characterized by undercut process, which carried out a huge amount of agricultural land, settlements, as well as other infrastructures.

Here mainly I calculate the total area collapse in river from the year 2010 to 2014 by using Google earth image. Mainly I draw line from north to south of my study area the measure the horizontal distance of nearby road from river of the vertical section in 1 km, 2 km, 3km, 4km, 5km, 6km and 6.20 km. I take this measurement of the year 2010, 2012 and 2014.

Figure 6.1- Google earth image 2010

Figure-6.2 Google earth image 2012

Figure 6.3- Google earth image 2014

Table 6.1: year wise distance of nearby road from river **Source- Google Earth**

	2010	2012	2014		
Horizontal section(southern)	**Distance (road to bank) in meter**	**Distance(road to bank) in meter**	**Distance(road to bank) in meter**	**Change in land Area(m)**	
				2010-2012	**2010-2014**
1km	195.18	222.01	295.85	26.83(+)	100.67(+)
2 km	652.21	627.46	413.19	24.74(-)	239.02(-)
3 km	963.95	766.30	506	197.35(-)	457.95(-)
4 km	686.15	574.88	960.03	111.27(-)	273.88(+)
5 km	661.50	460.46	659.55	201.04(-)	1.95(-)
6 km	1267.43	1029.21	752.55	238.22(-)	514.88(-)
6.20 km	1262.85	1041.15	706.20	221.7(-)	556.65(-)

High risk area (-) loss of land, (+) increase of land area
Medium risk area
Low risk area

From the above table we can see that year-by-year distance of road from the river is gradually declining in the most of the area. The most risky zone is 2 km, 3km, 6 km and 5.2 km. in these section the distance of road is gradually decrease year by year. In 2 km vertical section distance in 2010 was 652.21 m which decrease at 413.19 km in 2014 and it's about 239.02m area collapsed in river during 2010-2014. As like as in 3 km, 6 km and 6.20 km the amount of land collapsed in river is about respectively 457.95 m, 514.88m and 556.65m during 2010-2014. So, these zones are characterized, as high risky zone as erosion rate of these vertical sections are higher than other area. In case of 1 km and 4 km, we can see that the horizontal distance of river from road is gradually increase from the year 2010 to 2014. In the zones mainly due to deposition of sediment land area gained instead of land collapse. The increase of land area is about 100.67 and 273.88(+) respectively in 1km and 4 km during 2010-2014. So these zones are characterized as low risky zone.

There is table given below which showing the river area and bank area in prospect of mainland area of the year 2010, 2012 and 2014 as well as total eroded area from 2010 to 2014.

Table 6.2: Comparison of Area (River area and Bank area) **Source- Google Earth**

Year	River Area(sq. km)	% with mainland area	Bank Area(sq. km)	% with mainland area	Eroded Area(2010-2014 in sq. km)
2010	16.87	63.07%	9.88	36.94%	.98
2012	17.51	65.46%	9.24	34.54%	
2014	17.85	66.73%	8.9	33.27%	

Form this table we can see that River area is increasing gradually whereas the bank area is declining day by day. In comparison with 2010 to 2014, the bank area decreased from 9.88 to 8.9 sq. km. whereas river area increased 16.87 to 17.85 sq. km. Total area eroded during 2010 - 2014 is about .98 sq. km. kazipur sadar union is a highly eroded area where it is about 1 sq. km. area had gone under water in last 4 year. Erosion of land mainly toeards through west to eastern side. The river is widening day by day towards the eastern side. If it will continue there are many homesteads, agricultural land, roads, other important infrastructures like hospital, union parichad office etc. will go under water in very near future as well as kazipur sadar union will vanish from the map of Bangladesh. There is an erosion map of kazipur sadar union shown here.

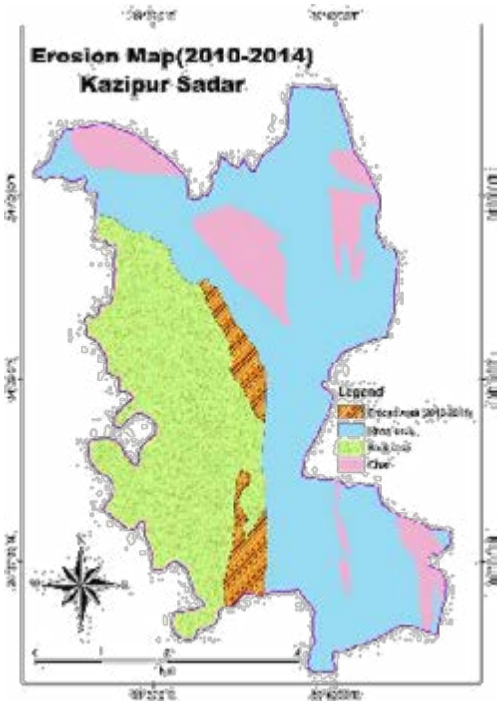

Figure 6.4 - Erosion Map(2010-2014) **Source-Author**

6.1.1 Loss and damage Extent: An attempt has been made to understand the losses occurred due to riverbank erosion in the study area. In view of this, losses were accounted through the loss of agricultural land and production, loss of homesteads, loss of cattle etc.

Table 4.3- Eroded land in 2011 in comparison to 1973-2009 (year wise) Source- (BBS 2011)

Study Area	Total Area (ha)	Average Eroded Land (ha/year-1973-2009)	Erosion in 2011 (ha)	Percentage of total land (%)
Kazipur sadar Union	2767.93	6.89	178.76	6.46

From the above table it showed that the amount of eroded land is increasing dramatically over 2009 to 2011 with the comparison of the average eroded area from 1973 to 2009 in Kazipur a union of sirajganj district while the average eroded area (1973-2009) of kazipur is 6.89 as it reached 178.76 and 203.36 in 2011. As we mention before riverbank erosion is a devastating hazard which cause a huge loss of life as well as valuable assets like crops, domestic animals etc. here we explain the loss and damage extent in two basic point which are-

- Loss of agricultural land
- Loss of households

*6.1.1.1 Loss of agricultural land***:** There is table is given below which presenting the amount of land collapsed in river and their value for several responded.

Table 4.4: Total land collapsed and their value **source: field survey (2014)**

Amount of land collapse in river in last decade(in Bigha)	Value of land collapsed land (taka in lakh)	Percentage of responded
12	60	5
6	30	8
5	25	10
4	20	15
3	15	28
2	10	32

From the above figure, we can say that people have lost huge amount of land due to river bank erosion in my study area. For more clarification there is an explanation is given below with pie chart.

In given chart shows that maximum responded loosed about two bigha land due to erosion whereas only 5% people loosed about 12 bighas land as well as 8%, 10%, 15%, 29% and 33% of responded losses respectively 6, 5, 4, 3, 2 bighas of land due to erosion in my study area. The value of land fluctuated between 60 to 10 lakh taka. From the above discussion there is a clear indication appear more clearly that, the people of river bank erosion prone area losses a huge amount of land every year. For this reason they have to fall in a miserable condition and there life also threaten. The

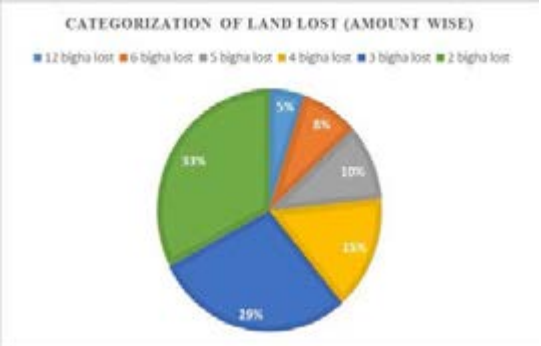

Figure 6.5: categorization of land lost (amount wise)

*6.1.1.2 Loss of Homesteads***:** The level of economic loss and vulnerability of population due to bank erosion has dramatically increased in recent years. The impact of land loss reflects primarily through the loss of homestead land. An estimated 300,000 displaced persons usually take shelter on roads, embankments, and government-requisitioned lands. It's about 100% of responded told me that they have lost their households due to erosion.

*6.1.2 Timing Of Erosion***:** River bank erosion mainly occur in after and before flood. It mentioned before that, in kazipur sadar union erosion mainly proceed through undercut process. It is because the soil characteristics of this area. Soil of this area is mainly sandy and have loose porosity. As a result water pushed in the lower portion thus lose sandy soil wash away through water and the segment of this site's land become thin as collapse in the river. This is the mechanism of undercut process. Flood has a connection with riverbank erosion in case of timing. Mainly erosion in this area starts at two points.

1. When water over flooded through the riverbank.
2. At the time when floodwater go down after flood.

That mean usually in this area erosion starts at august and then September to November in this area.

6.2 Adaptation With Riverbank Erosion: Adaptation means coping with urgent behavior of nature. In broader sense when a disaster or any kind of unnatural/natural and unpredicted or predicted natural incident occurs behind us, adaptation implies that how we cope, adjust and survive with such sudden incident. In my present study I try to focus how the people of erosion prone area survive, manage and prepare themselves to continue their live with such as hazardous situation. In case of river bank erosion adaptation may be defined how the people of associated area coping with before and after of erosion. Here I define the adaptation in various contexts of riverbank erosion.

6.2.1 Agricultural Practise: As the part of adaptation the people of erosion prone area try to continue the agriculture practice far from river bank as much as they can or they try to preserve a certain amount for harvested crops as erosion can start at very sudden. Such kind of adaptation measure also depends on the ability of local people. During field survey, it observed that most of the agricultural land is just beside the river which are

severely vulnerable as any time can go under water. Everyone of this area know they should buy agricultural land far from the river. But the problem is their low income. For this reason They are not capable to do that. Very few people are capable to buy land far from the erosion prone are as they are economically solvent than other.

From the above chart it can be stated that most of the people of my study area are landless. They lost their land in riverbank erosion due to river bank erosion of last decades. Only 10% people of this area have own land for agricultural purposes and it's about 85% people of this area are landless as well as it is also observed that there is only 5% people have their own land outside of this area.. Landless people earn their livelihood by working as a day labor in other land or by land digging. This the overall land ownership condition of my study area.

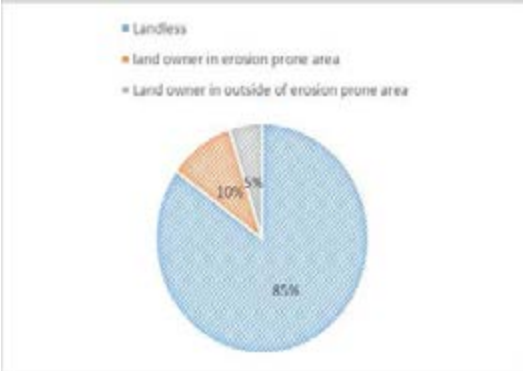

Figure 6.6: Land ownership

From survey it observed that, about 60% cultivation occurred during winter season as it is the most secure time for cultivation. In the meantime, of winter season there is no provability occurring natural hazard like river erosion. On the other hand, there is about 40% cultivation occur during summer season where as there is no cultivation or farmers do not continue their agricultural activity during rainy as this is high time of occurring riverbank erosion. There is a table given below which shown the cultivable crops of my study area. There isatable is given below that show thee various crops that produced in my study area. Mainly in this area is basically a sandy as well as a huge amount of siltation occur every year due to flooding. Paddy is the most cultivated crops in this area. About 44% of total cultivation is paddy cultivation. Boro amon and the chinese is two main species of paddy cultivated here. On the other hand, during winter season various winter crops as like as wheat, corn, nut etc. are harvesting here. People of this area try to cultivate the harvests which can be cultivated at low cost as like as pulse, nut, various kinds of oil seeds, various kinds vegetables which can be produced in winter as these time there is no probability of occurrence river bank erosion. They try to avoid cultivate in rainy season as well as cultivate those crops which need high cost to cultivate. In this point of view agricultural practice is modified here to adapt with the riverbank erosion.

6.2.2 Household Patterns: People of the study area know that their household can be diminishing at any time as they have to relocate their household in very short time when erosion starts. For that reason, they build their households with such building materials that can be transferred within short period during erosion starts. According to the responded, they construct their households by tin because for the easy access of low quality old tin as well as their low price also. On the other hand straw is not available in this area. Another reason of using tin is the easy movability. Such kind of tin shade structures can be move easily than straw made homesteads.Such strategy for household construction makes them less vulnerable in case of riverbank erosion. On the other hand, Due river bank erosion

many households go under water. In this case they become homeless as part of adaptation they move to another char or other area. As precaution measure they try to live at long distance from river.in my study area the distance of households from river is between 150 to 400 meters. About 35% of households are situated between 150-200m away from the river. These households are highly vulnerable to erosion whereas about 20% of households are situated between 250-300m and 300-400m and about 25% of households are situated between 200-250m. From the above explanation it can be said that most of the households of this area are in a vulnerable condition. Most of the responded know that it will better for them if they can move their household far from the river. But it depends on their ability. Most of the people living in this area are poor and they lost their everything un the river bank erosion of last few decades. As a result, they have to live with such vulnerable condition.

6.2.3 Migration: Many people of erosion prone area are becoming homeless every year due to riverbank erosion. They have to shit another place to survive As mentioned before most of the people of study area are poor and they live under poverty line. Most of them shifted in the nearby dam behind the river and it is about 60% whereas about 30% and 10% have a tendency to shift in nearby road and in sirajganj sadar.

6.2.4Food security: It is about 35% of the villagers preserved rice for their future according to their ability as well as about 20% and 10% people preserve gradually wheat and dry food according to their ability whereas about 35% of people preserve no food item for the future as they are unable to buy or preserve food item for future with their low income. Mainly preservation of food items mainly depends on their ability. Basically, all of the villagers of this area are concern about the fact what will happen in near future when erosion will start but they have nothing to do as they have a very low income. Although people of this area take steps as much as they can to cope up with such extreme hazardous situation.

6.2.5 Preparedness: We know that riverbank erosion is a devastating natural hazard, which may occur at very sudden. Therefore, the people of the erosion prone should be prepared themselves for such hazardous situation. Most of the people of my study area have a clear concept about when erosion will take place. When erosion will start it's about 90% people are concern about to move old and children as they are unable to move safely than the other member of the family. About 10% people are nit aware about that fact. It is about 95% people are capable of moving their household in safe place whereas about 5% people are not aware about that fact as they built their household with very low coast. At last about 95% of people are concern about the domestic animals of their own and they concern about to move them in safe place when erosion will start. In this case only 5% of them are not aware about this fact as they have domestic animals which are not easily movable like chickens, duck etc. This is the situation about the preparedness status in case of river erosion of my study area.

Occupation: About 70% people are day labor. Mainly day labors are working in the other's agricultural land, soil digging etc. whereas about 20% are earning their livelihood by farming and fishing as most of them have their own land for cultivation in this category. Only 10% people of this area are categories in other sector, which include garments worker whose are working in Dhaka, as they have nothing to do in their own area. Except this, many people go to nearby in district town such as in Sirajganj and Bogra for various working purpose like rickshaw pulling.

6.3 Learning's for surviving with river erosion: Various leanings to survive with riverbank erosion is discussed below which may be helpful to decline the impact of riverbank erosion in erosion effected area of Bangladesh.

- **Nature and intensity of erosion:** It is an important part about the learning and conceptual development about river bank erosion because if the people of erosion prone area have sufficient knowledge about the fact; they can easily estimate the impact as they will prepare for any remedial measurement thus the effect of erosion may be reduced on their livelihood.
- **Preparedness for urgent move:** Erosion usually starts at a very sudden and within a short time it occurs a huge destruction. So the people of this area always should be prepared both physically and mentally for urgent move in safer place. They have to learn which properties are moveable and which are not. As they have to focus on such moveable assets which will helpful for their further settlement. They should be prepare themselves for the urgent move of their movable assets such as households, domestic animals, other important household materials etc.
- **Proper agricultural practice:** We know that river bank erosion is an unpredictable hazard which occur at a very sudden and collapse a huge amount land in the river when erosion starts which include cultivable as well as cultivated land. So the people of the erosion effected people must be concern about this fact. They also have to learn about suitable agricultural practice because it will also be helpful for them for reducing the loss as agricultural land also collapse during erosion.
- **Proper household structure:** We know that riverbank erosion is uncertain as well as unpredictable which carried away households in river water. To avoid such loss of homesteads people of effected area must have concern about this fact as for proper house hold pattern it is must necessary to learn about appropriate materials and patterns which will easier to move in safe place during erosion starts. Thus it will possible to reduce the loss burden of erosion.
- **Distance of households and agricultural land from river:** The people of erosion prone area must pay attention on distance from riverbank in the case of household making or agricultural practice and build homesteads and harvesting far from the place towards which area erosion is occurring. If the distance between river and household or agricultural land is less then, possibility of collapse in river is more. So the distance between river and agricultural should be more thus it will efficient for reducing the loss. It is necessary because it will minimize the risk of house hold or agricultural field collapse during erosion as much as possible.
- **Communication with local government and NGOS:** Many NGOS are working for the development of effected and displaced population in erosion prone area. Besides them local government is also conscious about them also. In my study area there are about three NGO whose area working for the erosion effected people. The name of the NGOS area Karitas, Shouhardo and Brac, Mainly karitas and shhouhardo works for the erosion effected people So the people of these areas should maintain a communication with these organizations as they can get help and other facilities or information about the river bank erosion. Thus, they can also reduce the loss burden of erosion.
- **Concern and consciousness about the children and old people:** The risk of erosion varied through various age group whereas Children and old people are most vulnerable in this case. Because they are not capable like the other member of the family. So the people of this area must be concern about them. It should be planed and take necessary steps about how they moved from one place to another place during erosion. It will be possible then to move the old people and children in a safe place in a very short period.
- **Perfect place for domestic animals:** At the mean time of after erosion domestic animals will be the most helpful for them and it'll give them financial aid also which is very

fruitful for them at this period. So the people of this area must be careful about the domestic animals as these animals will be turned into a valuable asset at the time of hazardous situation. Various steps should be taken to safe domestic animals such as keep them in a safe place as these animals can be moved swiftly in safe place.

7. Findings: Here presenting finding of current research according to the objectives.

1. From this study it is possible to get a clear idea about the nature and intensity of erosion in study area. There is a table given below that shows the nature and intensity of erosion.

Tab.7.1- Findings for Objective 1

Types of erosion	Undercut
Timing of erosion	July-October
Loss and damage extent	Agricultural land, household, crops 32 bighas land collapsed in river in last decade and value of land about 1 core 60 lakh taka
Direction of erosion	Towards West to east
Rate of erosion	Average .44 sq. km per year

2. One of the objectives is to document the adaptation process of erosion-effected people in study area. The adaptation process of local people of study area is given below.

Tab.7.2- Findings for Objective 2

Agricultural practice	**Timing of cultivation**	Mainly in rainy and summer season, avoiding cultivation in rainy season
	Cultivated crops	Chienese, boro and amon paddy in summer, wheat, corn, nut, muster seed in winter.
	Distance from river	Very near to river, some of the land is far from river but it depends on owner's ability.
Households	**Distance from river**	150 to 400 meters away from river
	Building material	Maximum old tin
	House hold structure	Moveable structure.
Migration		Migrated in the nearby dam, district(Sirajganj and Bogra)
Food security		People preserve food for future and food items mainly rice and dry food
Preparedness		Prepared mentally and physically and concern abbot old and children of family as well as concern about timing of Erosion
Occupation		70% people are day labor, 20% are earning their livelihood by farming, and fishing and 10% people involve in other sector, which include garments worker whose are working in Dhaka.
Catelling		Most of the people of this area have their own domestic animals like cow, goat as it is an valuable asset of crisis period.

3. The last objective of the research is to find out the various learning's from adaptation process to survive in erosion prone area. Key findings of these objectives is discussed below-

   Erosion can't be stopped, its true because the bank line is made off sand materials which is erodible economically it is not possible to stop as the protection measures to stop or reduce river erosion is very expensive. Although if it is possible then it would be a better solution. Extensive loss of life and

properties clearly indicates that, this area is not suitable for permanent residence. So, it is better to make arrangement of alternative settlements for the people are living in this area. Make shift arrangement should be the best solution; which can be easily shift able. When one side of the river collapse, it develop in other side. So, it is necessary to make sure institutionally that, those who lost their land must get access in newly formed land area. Proper education system should be developed in these area so that, they can be well educated; get job in other side thus they don't have to depend on land. Finally erosion is physical but its impact is social and economic. It is not possible for the victims to overcome from such situation by own, all of us including the public leaders and govt. officials should stand beside them.

8. Recommendation:

- ☐ First, have to develop structural measure like dam, embankment etc. as it is an efficient way to mitigate the loss of river erosion.
- ☐ Emphasis on policies aimed at mitigating the impacts of erosion, which include various measures like giving loan to the victims in easy condition, help them to manage land, give monetary help for resettlement.
- ☐ Displaced people need more effectively organized local leadership to voice their scarcity, needs, and their demands to local administration and government offices. The voluntary organization can play important role by giving proper training to erosion effected people thus they can survive with such hazardous condition, have knowledge about warnings and them able to find most efficient way to adapt with such hazardous condition.
- ☐ There is a common rule river that is when bank of river collapse in one side then new landform in the other side. Government should make a policy thus effected people can be shift in the newly accreted land and must consider about the proper implementation of this policy in most efficient managed way should be ensure.
- ☐ Sustainable and efficient structure of embankment should be construct and its maintenance.
- ☐ Training on disaster preparedness involving local institution/ local government thus they can make people more conscious about the impact of such destruction.
- ☐ Massive afforestation with the experience of local knowledge and its proper maintenance must be ensured.
- ☐ Proper Action should be taken against deforestation.
- ☐ One of the most important fact that local government should take initiatives to reduce the unemployment problem of displaced population of erosion prone area.
- ☐ Long term measures should be taken to introduce suitable crops for sandy soil commonly associated with char area as well as more agricultural research should be conducted for the development of crop production in the erosion prone area.
- ☐ All of the effected people of erosion prone area possess a common skill that they have agricultural experience. So government should give priority to resettle homeless people in emerged charland which are highly potential for cultivation as these lands are mix with silt carried by river water flow.
- ☐ Proper measure should be taken to prevent to prevent the current practice of land grabbing by local powerful community thus exploitation will be removed and effected people will be benefited.
- ☐ As riverbank erosion occurred at sudden so emergency relief plan should be develop.
- ☐ Educated society, administrative bodies, as well as all the people of various communities should be concern about that fact and people of associated area should more conscious about this fact.

9. Conclusion: River bank erosion is an destructive natural event, from which the marginalized and poor people not only lose property but also experiences socioeconomic scarcity through displacement. Because of the dynamic and unpredictable behavior of the braided channeled river as well as the failure of structural measures, it assumed that the sufferings of the people would continue. Long-term plans and strategies should be taken to

adapt with the bank erosion taking into account the social and institutional adjustment measures. Ensuring the relocation of asserted land in systematic and efficient way is one of the suitable strategies to cope up with such disaster like riverbank erosion. In addition, a floodplain and risky area zoning is essential to lessen the vulnerability of riverbank erosion. At last we can say that river bank erosion is a most common natural hazard that occur at a very sudden and cause a huge destruction. But although many people have to live such risky area as they have nothing to do as well as they have no place to live. If proper measure is taken then it will be possible to minimize the loss burden of effected people. Government as well as non-government organization should come forward and should take proper steps to mitigate the impact of riverbank erosion.

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Title: Role of NGOs in Disaster Management for Sustainable Development of Bangladesh: A Comparative Analysis between the Policy Guideline and Practices

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1. Introduction

The geographic location of Bangladesh in South Asia is at the confluence of the three mighty river systems of the world: The Ganges, Brahmaputra and Meghna (Khan and Rahman, 2007). Such geographical setting and meteorological characteristics render the country one of the most vulnerable places on earth to different geo-hazards and hydro-metrological hazards like floods, cyclones, droughts, tidal surges, river bank erosion, water logging, water and soil salinity, epidemic, and various forms of pollution etc. (Khan, 2007; Bangladesh Disaster Report, 2013). Moreover, Bangladesh is one of the most populated countries in the world in terms of population density where 135 million of people have been affected by natural disasters in last 20 years (Ban Ki Moon, 2014). Since 1970‟s cyclone to 2014‟s Komen, Bangladesh has an age-old experience of dealing and coping with natural disasters. The country has a long history of experience of disaster management. Furthermore, the people of this country heroically withstand the adversity of nature and this resilience is appreciated worldwide (Khan and Rahman, 2007). Bangladesh has set an example by imparting disaster preparedness training to 62,000 people at rural level and keep 25,000 community volunteers standby to act promptly just after any disaster, remarking this effort UN secretary general Ban Ki Moon quoted that Bangladesh sets an example in disaster preparedness and disaster preparedness and management of Bangladesh can be followed by other disaster prone countries of the world. From past experience it has been found that all strata of society including the government, local communities, NGOs, CBOs, media, private sectors, academics, donor agencies always come forward and work in unity in relief and rehabilitation works for the distressed people during and after the natural disasters. This is the greatest strength of this nation and partnership could be built on this time-tested resilience.

The IRFC publication stated, “Since risk reduction goes to the heart of the development process, the challenge is well beyond the capacity of disaster managers alone. It requires cooperation between development agencies, governments, non-governmental organizations (NGOs), businesses, scientists and vulnerable communities.” In the context of Bangladesh, there is enough evidence that NGOs make up a vibrant sector in Bangladesh, which has been acclaimed worldwide. In addition, it is recognized historically that non-governmental, community-based organizations (NGOs/CBOs) and other informal support mechanisms have made significant contributions during and after disaster recovery (Khan and Rahman, 2007). Disaster management of Bangladesh has made paradigm shift from a post-disaster relief and response strategy towards a comprehensive risk minimization culture that encourages disaster resilience initiatives. To attain the current disaster management goals emphasis needed to be given on institutional partnership among government, NGOs/CBOs

and the private sectors. But, unfortunately gap between such partnerships is clearly evident in representation and functioning of disaster management at different level of the country. From the experience of achieving Millennium Development Goals (MDGs) and historic evidence of NGOs involvement in post disaster activities it is evident that NGOs can be potential actors/partners in the field of risk reduction and disaster management of Bangladesh. Therefore, it is encouraged to build a partnership approach between GO and NGOs for sustainable development led disaster management of Bangladesh.

2. Methodology

This study aims to analyze the present disaster management context of Bangladesh. This includes policy review focusing on the NGO roles recommended in disaster management plan, act and policy of Bangladesh and NGOs, CBOs practices in real world scenario comprising all three phases of disaster management (Pre disaster, during disaster and post disaster). In the context of Bangladesh disaster management, this paper targets to review the current disaster management practices of NGOs, investigate the communication gaps between NGOs and GOs in disaster management practices. By analyzing the activities of NGOs in disaster management the study aims to understand the factors encouraging or inhibiting work in disaster management and to promote good practice. Official government documents, research reports, NGO studies, reports and journals and newspaper articles formed the basic sources of information for this study.

Again, as disaster management activities of Bangladesh is on a verge of paradigm shift it is important that proper institutional mechanisms at different levels of administration in Bangladesh are embedded in a partnership of relevant stakeholders. Institutional partnership refers to the shift from a managerial approach to a process of participatory, collective decision-making and resource sharing to achieve shared goals of pre-and post-disaster risk management. To understand the current institutional mechanism present in several leading NGOs of Bangladesh and to investigate the gaps between NGOs and GOs a workshop was being held at Institute of Water and Flood Management (IWFM), BUET arranged by Institute of Water and Flood Management (IWFM) and Central for Sustainable Development (CSD), ULAB under the project entitled with „Disaster Prevention/Mitigation measures against Floods and Storm Surges". There almost 25 participants from several renowned NGOs were present and conveyed their valuable comments regarding disaster management of Bangladesh. In addition, to properly understand and investigate NGOs" field level activities a visit was being initiated to Gaibandha; there the team had closely observed NGO activities in disaster management, that is exemplary evidence of admirable disaster management of Bangladesh that may lead to sustainable development of Bangladesh. Assembling all the information both primary and secondary; this paper targets to summarize the existing policy-institutional framework of disaster management and the role and activities of various stakeholders focusing on the current practices of NGOs in disaster management practices of Bangladesh.

3.NGOs in National Disaster Management Framework of Bangladesh

According to the World Disasters Report 2003 Bangladesh was among the top three disaster-prone countries in the world and according to the World Risk Report 2012 Bangladesh was fifth most natural disaster prone country among 173 countries in the world. It is kind of a clear indication that, disaster management practices of Bangladesh is in a motion of continuous improvement and it is a matter of bliss that this achievement of Bangladesh is remarked worldwide.

The Government of Bangladesh has already taken a number of significant steps during the last few years for building up institutional arrangements from national to the union levels for effective and systematic disaster management facilitating mitigation to the sufferings of disaster victims in Bangladesh (Country Report, 2003). Though the National Disaster Management policy yet to be finalized the National Plan for Disaster Management 2010-2015 has been prepared in 2010. The plan has been developed in tune with the GoB Vision and MoFDM mission to reduce the vulnerability of the people, especially the poor and the disadvantaged, by bringing a paradigm shift in disaster management from traditional response and relief practice to a more comprehensive risk reduction culture (Hossain, M. A., n.d). Moreover, in National Plan for Disaster Management (2010-2015) of Bangladesh, mainstreaming risk reduction strategies within Govt., NGOs and Private sector is viewed as key to achieve sustainable development.

Table-1: Consideration of NGOs as a supporting agency under different strategic goas of NDMP (2010-2015)

Strategic goal	Key Target
1.Professionalizing the disaster management system	1.1 Design and implement training and Awareness programmes targeting national and District level policy officials.
2.Mainstreaming Disaster Risk Reduction and Climate Change adaptation	2.1. Risk reduction and climate change adaptation principles and practices are mainstreamed within all development programmes and policies 2.2 Disaster risk reduction and climate change considerations incorporated in NGO programmes and plans
3. Strengthening Institutional Mechanisms	3.1 Capacity Building of DMCs at all levels
4.Empowering at Risk Communities	4.1 Develop and establish a standard assessment procedure to identify community and household level risks 4.2 Strengthen community and household level capacity to withstand the disastrous situations 4.3 Reduce vulnerability of the at risk communities through social safety nets

5.Expanding Risk Reduction Programming across hazards and sectors	5.1 Across Hazards: Update hazard maps such as flood, cyclone, drought, earthquake and tsunami. Develop climate change scenarios and accordingly anticipated hazard risks following climate change 5.2 Establish an Integrated Approach to disaster management including Climate Change and climate variability impacts
6.Strengthening Emergency Response Systems	6.1 Strengthen and improve an all Hazard Early Warning Systems 6.2 Establish and operate a National Disaster Management Information Centre with an internet connection with all the 64 Districts and high risk Upazila DMCs 6.3 Establish an effective Community Alerting System through capacity strengthening of CPP and DMCs at District, Upazila and Union levels. 6.4 Establish and improve Search and Rescue Mechanism 6.5 Develop and establish emergency response plans
7. Developing and Strengthening regional and global Networks	7.1 Establish public and private partnerships for disaster risk reduction. 7.2 Support regional and global initiatives and ensure representation that is consistent with the government integrated all sector risk reduction approach at all levels

4. NGOs Involvement in Disaster Management of Bangladesh

Disaster management is handled locally by national government through its line departments and other government and non-government institutions. Moreover, various international stakeholders are involved in disaster management activities of a country. Therefore, disaster management around the world requires an effective collaboration and cooperation mechanism among the different stakeholder (i.e. National and Local government, local institutions, Civil Society Organizations, Non-government Organization, International Institutions, Media, Donor Agencies, Academicians etc.) directly or indirectly involved at different stages and activities of disaster management (Slaymaker, T. et. al., 2005; UNISDR, 2006).NGOs‟ involvement in Disaster Risk Reduction (DRR) activities has proved to be beneficial as they can operate at grassroots level with communities and local organizations as partners. In addition, NGOs are able to respond quickly and easily that made the efficient facilitators at disaster management activities (UNISDR, 2006). It is also being evident that, NGOs with a strong local base and long-term commitments to a particular location are best placed to implement sustainable mitigation programs (Joseph. P., 2006). In spite of being their primary involvement development activities, disaster management and risk reduction activities are always one of the major priorities of NGOs

around the world. In Bangladesh, NGOs have made up a vibrant sector and it has been acclaimed worldwide (Khan and Rahman, 2007). Particularly in the disaster management activities of Bangladesh, there are several historical evidence to display that both the national and international NGOs of this country have played diversified and significant roles at different stages of the disaster management cycle of the country. As a matter of fact, the advent of NGO activities in Bangladesh owes its origin to the rehabilitation works immediately after the devastating war of independence in 1971(Haque, C. E., & Uddin, M. S., 2013). Since then NGOs at both national and international have contributed greatly at different post disastrous situations of Bangladesh. Besides,NGOs like the Grameen Bank and Bangladesh Rural Advancement Committee (BRAC) have been able to extend their development and disaster management programs at the international level (Haque, C. E., & Uddin, M. S., 2013). Furthermore, a study showed that, about 20% of the assistance to emergency response, recovery, and rehabilitation during 1970 cyclone disaster was ensured by NGOs both national and internationals and it was more than 40% in 1991 cyclone disasters (ADB, 2009). Also, NGOs like BRAC, CARE-B and Muslim Aid etc. played exemplary roles at relief, rehabilitation and recovery phases after Sidr (2007), Aila (2009) of Bangladesh (Sarkar. M.A., 2009). It is also a positive factor that, in Bangladesh, a number of NGOs have attempted to study and draw lessons from traditional coping strategies in terms of disaster management (Benson, C. et. al., 2001, Joseph, P., 2006 and Sukhi, T. J., 2014).

Moreover, a study carried out by Haque and Uddin showed that, NGOs such as CARE-Bangladesh, OXFAM-Bangladesh, Action Aid, Intermediate Technology Development Group-Bangladesh, Bangladesh Disaster Preparedness Center (BDPC) and Disaster Forum are particularly involved in various pre-, during and post-disaster activities (Haque, C. E., & Uddin, M. S., 2013). Pre-disaster activities include advocacy, public education campaigns and training programs for personnel involved in disaster management from the national down to the union or local community level. Post disaster activities of NGOs can be broadly classified into three broad time periods i.e. short term, midterm and long term and they contribute their assistance at different sectors of development process to the affected people (Table-2). For instance, after SIDR 2007 BRAC had provided the SIDR affected peoples with seeds, fertilizers and tillage services for land preparation, irrigation and for other cultural activities up to the maximum of taka 5,000 per acre for rice production by instalment. In addition, they had introduced hybrid maize for human consumption as well as for poultry feed, provided grand to poor affected women with seeds for vegetable production and social forestry. These initiatives of BRAC provided an opportunity of quick rehabilitation to the poor affected people of the area and were helpful to restore their pre-SIDR livelihoods (Sarker. M. A., 2009).

Table-2: Summary of Sector wise involvement of NGOs at different time period of post disaster rehabilitation

Time period / Sector	Short term	Mid Term	Long Term
Agriculture and livestock	- Seed distribution	-Vegetable and agricultural seed distribution	-assistance to poor for cow rearing
Health	- Ensuring nutrition supplement		-Training on health and nutrition -Hygiene education
Water and Sanitation	-Ensuring safe water with water purification tablets	-Repair water Supply and sanitation and provision of new one	-Tube well raising
Housing and infrastructure	-resettlement of homeless		-Homestead raising -Housing with still frame -School renovation program/ School cum shelter Construction -Road, market, graveyard, etc. raising
Employment opportunity	-Short term employment - Agriculture based livelihood rehabilitation	-Cash for work -Food for work -Loan for buying net or boat	-Loan for small shop -Mandatory savings

Again, CARE-Bangladesh and BRAC had ensured safe water supply by providing emergency water treatment tablets and sanitation facilities for the affected of Barguna and Bagerhat (Sarkar. M.A., 2009, Shukhi. T.J., 2013). Even in the recent disaster event of 2015 Komen, NGOs have played a very important role in disseminating the early warning broadcast through radio in line with government agencies. Bangladesh NGOs Network for Radio and Communication (BNNRC) ensured full-time contact and coordination with the coastal community radio stations with support from Free Press Unlimited. Furthermore, one of the most important NGO initiatives for the disaster affected people is their „Cash for Work (CFW)" or „Food for Work" programs. For example, CARE-B had implemented CFW program with the objective of creating livelihood opportunities like road repairing, homestead gardening and homestead platform rising, and funds to support fishermen. In contrast, BRAC carried out the cash for work program with the objective of creating employment opportunities that would provide additional income for vulnerable households and restore the public rural infrastructures with an average wage of Tk. 100 per person per day to the the cyclone SIDR affected people (specially to the poor women) (Sarker. M. A., 2009).

NGOs also work with local community and generally try to accumulate local knowledge into their disaster management practices. An interesting experience was being shared in the NGO workshop held in BUET regarding the construction of shelter for disaster. Water Aid have thought about a concept titled with "Shelter Catchment Area" based on the local

people‟s comfort to take shelter during disastrous situation and they have a plan to facilitate the chosen places with necessary aids and facilities preferred by the local people. Besides, it was being found that Gono Unnayan Kendro (GUK), local NGO of Gaibandha contribute a lot in disaster management activities of that district specially to the poor char people by extending their activities in post disaster evacuation and distribution of food and emergency medicine to pre-disaster activities like training local people about preparedness measures of disaster. They were also dominantly involved in establishing a community based flood shelter known as "Matir Killa" which is still sustaining since 1996 and has survived almost 5 large flood events till date.

5. A Case Study of NGO Involvement in Disaster Management of Bangladesh

As a follow-up activity of the Dialogue with NGOs held in BUET a team was set to visit Gaibandha to closely observe the disaster management practices in "*Matir Killa"* which is situated at Kunderpara Char, Kamatjani Union, Gaibandha. After closely observing the project it was being realized that, this establishment is a very good example of community participation in disaster management at local level of Bangladesh. Moreover, it was completely a community initiative made by local people and contribution of NGO was at its most there and no significant government support was there during and even after the establishment of such exemplary initiative at rural area of Bangladesh.

'Matir Killa' was first came into local peoples‟ mind after the devastating 1994 flood of Bangladesh as that flood had cost a lot to the community of Kuderpara Char of Gaibandha District. Local people then raised a proposal to the then chairman of that upazilla; their demand was to elevate a sufficient land within the char and establish a flood shelter on that. GUK, the local NGO played a vital role to make this possible and the funding was being managed through OXFAM and a huge amount of land was being willingly donated by the local people to make all the efforts possible. It was really a great effort of community participation at such rural area of Bangladesh. It is a matter of fact that, after establishing the center in 1996, this Killa have served three devastating floods of 1998,1999, 2000, 2004 and many smaller flood events and this not only serves the people of Kunderpara Char but also people from four other surrounding Moujas come here to take shelter during disaster. but, during the flood of 2007 there were some damage of property and life in the char area. Therefore, after 2007, people of this char with the help of GUK decided to elevate the land of each household one feet over the measured water level of 2007 flood and now-a-days under Char Development Program (CLP) they are doing this for each household. It was so obvious in Kunderpara char that, since 1996 till date the char people still work unitedly and leading their way to sustainable development.

Among the major activities of GUK regarding the establishment of *Killa* and managing disaster were: elevating the land to a selected level proposed by the local people, disseminating various training among local people like emergency activities during disaster, child-elderly-pregnant women care activities, volunteer services etc., establishment of Disaster Management Committee and so on. In the present time, GUK and Shelter‟s

Disaster Management Committee initiate meeting and revise their training activities in every three months‟ duration and before the monsoon season they start investigating the vulnerable people and element at risk and with the priority basis they start solving all the identified problems with the help of GUK. Furthermore, after the establishment of the shelter education sector of this char has been flourished to a mentionable extend. Now-a-days both boys and girls of this char have stepped their feet at different higher education sectors of Bangladesh whereas before there were not much opportunity for people to continue studies after primary level. This char is a perfect example of effective disaster management that is leading steadily towards sustainable development of that area. Also, the importance of NGOs involvement in disaster management for sustainable development of Bangladesh was clearly visible in this area. GUK, so far have contributed greatly in mainstreaming disaster risk reduction within the community and strengthening the institutional mechanism of disaster management at one of the extreme rural areas of the country as stated in National Disaster Management Plan of Bangladesh. Also, they are involved in providing training to strengthen the capacity volunteers involved in disaster management.

But, the most unfortunate thing is that this settlement is now at great risk due to massive erosion at the bank of the river and the local community is afraid to lose their belongings in the upcoming flood and its associated river bank erosion. Although, since now government have not played any significant role on the life of local people of this area but it is high time that the government agencies pay some attention to the problems of Kuderpara char. Because, even though it might be possible to take small scale initiatives by NGO and local community to manage flood in this area but large scale initiative like erosion protection though some structural or non-structural measures is not possible without the concern and contributions of central and local government agencies involved in disaster management of this area. Besides, even if it is not possible to protect the char fully at least proper evacuation plan and system needed to be pre-planned by the government body through NGOs like GUK to ensure the survival of the people living in Kunderpara char.

6. The Broken Bridge between Policy Guideline and Practices

The discourse of disaster management has undergone significant changes in recent decades and their effects have been profoundly felt in the developing world, particularly in terms of reduction in the loss of human lives (Haque and Uddin, n.d). It is being evident that, while most of the world was still grappling with the relief approach, disaster management strategy of Bangladesh has gone through a paradigm shift from relief and rehabilitation to disaster preparedness measures. The Government of Bangladesh has already established a multilayered institutional mechanism for disaster management, with formal recognition of the role of various stakeholders but even with the presence of some strengths, such as long experience in disaster response and recovery, the people‟s resilience, and donor support, the current disaster management strategies of Bangladesh suffer from a host of policy and institutional weaknesses (Khan and Rahman, 2007).

Through the NGO workshop held in BUET it was being found that, though NGO/CBO representatives were supposed to be included in the disaster management committees at different levels according to the national plan for disaster management of Bangladesh, but in most cases they are either not yet formed or non-functional, or they function only in times of crises. Same thing has been stated by Khan and Rahman, 2007 and again according to their study no regular meeting of any committee from top to bottom takes place except after a large-scale disaster. Furthermore, it has been found that, there is no representative from the NGOs/CBOs, the private sector, academia or the media in the highest-level National Disaster Management Committees (NDMCs).

Moreover, One of NGO representatives at the workshop said that, at the field level it is being experienced that, the alignment between GOs and NGOs is not harmonious. Moreover, in the context of Bangladesh, it is evident that, the Local Governments (LGs) or Local Disaster Management Committees (LDMCs) have no autonomy either in decision-making or financial matters. The center strictly controls the LGs as kind of a „„vote bank"" forthe party in power (Khan and Rahman, 2007). According to the NGO representative, in such cases LDMCs are just the shadow of the central government where NGOs and their activities are not well accepted. Besides, an academician from Dhaka University who is involved in disaster management studies of Bangladesh for long criticized about the Standing Orders of Disaster (SOD) of Bangladesh as although it covers instructions for almost all the government agencies but they do not cover the roles and activities of NGOs and CBOs. On the other hand, NGOs are actively involved in disaster management of Bangladesh and they frequently arrange public education campaigns and training programs for personnel involved in disaster management from national down to the union or community level (Khan and Rahman, 2007). But, as there is no proper documentation is available for such activities of NGOs and this is one of the main reasons that importance of NGOs involvement in disaster management is still resided in the shadow, this was one of the major issues raised by almost all the NGO representatives who were present in the workshop. In addition, a major loophole in the central system appears to be the absence of documentation and public disclosure of information, related particularly to internal resource mobilization and allocation for disaster management though the larger population actively participates in the relief and rehabilitation work individually or collectively through CBOs/NGOs (Khan and Rahman, 2007). Again, is was being found through the discussion with NGO representatives that, the information provided by the government officials regarding post disaster review are not specific rather it is too vague and it is really difficult to review and document the post disaster activities as the format is very lengthy and not straightforwardly comprehensible to local people.

In addition, one of the NGO representatives at the workshop stated that, although NGOs" involvement has been indicated in the national disaster management but no NGOs representatives were included in the formulation of the policy. Therefore, there is always a huge confusion and gaps between the policy guideline for NGOs and in field practices. Moreover, it was also being raised in the workshop that, NGOs do not have total autonomy, since the release of foreign funds has to be approved by the NGO Affairs Bureau, an agency

under the Prime Minister‟s Office. Therefore, the government has a tendency to control NGO activities and guide them towards the regime‟s political ends, rather than accept them as partners of a collective decision-making process. Besides, it appears that the government not yet ready to share resources or decision-making with the NGOs/ CBOs (Khan and Rahman, 2007). Furthermore, it was being come out through the discussion with NGOs that the bottom to top approach in disaster management is more realistic to achieve long term benefit for sustainable development activities and it is necessary to empower community to take their responsibility.

7. Conclusion

Disaster Risk Reduction (DRR) is at the very core of development of a country and NGOs are recognized as one of the prominent actors of disaster risk reduction and management around the world because of their quick response and mentionable efficiency. In spite of contributing with great effort in disaster management of Bangladesh, NGOs are getting less acknowledgment than what they really deserve as there is no proper documentation of their activities. Furthermore, the effort and activities of local NGOs get even less recognition whereas they are the only prompt actors and facilitators during and after any disastrous situation of the country. However, NGOs are still conducting various disaster management activities at different level of Bangladesh and their efforts are sometimes exemplary and worth following. Therefore, an effective partnership between government agencies of disaster management and NGOs are necessary to build and there must be a bridge to transfer the knowledge and experiences of both of these organizations for sustainable disaster management of the country. The extent of NGOs activities needed to be well defined by the government agencies after undertaking an appropriate academic evaluation of NGOs field based practices. Furthermore, NGO representatives must be included at the very initial moments of the policy formulation otherwise NGO may gradually lose their volunteerism mentality, which is of course not acceptable for sustainable disaster management of a country like Bangladesh. Therefore, it is necessary to recognize NGOs roles in disaster management with proper documentation and to boost up their volunteerism attitude they are needed to be included actively at policy level of the country. To conclude it can be said that, it is necessary to construct a bridge between effective disaster management and development actions to ensure the sustainable development of a disaster prone country like Bangladesh.

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Title: Sanitation System and Health: A Case Study at Teghori-Kalagachi Mauza in Chuadanga Sadar Upazila.

Md. Easin Ali, Professor Sheikh Md. Monzural Huq

1. Introduction

Health and sanitation are connected with each other. Each year thousands of people die from various types of infectious diseases. These diseases are caused by poor sanitation and hygiene practices. The disease that spread more in rural areas of Bangladesh are diarrhoea, dysentery, jaundice, cholera, hook worm, chicken typhoid and so on. A study observed that the health related economic loss due to inadequate sanitation was 84% of the total economic impacts or equivalent to 5.3% of Gross Domestic product (GDP) of Bangladesh (WSP, 2012). Another study in Bangladesh suggests that improved water and sanitation facilities actually reduce diarrhoea by 99%, dysentery by 90%, intestinal worms by 51% (NHPS, 2012). Washing hand with soap or simply rinsing hands without soap prior to preparation of food can reduce occurrence of diarrhoea in children (NHPS, 2012). This indicates that sanitation and hygiene practices are major components of environmental health. To keep the environment healthy for human habitation and health purposes, sanitation is needed because sanitation system is related to whole way of life. Still now people of the country are not aware about sanitation and hygiene practices. In Bangladesh, about 33% of the people have hygienic latrines (Online Research, 2010 Every 90 seconds a child dies from a water-related disease (Water Organization, 2015). About .1.2 million people of the country need access to clean water supply and 3 million people are without sanitation facilities (Online Research, 2010). To avoid this problem different plan are taken into account and attempts has been made to develop sanitation system. It is estimated that with a population of 149 million only 10% of the population in Bangladesh practices Open Defecation (Dietvorst and Gift, 2014). Only 56% of the population estimated to have had access to adequate sanitation facilities in 2010 (Wikipedia, 2012). A new approach to improve sanitation coverage in rural area such as, community-led total sanitation concept has been first introduced in Bangladesh (Wikipedia, 2012).

Though the progresses in sanitation and hygiene practices have been made substantially, the coverage is not satisfactory. In the remote areas the progress is significantly low. The study area of this study is one of the backward regions of the country and due this fact this study was carried to examine the health, hygiene and sanitation practices.

1.1 Aim and Objectives

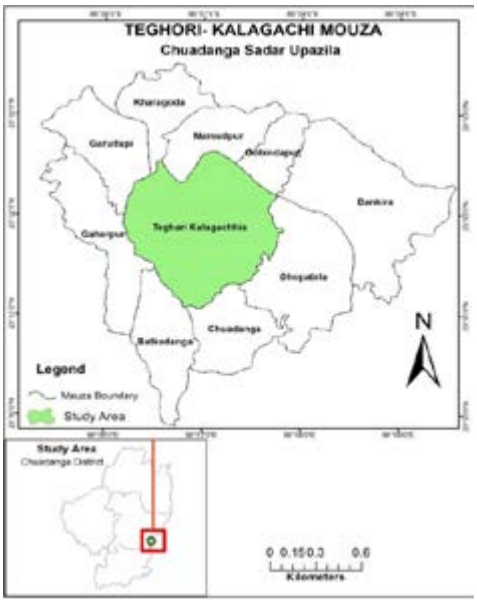
The main aim of this research is to identify the sanitation and hygiene practices and their impacts on health at Teghori-Kalagachi Mauza in Chuadanga Sadar Upazila. The study was carried out in 2015 and the aim is to examine the relationships between sanitation system, hygiene practice and health.

The objectives of the study are-

a)To examine the present sanitation system hygiene practices in the study area;
b)To identify the health status of the people of the study area from 2010 to 2015;
c) To find out the common health problems those are directly or indirectly related to the use of water and sanitation;
d)To put forward recommendations in this respect.

2. Data Sources and Research Methodology

For this research the primary information was collected through questionnaire survey. The questionnaires contain information on household, socio economic information, sanitation system, hygiene practice, location and situation of water sources, different diseases that occurred among respondents during the last 5 years. Data were collected from 64 households who permanently live in the study area. Secondary data were collected from different published and unpublished materials and books. Data obtained from the survey were analyzed using descriptive and inferential statistical tools. Different software such as, Microsoft word, Microsoft Excel, Arc View GIS are used for data analysis. Teghori-Kalagachi Mauza had in total 2604 people. The ratio of male and female was 105:100. It has total 621 units of household (BBS, 2011). In 2011 the total literacy rate was 54.1% (male literacy rate is 52.9% and female literacy rate 47.1%).



Source: LGED

Fig-2.1: Teghori-Kalagachi Mauza map

4. Present Health status of the population of the study area

Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (WHO, 1948). To know the health status it is need to consider determiner of health. The main determinants of health include the social and economic environment, the physical environment, and the person's individual

characteristics and behaviors. More specifically, key factors that have been found to influence whether people are healthy or unhealthy are Income and social status, social support networks, education and literacy, employment/working conditions, social environments, personal health practices and coping skills, healthy child development, biology and genetics and health care services (WHO, 1986).

4.1 Different Disease

It was observed that fever is a common disease in the study area. Figure- 4.1 shows that about 50.97% people suffered from fever. Besides, this dysentery and diarrhoea were other common diseases. Among 257 people, 10.97% suffered from dysentery and 9.34% suffered by Diarrhoea. Other diseases were chickenpox, pneumonia skin disease, typhoid, headache etc.

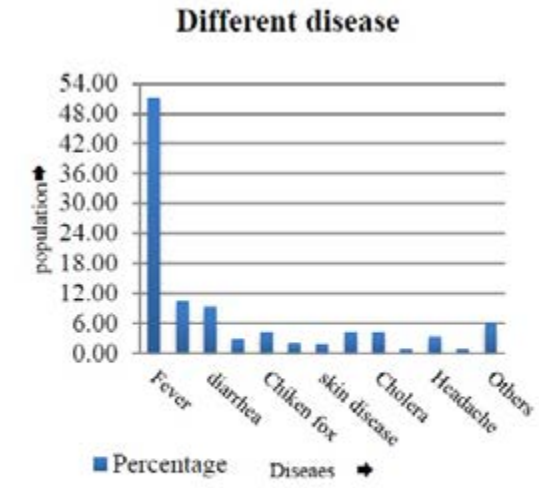
Table:-4.1 Disease pattern in the study area

Disease	Number	Percentage
Fever	131	50.97
Dysentery	26	10.12
Diarrhea	24	9.34
Jaundice	7	2.72
Chickenpox	11	4.28
Pneumonia	5	1.95
Skin Disease	4	1.56
Typhoid	11	4.28
Cholera	11	4.28
Strokes	2	0.78
Headache	8	3.11
Phthisis	2	0.78
Others	15	5.83
Total	257	100.00

(Source: Questionnaire Survey, 2015)

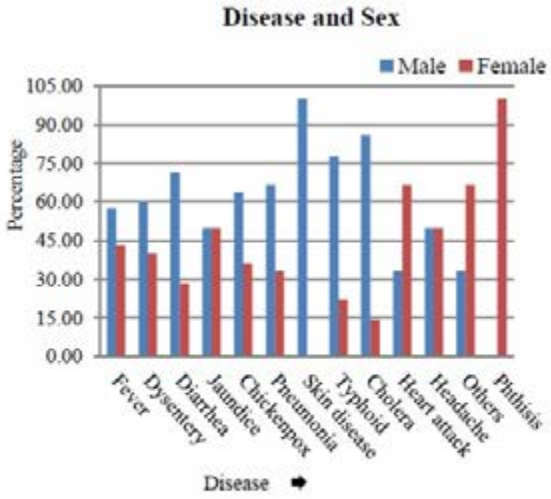
4.2 Sex, Ag, Occupation and Disease

There are different disease are found in different sex. Figure- 4.2 represents that male suffered more from dysentery, diarrhoea, chickenpox, skin disease and cholera their female counterpart. On the other hand, female suffered more from heart disease. It was found that there was a variation between age group and disease occurrence. Figure- 4.3 reveals that in the study area 11-30 year old people suffered from different disease and 51-75 years old people were less prone to disease. From the fig: 4.4 it is seen that service holder, unemployment, and labour are less attacked by disease. On the other hand farmer housewife and student are more suffered by disease. It also show that student 35.17% house wife 29.24% and farmer 19.49% are more suffered from disease than other occupation people.



(Source: Questionnaire Survey, 2015)

Fig-4.1: Different disease in the study area

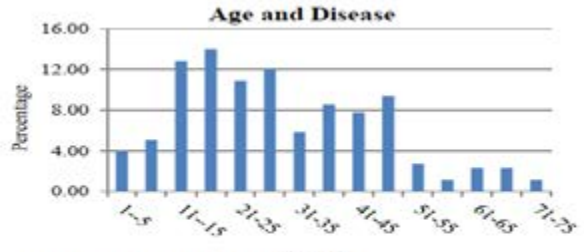


(Source: Questionnaire Survey, 2015)

Fig-4.2: Sex and Disease

5. Present sanitation condition in the study area:

Sanitation means the collection, transport, treatment and disposal or reuse of human excreta, domestic wastewater and solid waste, and associated hygiene promotion (Velleman and Slaymaker, 2011) Sanitation includes four engineering infrastructure items. These are- excreta management systems, wastewater management systems, solid waste management systems and drainage systems for rainwater, also called storm water drainage.



(Source: Questionnaire Survey, 2015)

Fig-4.3: Age variation and disease

(Source: Questionnaire Survey, 2015)

Fig-4.4: Occupation Status variation and Disease

5.1 Hand washing (after latrine)

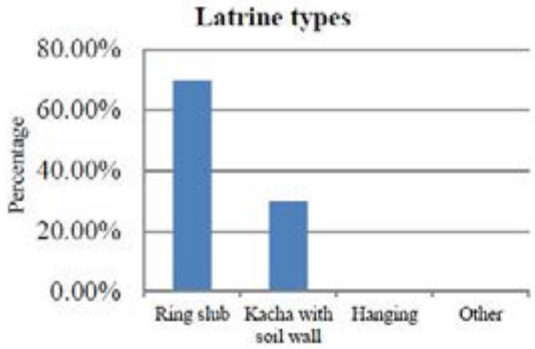
Figure 5.1 depicts that among 64 respondents, 39% people used soap, 34.38% used ash, 23.44% used soil 2% use nothing to wash their hands after defecation. Even most of the people (about 61%) do not use soap after defecation. Figure 5.2 also shows that among 64 respondents, 57.81 % people used shoe to go to a toilet and on the other hand, 17.19% used shoe sometime, Strikingly, 25% people never used while using toilet.

5.3 Latrine types

Figure 5.3 depicts that among 64 respondents, 70% used ring slab toilet. On the other hand, 30% people had kacha toilet. There was no hanging toilet in the study area. Among 64 families, 60 families 93.25% of total sample) had at least one toilet facility. DPHE (2010) observed that in rural areas of the country, only 53.10% families have latrine facilities (DPEH, 2010).

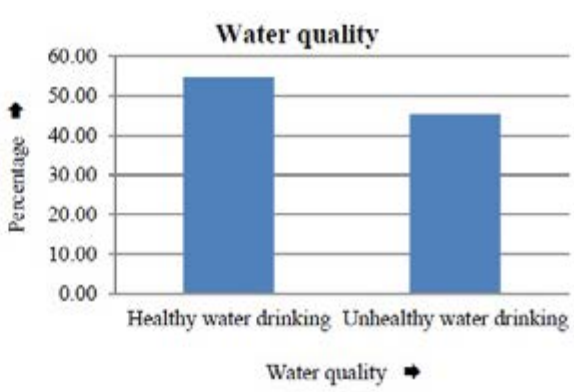
5.4 Water quality

It was observed that is found that 54.69% people drank clean tube well water and 45.31% drank poor quality water. The water of the study is contaminated with arsenic. According to the Demographic and Health Survey (2004), 99% of the urban population and 97% of the



(Source: Questionnaire Survey, 2015)

Fig-5.3: Latrine types



(Source: Questionnaire Survey, 2015)

Fig-5.4: Water quality

rural population actually had access to an improved source of water supply. In Teghori-Kalagachi Mauza only 54.69 % people had access to arsenic free water (JMP, 2010)

6. Sanitation system, hygiene practice and health

6.1 Shoes usage and disease

It was revealed that among 64 respondents, 57.81% used shoe in a toilet, 17.19% used shoes sometime and 25% never used shoe while using a toilet. About 53.12% of the respondents affected from chronic disease such as dysentery, diarrhea, typhoid, and cholera that are directly related to poor quality water and poor sanitation. On the other hand, 46.88% people suffered from other diseases as like as fever, headache, diabetes, high pressure, low pressure, and brain strokes.

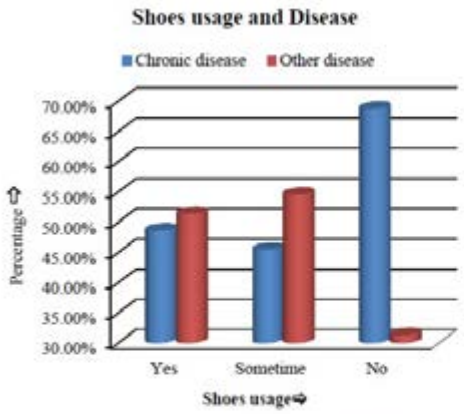
Table-6.1: Variables for Correlation

Coding	Shoe user (X)	Coding	Disease(Y)
1	Yes	1	Fever
2	Sometime	2	Dysentery
3	No	3	Diarrhea
		4	Jaundice
		5	Chicken Pox
		6	Pneumonia
		7	Skin Disease
		8	Typhoid
		9	Cholera
		10	Strokes
		11	Headache
		12	Phthisis
		13	Others

Table-6.2: Correlations between Shoes usage and disease

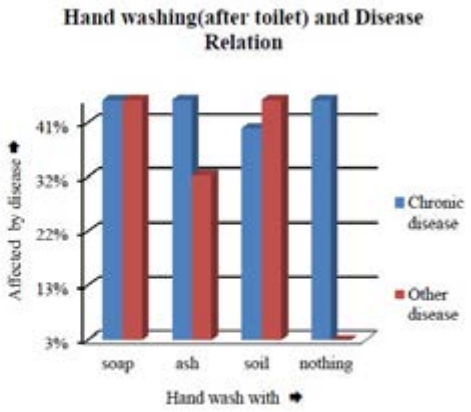
Correlations			
		Disease	Shoe user
Disease	Pearson Correlation	1	-.014
	Sig. (2-tailed)		.911
	N	64	64
Shoe user	Pearson Correlation	-.014	1
	Sig. (2-tailed)	.911	
	N	64	64

For examine the relationship between shoe use and diseases Pearson (bivariate) correlation method was used. Table 6.2 shows that there is a low negative correlation between shoes usage and disease. This indicates that people who used shoe during defecation have lower probability of infectious disease.



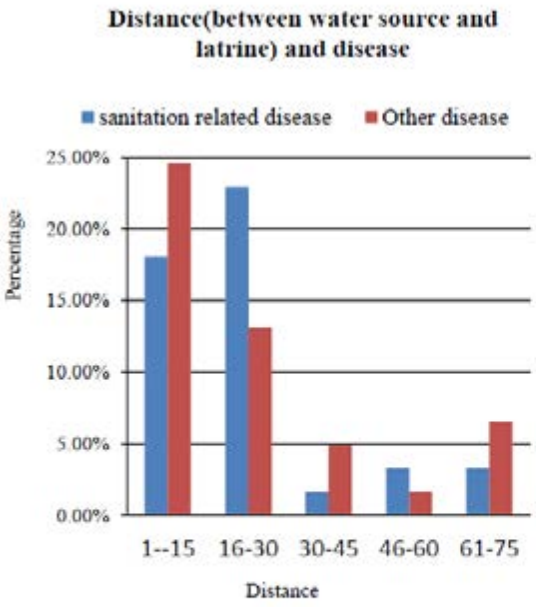
(Source: Questionnaire Survey, 2015)

Fig-6.1: Shoes use and disease relationship



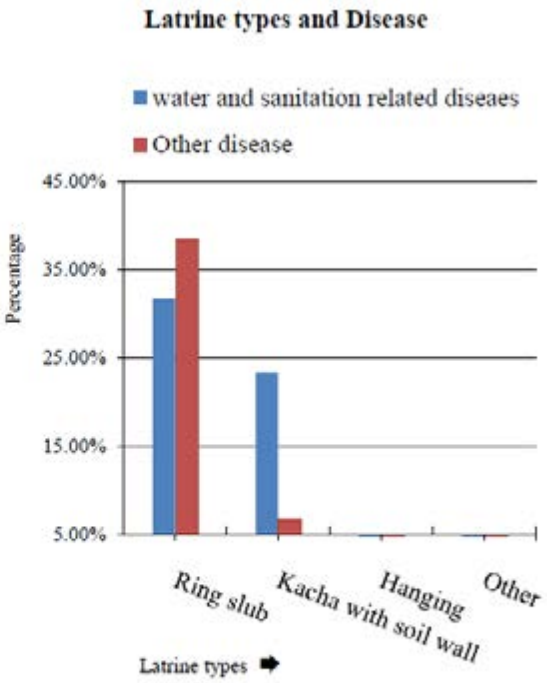
(Source: Questionnaire Survey, 2015)

Fig-6.2: The relationship between Hand washing and disease relationship



(Source: Questionnaire Survey, 2015)

Fig-6.3: Distance (between water source and latrine) and Disease relationship



(Source: Questionnaire Survey, 2015)

Fig-6.4: Latrine types and Disease relationship

6.2 Hand washing and disease (after toilet)

Hand washing is an important factor in sanitation. In rural areas of Bangladesh many people cannot use soap for washing their hand after defecation. It was observed that people who used soap and soil to clean their hands were less affected by chronic disease (Dysentery, Diarrhea, Jaundices, Chicken pox, Pneumonia, Typhoid, and Cholera). Among the soap users, 48% were affected by infectious disease. Strikingly, almost all respondents who did not use soap for cleaning their hands were attacked by infectious disease.

Title: Farmers Percption On Drought And Its Impacts In Barind Tracts

Md. Shafiqul Islam, Mahbuba Nasreen and Hamidul Huq

1. INTRODUCTION

It is not easy to define drought in a simple word. It is as like as chronic disease. Drought might be defined on the basis of non-availability of rainfall, leading to decrease in base flow and surface flow of water bodies and depletion of soil moisture (Nandargi, et al., 2005). Drought is a relative term that can mean different things to people from different backgrounds and with different viewpoints. What is drought in one place may not be drought in another place. Even in the same region, what one farmer considers as drought, the other farmer may view as normal. UNDP (2000) defines drought as a sustained period of deficient precipitation with a low frequency of occurrence. Drought is defined as the consequence of a period of lower than expected normal precipitation over an extended period of time, which leads to a water crisis for certain activities, groups, or environmental sectors. The impact of drought relies on the interaction between a lack of precipitation, demand for water, and human activities, which may exacerbate the impacts. In terms of impacts, drought classifies in four categories: meteorological, agricultural, hydrological, and socio-economic. Frequent and relentless droughts lead to the insidious falling of water tables, resulting in serious water problems in Barind areas. Consequent drought leads land degradation and desertification resulting water crisis in the Barind Tract. Droughts have caused human suffering for a very long time and still wreak havoc on ecosystems and societies. In Barind Tracts, drought increases the vulnerability of local populations. The capability of vulnerable populations to retort to drought is inadequate; this is happened not only due to frequency of drought but also to non-resilient livelihoods. Drought impacted not only on human life but also, increasingly, in terms of short-term and long-term economic losses. Sectors that are heavily affected by drought include agriculture, health, livelihoods and the natural environment. The impact of intermittent drought-related predicaments across the country is speedily getting higher, with more and more people being affected each time a drought occurs. Several research results reported that drought pose highest risk to the northern and northwestern part of Bangladesh. Series of studies have been pointed the impact of droughts on agriculture (Karim er al, 1990; Jabber 1990;, Jabber et al, 1982; Saleh et al, 2000; Mazid et al, 2005 cited in Shamsuddin & Houshang 2008), food production (Ahmed and Bernard1989; Erickson et al, 1993 cited in Shamsuddin & Houshang 2008), land degradation (Rasheed 1998; Karim and Iqbal 2001; Government of Bangladesh 2005 cited in Shamsuddin & Houshang 2008), economy Erickson et al, 1993; World Bank Bangladesh 1998 cited in Shamsuddin & Houshang 2008), and society (Erickson et al 1993; Paul 1998 cited in Shamsuddin & Houshang 2008). Research findings showed that the drought victims often are compelled to buy food by selling their lands, household goods, and livestock at distressed prices (Reardon et al. 1988). As a result the poor are becoming poorer to tackle with such harsh situation. Bangladesh has already shown an increased frequency of droughts in recent years (National Drought Mitigation Center 2006). Droughts cause problems to the country at least as frequently as do major floods and cyclones, averaging about once in 2.5 years (Ericksen 1993; Paul, 1995). Water paucity and drought (irrigated water deficit) may increase risks for agricultural sustainability and food security in varied regions (Kijne et al. 2003). Drought is a harsh restraint to crop production throughout Asia (Wade et al. 1999), and is also considered

important in some intensively cropped, irrigated farming systems such as on the Indo Gangetic plain (Kataki et al. 2001).

2. STUDY OBJECTIVE

The broad objective of the study was to know farmers perception on drought and its impacts in the study areas. Specific objectives of the study were to: i) explore the causes of drought; ii) know the drought symptoms; iii) know drought frequency and recent drought year; iv) how drought impacted livelihoods; and v) how agriculture is affected by drought

3. METHODOLOGY

The study was concentrated in six villages under six upazila in three districts of Bangladesh over a period of nine months. Based on CEGIS report 2013, Tanore and Godagari Upazila were selected from Rajshahi considering drought severity ranking. Similarly, Nachole and Shibganj Upazila were selected from Chapainawabganj district and Niamatpur and Porsha Upazila from Naogaon district. Six villages were selected from six Upazila randomly (one village from one Upazila). Total 343 respondents (30% women and 70% men) were interviewed using structured questionnaire. The study was also used focus group discussion with the homogeneous group. Total twelve focus groups discussion were carried out with male and female participants separately. In-depth and key informants interview and field observation were made during data collection. Thirty In-depth interviews and fifteen Key Informants Interviews (KIIs) were administrated for the study. Collected data were analyzed using SPSS software and results were presented in the report.

4. RESULTS AND DISCUSSION

4.1 Perception of drought

The respondents of the study area do not know the definition of drought clearly. They just understand drought as a natural disaster with extreme temperature and lack of rainfall. Most people think of a drought as a period of unusually dry weather that persists long enough to cause problems such as crop damage and water supply shortages.

There is no firm definition and clear understanding of drought as perceived by the respondents. Drought means lack of soil moisture for the spell of periods, dryness of weather and no rainfall for over the periods. As perceived by the local people water table goes down and high temperature prevails during drought and no water for irrigation. If there is no rainfall for consecutive fifteen days during summer and rainy season except winter is also considered as drought. Few indications were made by the local people to perceive drought. If there is no rainfall for consecutive twenty one days during Aman season, nine consecutive days during Boro and fifteen consecutive days during Aus is termed as drought. Mostly people in the study areas were well understood of drought in absence of rainfall for long time. A reduction of water availability might qualify as a drought. Thus drought is the periods of anomalous dryness, are therefore a natural climatic occurrence. It is defined as transitory reduction of soil moisture availability drastically below the normal for a specified period. Basically drought is transitory. Both long and temporary drought may transpire in an

area that normally experiences blinking wet and dry periods. Essentially temporary cutback of water/moisture accessibility as a drought is extremely complex and depends upon the time period being considered.

4.2 Causes of drought

Erratic and less rainfall in any season, non availability of ground water and extreme temperature causes drought in the Barind Tract. The respondents do not know the causes of drought clearly. Most of them think that it is a natural disaster given by the almighty God. Some respondents are informed about global warming and desertification due to deforestation. They told that, drought occur in the hot summer season due to the extreme temperature, lack of rainfall and absence of available soil moisture. Lack of soil moisture associated with agricultural drought. Meteorological drought is associated with the reduction of monsoon rainfall. Hydrological drought is associated with the reduction of ground water level, stream flow and surface water in canal, rivers and ponds. Drought conditions are becoming severe due to lack of moisture retention of the soil, unavailability of ground water, high erratic & low rainfall and low adaptive capacity of the farmers.

Drought in Bangladesh is interlinked with climate extremes, lack of soil moisture and non-availability of ground water and surface water resources. Erratic rainfall or low rainfall is also one of the causes of drought in the study areas. Unwise use of surface water and over extraction of ground water is also important causes of drought. Excess evaporation and transpiration is also making the situation more critical. The depletion of pond, canal and *kahri* is also limiting the surface water availability. Siltation of ponds, canals and rivers are restricted water flow through the true channel. The direct cause of a rainfall deficiency may be due to several factors including moisture deficiency in the atmosphere or large-scale downward movement of air within the atmosphere which restrains rainfall. Alterations in such factors lead changes in local, regional and global weather and climate.

Increased carbon dioxide and other greenhouse gasses have been suggested as causes of erratic and low rainfall, which are, in turn, attributed as climate change. There is strong evidence that climate change will affect the rainfall pattern and as a result, droughts that are more frequent are expected. The local level factors are human-induced activities resulting from vegetation loss due to over exploitation of resources and deforestation.

On an average, more than 97% respondent (n=335) of study area pointed out that drought has been occur due to high temperature followed by lack of ground water (97. 38%), lack of soil moisture(98.79%), less rainfall(93.29%), erratic rainfall (86.595) and environmental hazards (86.59%) respectively (Table 4.1). The people of the study area were believed that drought occur due to number of causes. In Chapainawabganj 100% respondents (n=126) reported that drought occurs due to lack of soil moisture, erratic rainfall, high temperature, less rainfall, lack of ground water and environmental hazards respectively (Table 4.1). In Rajshahi, all the respondents (n=52) from Parisho village were agreed with the same but in Aye-Hi village 100% (n=62) respondents were identified high temperature is the main cause and then 96.8% (n=60) respondent talking about less rainfall followed by 90.3% (n=56) respondent of lack of ground water, 88.7% (n=55) respondent of lack of soil moisture, 67.7% (n=75) respondent of erratic rainfall and 66.1% (n=41) respondent of environmental hazards. In Naogoan, all the respondents (63) of Bhabicha pointed out that lack of soil moisture and lack of ground water were responsible for the drought. About 98.4% (62) respondents claimed in high temperature and another causes claimed by 81%

(51) respondents was erratic rainfall, less rainfall and environmental hazards were responsible for the occurrence of drought. On the other hand, the respondents of Mollapara pointed out that lack of ground water 92.5% (n=37) was the main cause followed by lack of soil moisture 90% (n=36), high temperature 82% (n=33), less rainfall 77.5% (n=31), environmental hazards 67.5% (n=27) and erratic rainfall 65% (n=26).

Table 4.1 causes of drought

Causes	Study location with respondents (Number and percentage)													
	Rajshahi				Chapainawabganj				Naogaon				All N=343	
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Lack of soil moisture	52	100	55	88.7	75	100	51	100	63	100	36	90	332	96.79
Erratic rainfall	52	100	42	67.7	75	100	51	100	51	81	26	65	297	86.59
High temperature	52	100	62	100	75	100	51	100	62	98.4	33	82	335	97.67
Less rainfall	52	100	60	96.8	75	100	51	100	51	81	31	77.5	320	93.29
Lack of ground water	52	100	56	90.3	75	100	51	100	63	100	37	92.5	334	97.38
Environmental hazards	52	100	41	66.1	75	100	51	100	51	81	27	67.5	297	86.59

4.3 **Types of drought**

It is not clear on drought types as perceived by the respondents. They were claimed only agricultural drought, hydrological drought and meteorological drought. They were marked agricultural drought if the soil is lacking from moisture; hydrological drought if there is no water flow in the river; meteorological drought if there is no rainfall for long time. Several literatures were mentioned five types of drought including agricultural drought, meteorological drought, hydrological drought, socioeconomic drought and seasonal drought. Meteorological drought notices when the reduction in rainfall for a specified period of time. Hydrological drought occurs when deficiencies in surface and subsurface water supplies based on measurements of stream flow and lake, reservoir and groundwater levels. Agricultural drought happens when there is no enough soil moisture to meet the needs of agricultural production at a particular time. Socioeconomic drought occurs when physical water shortage starts to affect people. Seasonal droughts are related to deficit soil moisture during certain periods within a season. There are three types of seasonal droughts in Bangladesh during monsoon season likely early season drought, mid season drought and terminal season drought. Early-season droughts are due to delayed start or early breaks in monsoon rainfall. Mid-season droughts are originated by sporadic or extended dry spells. Terminal-season droughts are rooted by early withdrawal of monsoon rainfall. In the study areas, terminal droughts are more dominant and coincide with the most important growth phases of the rice crop.

4.4 **Drought symptoms**

Extreme temperature is one of the symptoms of drought as mentioned by the study population. The respondents were reported that, they have to face temperature above $40^{\circ}C$ during drought season. Lack of rainfall is another indication of drought. They were

experienced over a month without any rainfall for several droughts. It is also depend on drought severity and spatial arrangement. Water was dried out from the surface sources including ponds, rivers and canals. Water table is going down than the normal level and the respondents are not able to collect ground water from tube-well. Sometimes they have to collect drinking water from pond and purify by boiling water or using fitkary before drinking. The agricultural lands are dried out along with the crops growing in the fields and the soil has been cracked due to over evaporation. Even the grasses, herbs, shrubs are dried in the drought season. Wilting of the crops usually starts during drought. Increase of dust particles in the air is another symptom of drought. Three important drought damage symptoms were recognized by the respondents in the study area. 97.67% respondents (n=335) were mentioned cracking of soil as the top drought symptoms followed by burnings crops and drying of pond/canals or rivers respectively (Table 5.4). (crack krotovina). In Bhabicha, 95.2% respondents (n=59) were mentioned burning of crops as the top drought damage symptoms.

Table 4.2 Drought damage symptoms

Drought damage symptoms	Study locations with drought damage symptoms												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Burning of crops	52	100	62	100	72	96	51	100	59	95.2	30	75	326	95.04
Cracking of soil	52	100	62	100	75	100	51	100	58	93.5	37	92.5	335	97.67
Drying of pond/canal/river	52	100	59	95.2	72	96	51	100	37	59.7	38	95	309	90.09

4.5 Drought frequency

The sample respondents were asked to provide with the issue on the frequency of drought in the study area. Data in Table 3 indicate that all the respondent of Rajshahi and Chapainawabganj districts agreed about the drought is occurred in each and every year but in Naogoan respondents were argued with the statement. In Naogaon, 44.4% (n=28) and 90% (n=36) respondents of Bhabicha and Mollapara village respectively believed that drought is occurred in every year but 54% (n=34) respondent of Bhabicha and 10% (n=4) respondent Mollapara said that drought is occurred in 2-4 years interval. And only 1.6% respondent in Bhabicha said drought is occurred in 5-9 years interval. Table 4.3 represents 88.63% respondents (n=304) were reported that the drought is frequently occurred in each and every year but 11.08% respondents (n=38) were argued with there. They said that drought occurred after 2-4 years interval and only 0.29% respondent supported the interval is 5-9 years.Drought occurs almost every year in the study area but the drought severity varies by years. The respondents from the study area were mentioned that, the last drought occurring year was 2014. Drought severity is higher in the Bengali months *Choitro* and *Boisakh*. The severe drought occurring years in the study areas were 1981, 1983, 1994, 2000 and 2006.

Table 4.3 Drought frequency

Drought frequency	Study location with Drought Frequency												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Every year	52	100	62	100	75	100	51	100	28	44.4	36	90	304	88.63
After 2-4 years									34	54.0	4	10	38	11.08
After 5-9 years									1	1.6			1	0.29

4.6 Last drought year

The respondents were also asked to know the status of last drought. On an average 99.42% respondents (n=341) was agreed about the occurrence of drought in several years. Around 71.72% respondents (n=246) were identified that 2014 was the last drought year and 18.95% respondents (n=65) pointed out the last drought year was 2013. Beside these some of the respondents were also identified the several drought years from 1998 to 2015. Only 2.04% respondents were reported 2015 was the last drought year and 0.58% respondents pointed the last drought was 1998 (Table 4.4). In Rajshahi district, all the respondents (n=52) from Parisho village were identified that the last drought year was 2014, while 69.4% respondents (n=43) from Aye-Hi village. 1.3% respondents from Aye-Hi village were also remarked 2015 was the last drought year followed by 2012 (8.1%), 2010 (4.8%) and 2000 (1.6%). In Chapainawabganj, 93.3% (70) respondent of Nizampur village identified that 2014 was the last drought year while 98% (50) respondent of Chokghorpakhia. On the other hand 5.3% (4) respondent of Nizampur marked that 2006 is another drought year but the remaining 2% (1) respondent of Chokghorpakhia remarked 2013is the last drought year. But in Naogoan, the scenario was different there. 95.2% respondents (n=60) from Bhabicha village said that 2013 is the last drought year while only 10% respondents from Mollapara. Although 75% (30) respondents (n=30) of Mollapara mentioned that 2014 was the last drought year followed by 7.5% in 2011, 2.5% in 2006 and 1998 respectively.

Table 4.4 Last Drought year

Last drought	Study locations and drought year												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1998									1	1.6	1	2.5	2	0.58
2000			1	1.6									1	0.29
2006					4	5.3					1	2.5	5	1.46
2008											1	2.5	1	0.29
2010			3	4.8									3	0.87
2011			2	3.2							3	7.5	5	1.46
2012			5	8.1					1	1.6			6	1.75
2013							1	2.0	60	95.2	4	10.0	65	18.95
2014	52	100	43	69.4	70	93.3	50	98.0	1	1.6	30	75.0	246	71.72
2015			7	11.3									7	2.04
Total	52	100	61	98.4	74	98.7	51	100	63	100	40	100	341	99.42

4.6 **Drought impacts**

Drought impacted on agriculture, livelihoods, health and society. The dilemma of drought impacts is critical. The situation is not come to observation within single or couples of days. You can notice gradually for over the period. Local level droughts occur in each and every year and affect crop production (Dey et al, 2011).

4.6.1 **Impacts on livelihood**

Loss of employment occurs in each and every drought year due to crop failure in the drought season because the respondents are directly or indirectly involved with agriculture for their livelihood. Respondents look for an alternative livelihood option to feed their family. The alternative livelihood options are day wage labor, rickshaw or van-pulling, auto-bike or nosimon driver, and small business. Some people migrated to nearby city or Dhaka city for alternatives livelihood options.

4.6.2 **Impacts on food production and security**

Drought caused huge damage to the crops depend on season, scale and crops. It reduced crop production and impacted on food security issues. Few farmers were claimed that they

have no food for eat, even the price is so high during drought period and they have no money to buy it from market with high price. The ultimate results it leads towards food insecurity for the affected people.

4.6.3 **Impacts on fish production**

The respondents involved with fish farming reported that, it is highly blasting to cultivate fish in drought season. Lack of rainfall and high temperature has resulted in reduced fish production. Fish farming hampered for the shortage of water in the ponds due to over evaporation. People irrigate in their pond by water pump or deep tube-well. Methane and ammonia gas formed in the pond water due to excessive temperature which is very harmful for fish cultivation. Gas bubbles come out from the bottom of the pond. Oxygen shortage appeared in the pond water in drought season. Gradually all of the fishes dies and float on the water surface of the pond. The respondents involved with fish firming reported that, fish production decreased up to 80% when drought occurred. They apply fitkiri, lime and chemicals (ammoline, zeolite etc.) to purify pond water from the impact of methane and ammonia in drought season. Sometimes, drought occur so harshly that fish farming is not possible and the fisherman include the people involved with only fish firming became unemployed or migrated to other job like day labor.

4.6.4 **Impacts on Health**

Several diseases break out in the drought seasons. The mentionable diseases are fever, dizziness, heat stroke, skin diseases due to sun burn diarrhea, dysentery, blood pressure, heart stroke and respiratory problems related to dust etc. Sometimes drought occurred so severely that many people including the old people and little baby died. 99.71% respondents (n=342) of the study area were agreed with health problems due to drought (Table 4.5a). Only 0.29% respondent was mentioned that there is no health ailment due to drought. 100% respondents from four study locations were mentioned that drought cause health impacts to the human. The respondents reported that, different types of health hazards erupt in the drought season. Almost all of the people became attacked by water borne diseases like diarrhea, dysentery in drought season. These are caused by drinking unpurified water. Safe drinking water from tube-wells became unavailable because water table goes down in the drought season. The excessive temperature also increases blood pressure and heart attack of the old people. Depression due to drought is an important cause of health hazard in the drought prone areas.

Table 4.5a health impact

Yes/No	Study locations												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Yes	52	100	62	100	74	98.7	51	100	63	100	40	100	342	99.71
No					1	1.3							1	0.29
Total	52	100	62	100	75	100	51	100	63	100	40	100	343	100

Peoples' lived in the study area were mentioned that there are number of disease occurs due to drought. Around 91% respondents (n=313) agreed that drought is liable for diarrhea followed by heat stroke 90%, skin diseases 83% and dysentery 79% (table 4.5b). In Parisha all the respondents were reported that diarrhea is the primary disease which occurs due to drought followed by skin diseases 98%, heat stroke 96.15% and dysentery 92% while 96.77% , 88.71% , 83.87% and 62.90% respectively at Aye-Hi village. Skin diseases and dysentery is the primary diseases which was identified by the entire respondents of Chokghorpakhia village of Chapainawabganj and 98% respondents were noticed diarrhea occurs due to drought followed by heat stroke 88%. 96% respondents of Nizampur village were mentioned that heat stroke and skin diseases are the primary health hazard followed by dysentery and diarrhea. In Naogoan, 87.30% respondents from Bhabicha were noticed that heat stroke is the primary health hazard followed by diarrhea 85.71% and dysentery 73% while the respondents of Mollapara were reported 87.5%, 67.5% and 42.5% respectively.

Table 4.5b diseases occurred by drought

Health problems	Study location with health problems (both number and percentage)												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Skin diseases	51	98.08	55	88.71	72	96	51	100	34	53.97	22	55	285	83.09
Dysentery	48	92.31	39	62.90	70	93.33	51	100	46	73.01	17	42.5	271	79.01
Diarrhea	52	100	60	96.77	70	93.33	50	98.03	54	85.71	27	67.5	313	91.25
Heat stroke	50	96.15	52	83.87	72	96	45	88.24	55	87.30	35	87.5	309	90.09

4.6.5 **Impacts on agriculture**

4.6.5.1 Impacts on crops

Agriculture and agricultural production is affected by drought. This part depicts the information related to the damage of crop due to drought. Among all 83.09% respondents (n=285) were believed that crop damage occurred due to drought and another 16.04% respondents (n=55) disagreed the statement can't believe the interference of drought in crop damage (Table 4.6a).

It was found that the higher damage occurred in Chapainawabganj district. 98% respondents (n=50) of Chokghorpakia village were agreed that less than 5% crops were damaged due to drought while 96% respondents (n=72) reported from Nizampur (Table 4.6b). The percentage of crop damage due to drought in Rajshahi district was found lower compare to other two districts. In this district 77.4% respondents from Aye-Hi village were reported that the crops were damaged due to drought while 53.8% respondents from Parisho village.

Table 4.6a Crop damage

Crop damage	Study locations with crop damage due to drought												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Yes	28	53.8	48	77.4	72	96.0	50	98.0	56	88.9	31	77.5	285	83.09
No	23	44.2	13	21.0	3	4.0	1	2.0	7	11.1	8	20.0	55	16.035

Table 4.6b Crop damage percentage

Damage crops	Study locations with crop loss in percentage												All N=343	
	Rajshahi				Chapainawabganj				Naogaon					
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
5 and less	28	53.8	49	79.0			50	98.0	26	41.3	16	40.0	169	49.271
6-15					27	36.0			22	34.9	14	35.0	63	18.367
16-25					20	26.7			4	6.3	3	7.5	27	7.8717
26=35					13	17.3			3	4.8			16	4.6647
36-45					7	9.3			2	3.2			9	2.6239
46-55					2	2.7							2	0.5831

Additionally, Farmers lost money as because drought destroys their crops. The agricultural lands cracked due to the over evaporation & lack of water and it becomes harder to cultivate. Shortage of water for irrigation is the common problem in the drought prone area. Lack of hardware (irrigation pump and water source) are crucial in the study area especially in Nizampur and Mollapara. If hardware is available farmers have to spend more money for irrigation during drought. The respondents reported that, raid of rats become intolerable in the drought season. The respondents added that, about 20-25% of the crops are being damaged by the rats in the drought prone area. They also added that, every year about two lakh metric ton crops are being damaged by the raid of rats in the whole Barind when drought occurred.Among the three cropping seasons, the Boro (IRRI) season become most affected by drought. People have to face less rice production with maximum cost and effort due to drought. Sometimes drought occurs so cruelly that the crop dries just before the harvesting period. The respondents told that, average 20% of their crops damage every year due to drought. The production loss is about BDT4000 per bigha. They were also added that, they get at least 200ks less production per bigha when drought occur in the IRRI season.

4.6.5.2 Impacts on livestock

Low rainfall causes shortage of fodder supply and that lead to the poor pasture growth. In the drought season, cattle are attacked by different diseases and food poisoning. Among them, foot rot is very common to the cows in the drought season. The respondents reported that, about 5% of the cattle died in their area when drought occurred. The respondents keep their cattle under shade in day time and give them more drinking water to release drought impacts on cattle. Some people sale their cattle in drought season due to the lack of available fodder. To maintain their livelihood is another reason for selling cattle as they remain unemployed in the drought season. The respondents reported that, they have to pay average BDT1000-2000 for the treatment of cattle disease in drought season.

4.6.5.3 Impacts on poultry

Poultry loss is too much common in this drought prone study area. The respondents reported that, they lost about 25% of their chicken and duck in the drought season. The respondents having poultry farm, faced a huge economic loss due to the death of chicken. They have nothing to do to save of their poultry from drought impacts. They just serve them more water to drink.

4.6.6 Other impacts

The respondents were also asked to know the other damages due to drought besides crops damage, cropping area damage and health hazards. The results represents that on an average 76.09% respondents (n=261) of the study area claimed that livestock loss was the prime other damage. Among these respondents the higher percentage was found in Parisho village (86.54%) followed by Nizampur (82.67%), Mollapara (80%), and Aye-Hi (70.97%) respectively (Table 4.7). The average 48.40% respondents (n=166) were identified economic loss was the second prime damage of the study area in which the higher percentage found among them 100% in Chokghorpakhia followed by Bhabicha (57.14%), Aye-Hi(46.77%), Mollapara (45%), Nizampur (29.33%) and Parisho (19.23%) respectively. There were also 13.12% respondents (n=45) said that loss of employment and 18.95% respondents (n=65) assets loss occurs due to drought.

Table 4.7 Other damage due to drought

	Rajshahi				Chapainawabganj				Naogaon				Total N=343	
	Parisho n=52		Aye-Hi n=62		Nizampur n=75		Chokghorpakhia n=51		Bhabicha n=63		Mollapara n=40			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Economic loss	10	19.23	29	46.77	22	29.33	51	100	36	57.14	18	45	166	48.40
Asset loss	5	9.62	3	4.84	2	2.67	18	35.29	34	53.97	3	7.5	65	18.95
Livestock loss	45	86.54	44	70.97	62	82.67	34	66.67	44	69.84	32	80	261	76.09
Loss of employment	3	5.78	2	3.23	2	2.67	7	13.73	30	47.62	1	2.5	45	13.12

4.6.6.1.1 Impact on society

Societies become helpless and hopeless due to anxiety or depression about economic losses caused by drought. Loss of human life occurred especially older people and new born children died during drought. Seasonal migrations were taken place due to drought. Conflicts were raised among water users. Drought also affects the quality of life and increase hunger and famine.

4.6.6.1.2 Environmental impact

It was observed that most of the canals, khari, ponds and wetlands became dry due to lack of surface water and adequate rainfall. On the other hand, rivers are becoming dry during drought period which lead toward water scarcity during drought period. Siltation and agricultural practices are responsible for the siltation. Remarkable environmental drawbacks were mentioned by the respondents during key informants interview and focus group discussion. Drought reduces biodiversity and causes damage to plant and animal

species, damage to wildlife habitat and deteriorating water and air quality. It also degrades landscape quality through loss of biodiversity and soil erosion.

4.7 Drought prediction

The respondents predict drought by feeling extreme temperature, lack of rainfall, settled water table and crack of soil for the absence of soil moisture. Some respondents added that, they predict drought by observing the dust in the air, excess evaporation from the water body, color of the sky in the horizon at evening, poor condition of cattle, flapping of birds, aviate of insects especially termites and grasshopper, and lack of water supply by their tube-well due to the reduction of ground water table.

4. CONCLUSION

Drought perception makes them aware on its impacts to the livelihoods and enhances their capacity and awareness for next steps planning. As they perceived drought and its consequences, they adopt both coping and adaptation measures accordingly. The respondents are heavily dependent on their traditional knowledge on drought prediction and management. Though the traditional local knowledge makes them vulnerable to drought but they can apply their knowledge in their own way. Sustainable drought management approaches may help them to mitigate drought impacts effectively. The combination of both local knowledge and scientific knowledge can reduce drought impacts and severity in Barind Tracts. More participatory action research can enhance farmer's capacity to make them drought resilient society.

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Gender & SDGs

Title: Socialization and Gender; A Socio-political Learning Process of Role Determination that is more than Biological

Tunvir Ahamed Shohel and Tanvir Hossain

1. Introduction

In 1994, one of the events opening of American Baseball season, President Bill Clinton and first lady Hillary Clinton were photographed, throwing the baseball. The very "next day, some newspapers carried the two photographs together" and "a striking difference was thus made apparent in the Clintons' styles of throwing" (Inglis 2005:21). People talked and separated the way of Clinton's throwing was manly, whereas, Hillary's was considered fully feminine in gesture. In this regard, later on people scrutinized the throwing style of Clinton was quite perfect, on the contrary, the First lady was considered unsuccessful, and quoted as 'throwing like a girl' (Inglis 2005:21). Hence, questions may arise; was it because of physical ineffectiveness? Differences? Or limitations of Hilary's throwing to be treated as 'unsuccessful'? Or, was it because of personal learning with cultural attributes of meaning that overly shaded the society to construct the binary (masculine/feminine)? We will come out with the answers later on this discussion.

One significant research conducted by Nasreen and Tate (2007:108) showed that in Bangladesh, teachers found boys are better in solving math compare to girls. In this consideration, the study explored some of the reasons of why it happens, and they found that, outside of class, girls are taught to engage with 'household chores'; 'cooking'; 'weaving mats'; 'needlework'; 'making fences', and so on. In contrast, boys are mostly engaged with works, habits or sports, those are directly connected to math or 'score keeping'. Nasreen and Tate found it clear that boys and girls have different socialization learning from social surface, which made them to understand their roles differently, and that simply one example of making boys as prudent in math solving compare to girls.

Distinguish of learning, understanding or constructing gender identity, evidence clarifies that most of the societies have practiced boy's supremacy over girls, both traditionally, and historically (Giddens et al. 2012). Perhaps, foundation of this distinction started from a symbolic process of detecting the binary, where we have the primary question at birth, 'is it a boy? Or a girl?' (Crespi 2004). Hence, this way we mark the gender at first phase, which may have the foundation from anatomical attributes, but gets social significance and functionalities with the imposition of cultural meaning over them (Hynes 2010:206). In this process, from the very beginning of human life force, we separate the new born by labeling 'boys' and 'girls', and later on different types of cultural treatments and meaning start rolling with different functionalities. Upon this foundation, parents and others have the imagination of how they are going to dress the child, what toys they are going to give them to play, and how they will taught them the social relations/interactions or attitudes to coherent. Therefore, primarily the foundation comes up as 'children are born sexed but

gender is something which is learned' and by this procession 'individuals are taught to be masculine or feminine' (Hynes 2010:206).

2. Methodology

Our study inputs discursive materialization of textual understanding taken from theoretical publications, evidence from empirical research, academic talks, and published reports. In this respect, we used Foucauldian approach of discourse analysis that is to view the history of knowledge as the process to solidify or standardize beliefs and practices, and to look at the structural root of continuation (Wall, Stahl and Salam 2015). Looking at the root of beliefs and practices that is orderly disseminated in relation to power, span over centuries with the continuation of the similar meaningful beliefs and practices, and in results, it may bring imbalance of expression (Foucault 1970), but it is important to understand how cultural context is deeply arranged in actor's mind to go for meaningful actions. Our intention of using discourse analysis derives from the incompatible underpinning of gender/sex role variations, whether from biological functionalities, or from the cultural construction of imposing meaning upon these functionalities. Under scrutiny, we put prevailing discourse of the order and arrangement between two sexes, and of how one should be a Man or Women in the dominant discourse of *patriarchy*[6]. In this paper, we revisit different theoretical accounts on the relationship of sex and gender, and our discussion tries to explain the different discourses on gender by looking at how it is defined, redefined, constructed and continued (e.g. using the simple example of toys). We put on discussion, how the dominant discourse emancipate the hegemonic power which in more than just an expression, that puts structure and actors aligned to guide behavior, and carries the circular continuation (Wall, Stahl and Salam 2015) with the materialization of communication (e.g. the dominant discourse of male supremacy over female timidity/shyness were exemplified by analyzing the materialization discourse of toys). However, framing the theoretical structure of this research, *Cultural Sociological*[7] approach has been conceptualized, and *Constructionism*[8] also has been taken as the foundation of understanding. In procession, we have used several theoretical and empirical research doctrines (e.g. C.H Cooley, G.H. Mead, M. Mead, J. Butler, Berger and Luckmann), and placed the genre of knowledge in support or to dispute of what we are trying to relate.

[6] Prevailing social system of male domination and authoritative practice over female counterpart (e.g. cultural learning, political power practice, moral domination, privileges, resource control) in the domain from micro (individual-family) to macro (community, society, nation) level.

[7] Branch of Sociology, usually concerns about the systematic analysis of cultural code, meaning and understanding used by the members of the society.

[8] How we see the reality exist within or outside of us. We put meaning on every reality we perceive or act, the interpretation comes from our cultural understanding, prior knowledge, existing knowledge, belief, practices, and learning within the social surface. Reality comes as real, because we think it is real and construct with social meaning on it.

3. Discussing the Discourses

3.1 Anatomy to define sex, or Social meaning to understand Gender?

The way we do identify our functionality throughout the socialization process, not only signifies our gender marks, but also articulate socio-political relationship between sexes, and that is rooted deep in *Cultural Structure*[9]. Covering the heading of this paper, we may highlight our understanding on 'Socialization', a process whereby a child grew up, learned how to fit with his/her culture, and in doing this, he or she incorporates the values, norms and practices done by their elders (Giddens et al. 2012:82). By the learning of socialization treatments, children also internalize the cultural traits inside of them, which is most important part in transmission, and understanding the meaningful functionality. Thus, they follow their existing culture by following their preceding generations. Here to say, connected to socialization treatment, gender is that social signification of how people differentiate boys' roles with those of girls' roles. Gender is the learned behavior that a human being acquired throughout his/her socialization process. Hence, some might see this process as completely depends upon biology (Sex), but others see the social and socio-psychological (Jary and Jary 2004) part of construction as well.

Denying biological explanation of differentiations, Judith Butler (1999), in her book "*Gender Trouble: Feminism and the Subversion of Identity*", defines gender and sex, and valued both as culturally constructed. She denies the social signification of gender under the execution of anatomical differences. Answering the dialectic, Butler (1999) studied both gender and sex, and described these two as inseparable cultural forces. Under her research scrutiny, Butler explained that gender roles are imposed culturally, though starts with the determination of anatomy between boys and girls, but perceptions come from the cultural construction of the existing power structure. Butler (1999) argues that, sex body gets its functionality under the imposed cultural meaning. Therefore, functionality of anatomies comes significant with the cultural explanation, and without these cultural meaning imposed on sex body, it has mere function.

3.2 Performing Gender and Recognizing Social Self

J.H Mead (1934), in his theory '*Development of self*'', explained that, young children develop their self-understanding by incorporating other's role around them. Mead explained how an infant goes through the unconscious social being, that is 'I', to the self-conscious and meaningful 'social self', which is 'Me' (Giddens et al. 2012:84). Experiencing socialization of the stages from 'I' to 'Me', children learn about their social values, where they generalized other members as well as themselves in the society (Giddens et al.

[9] How human understanding comes with meaning? How we construct our actions and impose meaning on it? Center of analysis of these question are cultural structure. We construct our self within the society imposing meaning on our role that is coming from long lasting traditions, learning, established customs within the society and regular performance in social arena makes this structure to sustain. Culture is the tool kit through which our habit, skills, styles, perceptions, and actions are governed. Cultural structure in the center from where all these meanings are constituting our reality, where we understand our social self as well as others.

2012:84). Mead's theory of 'self' explained how children recognizing their parents (father and mother) separately, and how they incorporate their roles as well. On the other hand, C.H Colley (1902) in his theory '*Looking glass self'*, emphasized on the internalization of socialization process. Colley examined and described that 'self' developed with the imagination of other's roles, and then the internalization of these roles within 'self' take place (Solomon 1983:321). In reference, Colley (1902) exemplifies, during the playing stage, girl child internalizes mother's role within herself, whereas, boys like to play those roles of father. This process, Colley (1902) states is not just the recognition of other's role in reality, but also the internalization of appropriate and desired social roles inside of the children. Significant numbers of Sociologist believed that, "*gender roles are learned from child's environment*" and "*they argue that society teaches people the behaviors which society deems appropriate for their sex*" (Hynes 2010:205).

Considering socialization process as the decider to perform gender roles, the early childhood is very important. Most of the psychic and mental development is the direct impact of surrounding cultural structure, and that is connected to early childhood. In this respect, boys and girls learned to practice differences of attitudes, perceptions and actions in their early life. Such as, in this early childhood development, playing with toys and types of toys are important in identifying gender binaries. Evidence from the research of Blakemore and Centers (2005:619) describes that, throughout the world, most of the boys have toys like, 'bus'; 'cars'; 'wagon'; 'motorcycle'; 'Shape sorting toys'; 'clocks'; 'magnets'; 'military toys'; 'educational and art materials' and so on. In contrast to the boys, in their room, girls have toys like 'dolls'; 'dolls house'; 'dishes'; 'stoves', and so on for playing. By excluding 'dolls' from their toy list, boys were identified with their masculine expectation by the society (Giddens et al. 2012:260), and opposite to that girls supposed to symbolize with their cool and calm subordinate order. Hence, in this respect, observing those toys it was found that, most of the 'action figure' toys have masculine outlook and prescribed for boys, whereas, girl's toys have represented the beauty and composure only (Blakemore and Centers 2005).

3.3 Foundation of Socio-political Learning; Using the Example of Toys

Gender learning not only separates the identity of boys and girls, but also gives weight to their functionality, and comes out as a result of preceding traditions. Therefore, a learning, that comes from a social surface with cultural interpretation, legalize and enforce separate power structure within the binaries. In this respect, Martin, Eisenbud and Rose (1995) in their study observed that by selecting 'own-sex-stereotype toys', children came up with the mind of different understanding, and these different types of toys introduce not only different types of playing, but also different types of gendered culture. Interestingly, Blakemore and Centers (2005: 621) identified that promotional display or advertisement of boy's toys includes generally "terms such as kill and destroy" on the other hand "the packages for girls' dolls use pastel colors, and show real girls playing with, holding,

grooming, or gazing at the dolls". Henceforth, It motivates boys to be brave and adventurous, whereas, girls to be soft and soul followers of their stereotype motherly roles. In reference to toys, we can see the different cultural practice, where girls have the orientation with beauty, calmness, and soft body gesture. On the contrary, boys do have aggressive, muscular, and adventurous cultural treatments. It seems quite influential for their upcoming life, while childhood development practices motivating boys to explore the world; on the other hand, it is limiting the boundaries for the girls.

3.4 Gender, a Cultural Construction in Different Social Spheres

Coming out from the question of whether sex as foundation of human binary (male/female), or social construction comes powerful in assembling gender identity, this paper describes the construction of gender by underpinning cultural structure. Hence, in describing gender construction, we refer culture as the force to assemble learning process (socialization), and teaches how to differentiate boys and girls. In doing this, different agents of socialization process like family, media, peer groups, community are playing the decisive role (Giddens et al. 2012). However, issues have been examined by considering gender in numerous spheres, such as, at work place, marketplace, in playing ground, leisure activities, schools, and so on, but traditionally, the most basic form of gender construction was observed within the household, where the boys/girls variations found most high-flying in nature (Gentry, Commuri and Jun 2003).

Some scholars patronized that, biologically men were found more aggressive, violent, and managerial than women (Giddens et al. 2012), but again, other scholars denied the biological importance over social attribution. In 1935, Margaret Mead studied on three different tribes known as, '*Mundugumor*', '*Tchambuli*', and '*Arapesh*' (Hynes 2010:205-206). Mead tried to explain her diverse inspections on women's gender perceptions, among those tribes, and found that, "*The Mundugumor (now Biwat) tribe saw women as violent and aggressive. The Tchambuli tribe (now Chambri) viewed women as managerial and impersonal. Contrastingly, the Arapesh tribe was somewhere where women are generally seen as peaceful and passive individuals*" (Hynes 2010:205-206).

Referencing the study of Margaret Mead, we may say it is true that both men and women do have the biological differences, and they might be introduced with different biological ability, but, based on these anatomical differences only, they are not treated differently, rather with cultural meaningful learning might signify social attitudes, and different identities in each existing societies. Three different tribes had different meaning and attributes imposed on their women's character distribution or role arrangement, and it surely articulated by the power of culture to mark gender boundary.

3.5 Social Learning and Gender Power structure; Underpinning the Constructionism

Above our discussion plotted different social learnings to search for identities, where we symbolize us by remark of established binaries (male/female), but the question may come

in mind of how we construct ourselves in this procession? Or, how we get the cultural meaning under practice and functionality to roll on? Answering to these questions, the process has been scrutinized by so many sociologists, in several ways of their discussion, but important explanation states that, we do construct our social self and gender identity by the process of Social Constructionism. Berger and Luckmann (1991), in their book "*The Social Construction of Reality*", explained that, Person by birth doesn't become part of the society, essentially 'he is born with a predisposition towards sociality, and he becomes a member of society' (p.149). They argued in favor of the primary socialization, which is strongly connected to the child development, and our early discussion tried to focus on that part significantly. Berger and Luckmann explained that, primary socialization is socially clarified, and every socialization steps are authenticated by the society. In-fact, society determines the different programs/functions/interactions with meaning that should be performed by different gender group and in different age level. In future, with the biological growth of the children, this practice becomes stronger, and rigorously performed by them, with meaningful constructed reality. And most interestingly, society regulates most of the socialization programs as definite and different for the boys and girls (Berger and Luckmann 1991:156).

At this moment, to answer the questions in our introductory part connected to Hilary and Bill Clinton, we may sum up with some explanations. Refereeing to that example if we can recall, we can answer that throwing of the first lady was not actually the result of personal ineffectiveness, perhaps she was following the throwing gesture, and that is different in style what she learned from her inhabiting culture. She had been socialized with different ways to move her body, and which is obviously learned different from those of men (Inglis 2005:21). Here the construction comes from both individual (male/female) and community level, where, one side of the individual level observation and evaluation is from the male part who considered their gestures are different (male like) and superior (manly) to female, on the other hand, another side is the female generated style (female like) that she use to learn from her society, taught to be different (feminine), from the male counterpart. In regards to the community level, it constructs reality that has separate meaning for different groups, and this meaningful constructions are the foundation of gender binaries from the very beginning to the end of human life force.

Therefore, to connect power structure sequentially with gender self, we can see that differences of socialization practice specify differences of identity, not only for gender, but also with different social significance. They have differences of socialization practice, not only in gesture or education, but also in dressing, food, mannerism, occupation, social perception, signification, and so on. Sooner or later, they explore kind of socialization treatments, which directly differentiate their habit and attitude. Substance of this process started form the early childhood, and continued towards different levels of their life span. In procession, from family to the larger community, these differences of attitudes and practice of regulations clearly separate 'the boys' from 'the girls', signify with detached identity and distinct entity. Most of the cases, these differences of socialization marked with boys'

supremacy, and valued by the social structure as subjectively typical. Valued to this procession, cultural structure surpasses the anatomical functionality and incorporates social significance among the boy's and girl's roles; constructs a meaningful context to them as an individual member of the community, and establishes a reoccurring reality of stereotyped gender learning that is literally more than biological determination.

4. Conclusion

Socialization is a never ending life long process; and eventually, it took place in every human society. In concern, every human child has grown up with some acceptable social identity, and socialization makes this procession possible. The dominant discourse of patriarchy promulgate male supremacy over female subjugation, with broadcasting meaningful male dominated power structure. Central point of these female subjugations comes from several biological explanations, what sees male functionalities are far more powerful than female. But in reality, cultural meaning explains the difference of actions, fixes the gender dissimilarities, and signifies the diverse social roles those are deemed inevitable for social communication. It is important that gender signification has come out first by the anatomical differences, where the society identifies both the binaries (boys/girls). And, inevitably it is sex (male/female), the decider of children's primary identity (boy or girl), but it has always come out with the social meaning, construction, imposition, practices, and that is known as gender (masculine/feminine). After social signification (cultural meaning imposed on functionality), sexes turned into gender, the boys and girls standardized themselves with different social identity. These differences of identification use to follow a different power structure (male superiority over female), and that is carried out by numerous practices like interactions, communications (verbal/oral), playing toys, sports, dresses, education, mannerism, bodily gesture, household work, community participation, media perception, and so on. In procession, the cultural learning shapes the diverse social roles, and that is how our construction of boys and girls gets the foundation. Therefore, to understand the socio-political variations between two genders, we must not look for answer in biology, rather we need to seek for answer in social reality, and the reality is deeply rooted in cultural structure, as much we go deep, we can find more explanation of it.

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Title: Eliminating Violence against women and girls: A study on the role of Women councilors of Local Government in Bangladesh.

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Ending violence against women is everyone's responsibility[10]
-Ban ki-Moon (UN General Secretary)

1. Violence against woman and girls (VAWG): a world view

Violence against women and girls (VAWG) is one of the most proliferating obstacles to girls and women's development all over the world. "Any act of gender-based violence that results in, or is likely to result in, physical, sexual or mental harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life" is called Violence against women and girls (United Nations 1993). This term is also named as violence against women, gender based violence, or sex. Violence can be occurred in any societies, to a greater or lesser degree and women and girls are subjected to physical, sexual and psychological abuse that cuts across lines of income, class and culture. Surprising but true, worldwide one in three women has experienced physical or sexual violence because of being a woman (UNiTE 2011). However, both men and women can be victims as well as perpetrators of violence; but the characteristics of VAWG differ in critical respects rather than men such as female infanticide, prenatal sex selection and systematic neglect of girls are so common in South and East Asia, North Africa, and the Middle East and women are the only victims of those violence (Wikipedia 2015). According to World Bank data, women aged (15-44) are more at danger from rape and domestic violence than from war, cancer or motor accidents. Women are also more likely to be victims of male intimate partner violence and sexual assault by family and kin. On average, 30% of women who have been in a relationship reported that they have experienced some form of physical or sexual violence by their partner. Globally, as many as 38% of murders of women are committed by an intimate partner (WHO 2014). Furthermore, across the 28 States of the European Union, a little over one in five women has experienced physical and/or sexual violence from a partner (European Union Agency for Fundamental Rights 2014). One woman is reportedly killed by her partner or former partner every six days in Colombia (WHO 2014). Most of the women are at greater risk of being sexually assaulted or exploited, either in childhood, adolescence, or as adults. According to UN Fact Sheet, 50% of schoolgirls surveyed reported sexual harassment at school in Malawi. Approximately, 40% to 50% of women in the European Union reported some form of sexual harassment in the workplace partner (European Union Agency for Fundamental Rights 2014). Indigenous women in Canada are five times more likely than other women of the same age to die as the result of violence. In Europe, North America and Australia, over half of women with disabilities have experienced physical abuse, compared to one-third of non-disabled women (UNiTE 2011).

[10]United Nations Secretary-General Ban Ki-Moon in an interview on his world-wide UNiTE Campaign to End Violence against women (2010)

2. Violence against women and girls (VAWG): Bangladesh perspective

The picture of violence is not different in Bangladesh as well, women are threatened with multiple forms of violence, namely sexual harassment, sexual assault including rape, murder and grievous hurt, domestic violence, dowry related violence, acid throwing, trafficking, kidnapping and abduction, illegal fatwa and illegal arbitration, minority violence, wage discrimination and social discrimination, health and nutritional deficiency etc. About 87% of married women in Bangladesh have ever experienced any type of violence only by husband (Survey on VAW 2011). There are many explored and unexplored reasons behind these violence such as patriarchal system and negative mindset; lack of implementation of laws; failure of the Judiciary; lack of victim and witness protection; corruption and criminalization of the members of law enforcement agencies; economic instability; and weak administration and so on (Odhikar 2015). In rural areas, women are mostly victim of domestic violence as they spend on hearth most of the time. Both in rural and urban areas, it is very common that women who are experiencing or have experienced violence are likely to be fearful or embarrassed to talk about their experiences to others (Begum 2000). Moreover, in a Muslim majority and traditional value dependent society like Bangladesh, many incidents of VAW are not reported to the police or in the media because of social stigma and sometimes because of family pressure. According to police data, 1, 09,621 complaints of various forms of violence against women were lodged within two years (2010-2012). Of these 18,484 complaints were taken into cognizance, but only 6,875 cases were deemed 'genuine' and 'fit' for further proceedings (Odhikar 2012). VAWG may also result in unwanted pregnancy and abortions and low birth weight among infants, a health report shows that 14% of pregnant women die as a result of violence in Bangladesh (WHO 2013). And this rate of violence is not decreasing rather it is increasing alarmingly every day. In between January – June 2015, 75 girls and women were victims of sexual harassment, 25 acid attacked, 84 women were subjected to dowry violence and 298 females were reportedly raped (Odhikar 2015).

Many government initiatives, plans; scholarly studies and national and international NGO projects and programs have already been done and proposed to eradicate, at least reduced VAWG from the society. World Health Organization (WHO) proposed to take school and community level interventions as well as media interventions to reduce VAWG and also emphasized on campaigns to build public awareness. Likewise, UN has identified five goals to end VAWG all over the world by 2015. Many countries have introduced new interventions to stop VAWG such as local government to eradicate VAWG from the root and to aware as much as people at the local level. In Bangladesh, local government is a legislative body controlled by the central government and also an important developing partner of central government. Upazila (mid-tier of LG) works as a bridge between local and national government and both Upozila and Union Parishad helps to promote and execute government (national and international) programs, projects etc at the local level all over the country. It is proved that local representatives can easily understand the demand or necessity of people than the representatives of central government (S. Yilmaz, Y. Beris, and R. S. Berthet 2008). The main purpose of the study is to see the extent of government interventions to reduce VAWG in Bangladesh and also to ascertain the possibility and capacity of women councilors of local government to reduce VAWG in Bangladesh based on secondary data.

3. Government initiatives to reduce VAWG in Bangladesh

Over the past two decades, a number of laws, policies and programs have been initiated by Bangladesh Government to ensure the women's right, especially to reduce VAWG. In the following paragraphs, some of them will be discussed briefly.

Under the Law commission Act, 1996 Bangladesh government has created a permanent Law Commission to review all laws related to protection of women's rights and to provide recommendations wherever it is necessary.

The government of Bangladesh has introduced, enacted and amended many relevant and necessary laws Such as the Human Trafficking Deterrence and Suppression Act 2012; the Domestic Violence (Prevention and Protection) Act 2010; the Citizenship Amendment Act 2009; the Bangladesh Labour Act 2006; the Acid Crime Prevention and Acid Crime Control Acts 2002; and the Prevention of Women and Children Repression Act 2000; the Hindu Marriage Registration Act 2012 only to ensure fair justice to women. Furthermore, recently the government has enacted a law primarily to restrict import and sale of acid in open market and death penalty for acid attack offences and also enacted a law to address sexual harassments at workplace.

In January 2002, the Bangladesh government has signed "SAARC Convention on Prevention and Combating Trafficking in Women and Children for Prostitution". Resolutions were adopted to step up cooperation among law enforcement authorities to fight trafficking in women and children, terrorism, and drug trafficking. The 13th SAARC Summit, which took place in Dhaka in November 2005, reiterated the pledge made at the 11th conference to continue to work towards addressing the challenges faced by women and children in SAARC countries.

A Multi-Sectoral Programme on Violence against Women under the Ministry of Women and Children's Affairs and a Joint United Nations Programme has started to Address Violence against Women in 2008. Seven One-Stop Crisis Centers have been established under this programme where victims receive medical, psychosocial and legal assistance. These centers are really helpful for acid-throwing and rape victims and for lodging quick Formal Investigation Record (FIR) and other legal services. There is also a National Trauma Counselling Centre and Helpline for victims.

The National Human Rights Commission has a women's cell assigned to monitor the rights of women in Bangladesh. It has launched several campaigns to raise awareness on the issue of violence against women. In addition, the police possesses a "zero tolerance" policy when dealing with cases of violence against women. Some police stations have Special Cell for Women. At the national, district and Thana levels, Committees for the Prevention of Violence against Women have been formed. In 2009, the first Victim Support Centre was established at Tejgaon Thana Model Police Station. The rehabilitation services are implemented by 10 NGOs who have signed Memoranda of Agreement with the police. Violence prevention cells also exist in the Department of Women's Affairs and the Jatiyo Mahila Sangastha. Shelter homes for abused and tortured women and for women under safe custody have also been established both by the government and NGOs, though far too inadequate to meet the needs.

Another step towards women's development is to reform policies to involve women in public and private sectors such as mandatory inclusion of women vice chairman and women members at the Upozilla and Union Parishad level in local government of Bangladesh. According to the Upozila parishad Act, 1998 Bangladesh government specified that women representatives should chair at least one-third percent of the local government at the Union Parishad level. Later on, in 2009, the government has amended the Act and ensured compulsory inclusion of woman representation as vice chairman at the upozila level of Local government. Women's entry into these positions and their experiences in negotiating with other actors have led to changes in their aspirations and increased their voice and legitimacy within their communities and also by negotiating with gender biased culture, attitude and norms they acquired skills and knowledge about how to operate in the public sphere and how to do politics (Nazneen, S; Tasneem, S 2010). According the Upozila Parishad Manual, women councilors have been assigned with some special duties such as upgrading the situation of women and children, building awareness and to take necessary steps on violence against women, dowry and child marriage and some others to ensure the rights of women and to strengthen the position of women in the society.

Besides the above, the National women's advancement policy, 2015 and some other long term national plans such as Vision 2021, the Perspective Plan (2010-2021), sixth Five Year Plan and Gender Mainstreaming have also taken with a common vision to empower women and for the advancement of women and to address and reduce VAW with a top priority. In addition, the Election Commission (EC) has taken steps towards strengthening women's political inclusion by imposing a 33% reservation for women in all political party's executive committee positions including the central committee by 2020 in Bangladesh.

4. A new concept: Worldwide promotion of Local Government to reduce VAWG

Most of the countries in the world have given best maximum priority and have undertaken lots of initiatives to reduce VAW. About 89 States worldwide had some form of legislative prohibition on domestic violence, and a growing number of countries had instituted national plans of action to end VAW (UN General Secretary 2006). Marital rape may be prosecuted in at least 104 States, and 90 States have some form of legislative provision against sexual harassment (UNiTE 2011). To engage local government and to create local committee or body to reduce VAW is a new trend and is flourishing and becoming popular with time. Many states engaged their local government to reduce VAW and reach as much as women at all level. In Australia, the government has introduced a National plan to reduce VAW, where strengthening the local and indigenous community is an important part to eradicate violence from the society. The United States of America has started a project to train male and female police officers on 'how to investigate gender-based violence cases'; built police stations in remote areas; and provided essential equipment enabling police to be more responsive to the community, and also funded a public awareness campaign on gender-based violence. Similarly, the Afghan government has also undertaken some initiatives for strengthening their local unit against violence. Furthermore, in Timor Leste, Fokupers, an NGO, provides legal aid services for women victims and raises public awareness of women's legal rights. It distributes information to service providers, religious institutions, government agencies and lawmakers. In Upper Egypt, NGOs used community mobilization to inform local and religious leaders of the adverse effects of female genital mutilation/cutting and to call for an end to the practice. So it has clearly seen that developing and as well as under developing or Islamic or non-Islamic both countries are

taking new and different initiatives such engaging local government to reduce VAW and most prioritizing the issue to ensure a safer environment for women to grow up.

5. The role of Women councillors of LG and their contribution to reduce VAWG

All over the world, women leaders are found sensitive and sympathetic to women's issues, interests, and concerns. In Bangladesh the local government women councillors are also serving their best and contributing their worth to bring positive changes to ensure women's economic, political and social freedoms and rights. According to the Upozila Manual, 2009 the local government councillors specially women councillors have some assigned duties for the advancement of women in Bangladesh such as initiating women empowering activities, increasing small entrepreneurship, and taking necessary actions against VAW. These women leaders have proved that being a woman they are performing as a government representative and at the same time also completing their household and reproductive duties. In a patriarchal society like Bangladesh, it is an achievement and strong step for women towards social equity. Furthermore, by promoting small entrepreneurship among rural women, women representatives are empowering the rural and the country economy as well. Women councillors are contributing to address poverty, income inequality, malnutrition, maternal mortality and famine and providing the benefits of safety net programs to local poor people.

As a member of Village Shalish committee, women councillors have brought about a positive change in the outcome of the rural Shalish[11] as well which help rural women to obtain social justice and a more secure life. Taking part in Shalish has a long-term effect in women's life such as now woman have proper capacity to deal with life-related matters with proper dignity and honour in their own family. On the other hand, it gives them a strong position to perform their social promises and duties and to ensure the rule of law in the society.

In 2013, Bangladesh Government including Ministry of Education (MoE), Local Government & Rural Development (LGRD), Ministry of Expatriate Welfare & Overseas Employment (MoEWOE), Ministry of Health & Family Welfare (MoH&FW), Ministry of Information (MoI), Ministry of Labour & Employment (MoLE), Ministry of Law, Justice & Parliamentary Affairs (MoLJPA), Ministry of Religious Affairs(MoRA), Ministry of Social Welfare (MoSW), Ministry of Women & Children Affairs (MoWCA), Ministry of Youth & Sports (MoYS) and UN including ILO , IOM , UNAIDS , UNES CO, UNFPA , UNI CEF , UN Women, WHO launched a programme to contribute to the long term sustainable socioeconomic development of rural Bangladesh specially supporting poor women under development programmes based on its Millennium Development Goals (MDG s) and Poverty Reduction Strategy Paper (PRSP). The main focus of the program was to encourage the adoption and implementation of policies for preventing violence and supporting survivors by enhancing the capacities of the government, improving information (data) and providing support to NGO s and civil society. The programme also emphasized in changing the attitudes and behaviour of men, women, boys and girls to reduce violence

[11] Shalish refers to a community-based, largely informal rural Bangladeshi process through which small panels of influential local figures help resolve community members' disputes and/or impose of sanctions on them

against women (VAW) and supported the survivors of gender-based violence with immediate care, aid and rehabilitation.

With the help of the Upozila and Union level women affair officers and Local government women representatives, this programme was launched in 44 unions under six upazilas (sub-districts) in six project districts and introduced a database with information on women survivors of violence (acid attacks, rape, murder, physical torture, dowry, early marriage, family conflict, suicide and hilla marriage etc.) and the services provided such as court cases by DLAC, counselling and legal aid by BRAC, shalish by the UP, and others. Also the local level officers were trained to provide legal and immediate support to the victim of violence as it was an objective of the programme.

Key results of the interventions include:
1. 100% of marriages have been registered (total 15,511)
2. 1,056 community members solicited legal, medical and counselling services
3. 858 family conflicts have been resolved
4. 243 early marriages have been stopped

Thus these women representatives are contributing to social justice and good governance at the local level, as well as enhancing women's position in the society. A significant number of cases reveal that woman councillors are playing desired role and deliver justice in the society if they are provided with an enabling environment and a legal framework.

6. Conclusion and recommendations to further reduce VAWG:

Bangladesh government and NGOs and international organizations are undertaking the best solutions to reduce violence against women and girls (VAWG) from the society but the violence are taking different forms and perpetrators are changing their strategies. So the government should adopt new policies and programs to stop them. It is recommended that a comprehensive response, based on principles of human rights and ensuring survivor-centered and empowering approaches, is needed to address violence against women; including political commitment and resource mobilization, legal, and judicial and security sector reform, health sector responses, response from the education sector, use of mass media and community mobilization (UNIFEM 2010). As a result of earlier researches on VAWG, a complete and updated database was a necessity for planning interventions to combat and prevent violence and also to determine women friendly policies, proper budget allocation, enact or amend legislation, along with identifying funding priorities and evaluation of existing measures, steps, interventions and laws (Farouk, S 2005). And this step towards reducing VAWG has been completed by 'MDG -F Thematic Window: Gender Equality and Women's Empowerment' program with the help of the local government specially the women councilors in 2013. Likewise, to eradicate the root of violence against women and girls (VAWG) and to change the attitude towards violence needs policies to engage men and boys in making public spheres free from violence and secure for women and girls, Moreover, programs should be taken for male perpetrators that are incorporated with the judicial sector. On the hand, victims must be provided legal, financial and medical support for quick recovery. It is proved that, women representatives of Local government in Bangladesh could be the key performers in raising awareness on the adverse impact of VAWG and promoting public legal education to strengthen legal solutions in their local

arears. Furthermore, women councilors are the most appropriate to contact and respond regarding primary preclusion of violence, responding to survivors of violence.

Women are almost the half of the nation in Bangladesh and the constitution of Bangladesh allows them to enjoy all the legal rights as men, so the government should strongly apply the most possible ways to reduce VAWG and to eradicate these to make a better and secure society for development of women and girls.

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Green Cities & Human Settlements

Title: Regeneration Guidelines For The Neighborhoods Located In Resedential Areas Of Khulna City, Bangladesh: A Case Study On Housing Three Stored Colony.

S.M. Asger Ali , Dr. Tanjil Sowgat, Dr. Shilpi Roy

1. Introduction

Bangladesh Government provides limited housing opportunity for government employees. Absence of maintenance and repair work, most of those colonies turn into dilapidated condition. People lived here in risky environment. Family structure has been change but floor space has been constant. Thus regeneration of such colonies can play crucial role for providing housing for the rapid growing urban population in Bangladesh. In 1998, considering 3.3% annual rate of growth in population it was estimated that there would be 144700 households with 129300 dwelling units with a backlog of about 15000 units. Thus by the year 2020, Khulna City will require additional 2, 92,331 new units for housing (KDA, 1998).

This Research responds to the scope for urban regeneration and wants to investigate the regeneration needs of citizens those occupying the lands already. This investigation focuses on a residential sites housing three stored colony (govt. rented). The Socio, Economic and Built Environmental factor will be examined and sustainable framework will be provided. Those demands slightly differ on the perspective of different income groups. This research focuses on that aspect and will help the planner to formulate policy for regenerating of those sites.

1.1 Study site at a glance

Housing Tin tola was established on 1965-66 by the HSD. It was mainly built for government official. It was situated in ward no 12, under Khulna City Corporation. There are 8 Three storied Building and both Single and Double room flat both are available in the sites. The number of Tin shed House was four and ten household lived there. The NHA are responsible for allotting the room to the household and carried way the improvement, maintenance and repair work. For the municipal service and facility, KCC was solely responsible. Most of the dweller is engage in the profession like city profession like City development sector, navy, National Housing authority, BGB, NSI, Non-government sector. There are five entrance gates and two security guards are assigned for maintaining the security of the site.

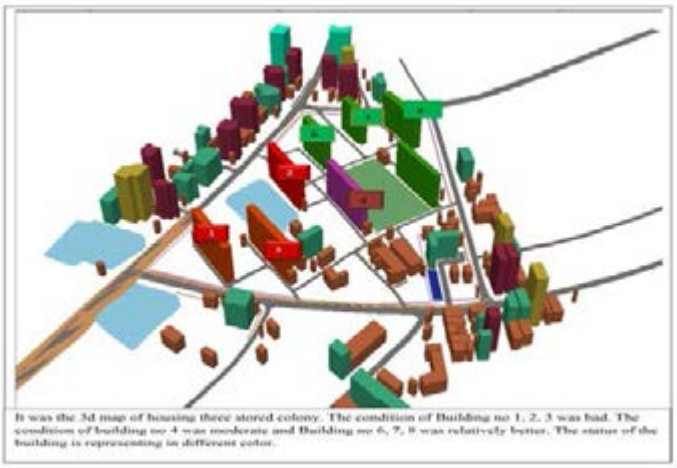

Fig 1.2: 3 D Map of Housing Tin Tola which shows the present Infrastructure situation
Source: Author, 2014

2. Conceptualization and Methodology

The Sustainable Urban Neighborhoods Network (SUNN) have used the term 'sustainable urban neighborhood' to refer to new communities that are built to last in social and economic as well as physical terms. It is crucial that what is built stands the test of time, and there are five basic ingredients:

1. A wide choice of housing and facilities to ensure long-term value and create a balanced community over time. A neighborhood with some common facilities requires a minimum of between 500 and 1,000 units, with homes catering for a range of incomes and ages.
2. Well-connected to jobs and services by foot and bike as well as other modes to cut travel time and costs. Creating connectivity so that people do not have to depend on their cars and can be economically active requires a location on a transport corridor or close to a town or city Centre.

3. Places of different character that appeal to different markets. Creating character or a sense of place typically requires a minimum average density of 30 units to the hectare (as in the early 'garden cities' and some of the New Towns 5).

4. Designed to save resources and ensure that neighborhoods are well looked after, and do not 'cost the earth'. Climate proofing a development includes provision of 'green infrastructure' to promote biodiversity and reduce environmental impact as well as measures to save energy.

5. Hands-on management and 'long-term stewardship' by responsible local organizations, such as housing associations, development trusts or community councils, both during development and after residents have moved in (Falk & Carley, 2012 , P. 3-5).

The present research focuses on four phases of analysis: economic sustainability, social sustainability, institutional sustainability and environmental sustainability (see Figure 2.1).

Some indicator like (local employment, business activity, house price, housing affordability sense of community, crime and safety, tenure mix, community involvement, partnerships, capacity building, housing/area conditions, housing state of repair, satisfaction with own home, green open space local health services) has been used to understanding the locality, past and present situation of site and surrounding with the residence. A conceptual framework has been development after conceptualization.

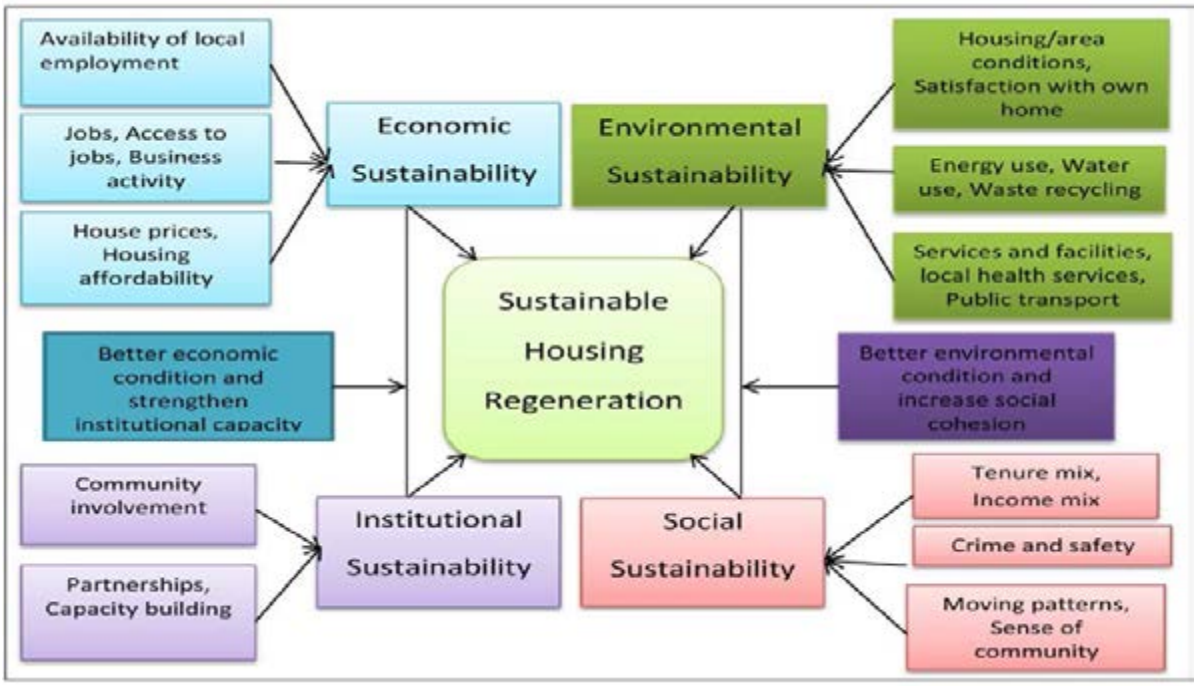

Figure 2.1: Analytical Framework for sustainable Housing Regeneration
Source: Adapted from Turcu (2012) , Salman and Qureshi, (2005)

Primary data are collected from the questionnaire surveys, household survey from the field. Applying different methods such as visual observation, Key informant interviews, field survey are done for the research. 2 FGD are done with the local residence. 3 Key informant was done with the local residence, Monrruzzan Muniir (General Seretary, Milon Sonshod) and Hafizur rahman (National Housing Authority). For sample case selection, systematic sampling method was followed. First housing unit was selected purposively and thereafter every 2/6th of the housing units interviewed. In this way 30% of total housing units of the each study area had taken under survey. The number of household taken as sample size was 50 which are more than the sample taken by percentage calculation.

Sample Size

Study site	Total housing unit	Sample size (30/%)
Housing Tree stored colony	144	43

This paper tends to linkup regeneration with sustainability. A Sustainability SWOT has been made to analyze the Strengths, Weakness, Opportunities and Threats of the community and the site.

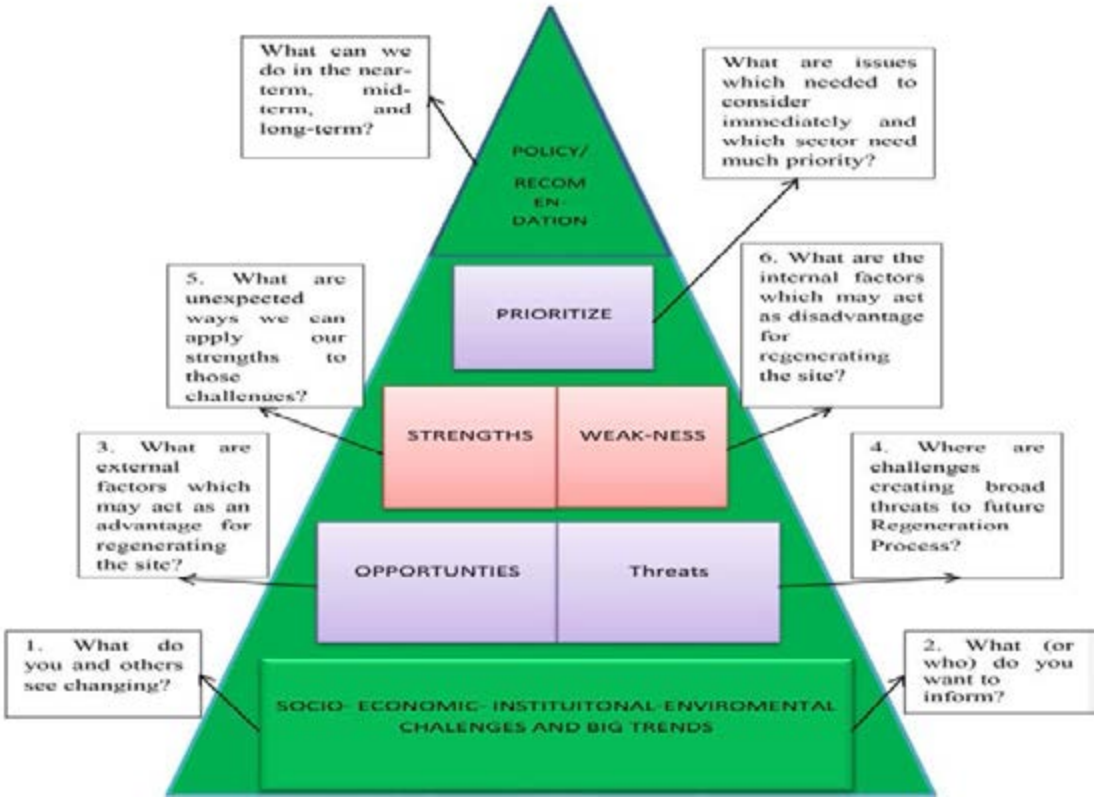

Figure 2.2: SSWOT for sustainable Housing Regeneration
Source: Adapted from Perera et, al. (2012)

This paper mainly focuses on regeneration potentials, issues and barriers for regenerating the sites. In the last section a sustainable policy for residential neighborhood has been provided. Likert scale has been used to measure the degree of satisfaction for municipal service facilities. Element like affordability, willingness, regeneration contribution, additional demand for floor space, buying capacity has been discussed and short term and term solution has been discuss.

Regeneration potentials of the site

Housing Tin Tola provides its resident housing in a very cheap rate. For 360 sq. ft. the rent was 1200 and for 600 sq. the rent was 3000 (Source : Field survey, FGD, 2014). Most of the resident prefers main advantage is low rent (See fig 3.3). The living environment in the study site was good. There are 4 playgrounds available in the study. Lots of trees are available in the study area.

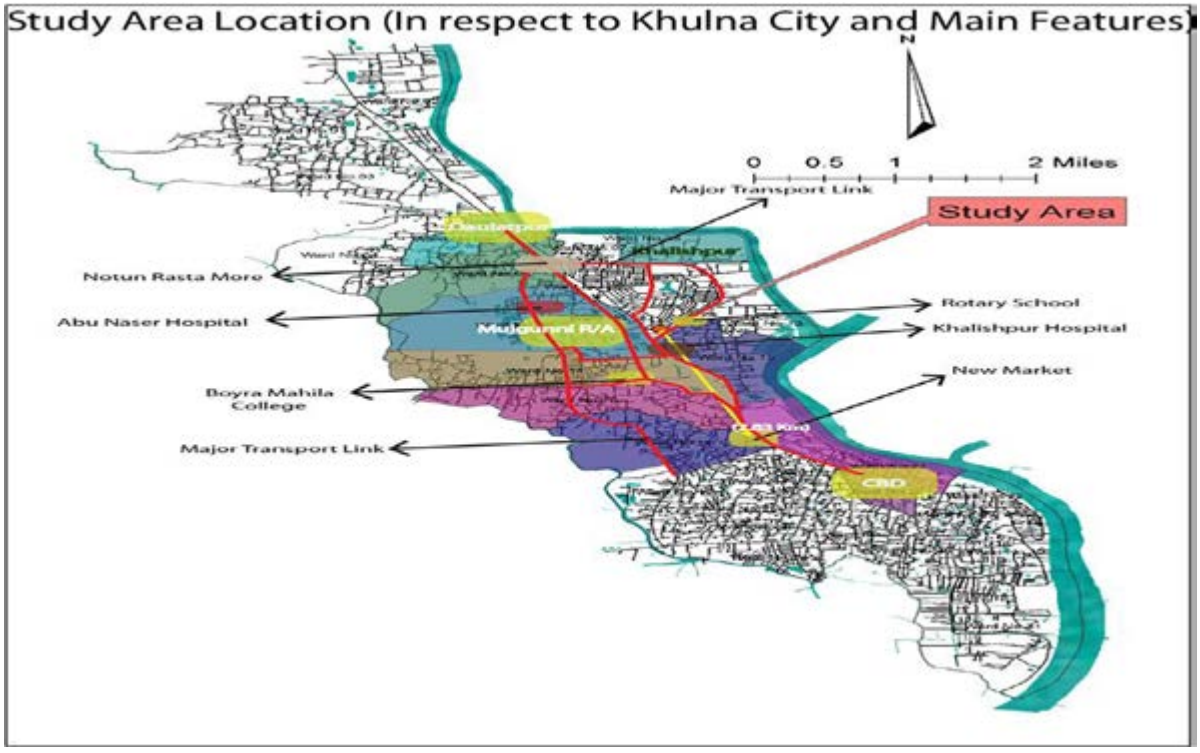

Fig 3.1: Community appraisal map and study area Location in respect of Khulna city
Source: Author, 2014

There is opportunity for children to spend their leisure time in playing different types of games in playground. A small park was available in the study site. There is enough green space. Water bodies found in the study are which make the environment cool. The site and surrounding was quite strong (See Fig 3.1). The neighborhood are surrounded by amenities like (school, collage, fire station , Bazar and Hospital) and most of them are available at working distance.

2.1 Social, Built Environmental and Economic :

As the colony was under national housing authority and it was the living place of different government official, it has a significance importance. The bonding between the communities is was very high. Picnic, Different kind of tournament, Get together was arranged by the community people (See Fig 3.2).

Fig 3.2 Picture of commu
Source: Field survey, 2014

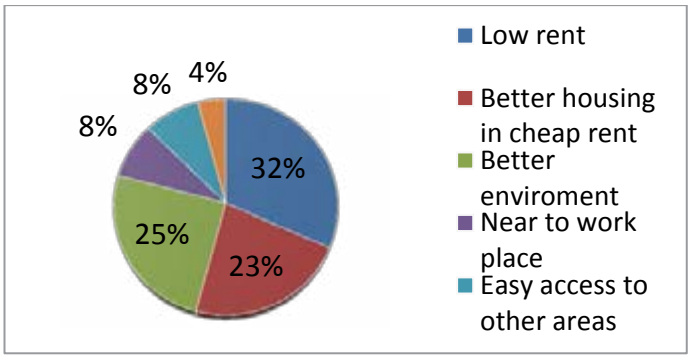

Figure: 3.3 Main advantage of Residing in the site
Source: Author, 2014

There are number of renowned Hospital is available around the site. Khalishpur Clinic, Fair clinic, Akij medical college and hospital was available around the site (See Fig 3.1). A number of primary health care centers were also available around the site. The neighborhood was blessed with the green space. A number of playgrounds were available inside the neighborhoods. Beside the Provati playground and Baikaly stadium was available in near distance. For recreational facility, Wonderland Park and Mujgunni Park was not very far.

4. Regeneration issues

Before 2008, Resident of housing Tin tola give 101 taka for per room in the 1, 2, 3, 4, 6 no building and 300 taka for per room in 7, 8 no building monthly. But govt. increase the rent 600tk for 1-6 no building and 3000 taka for 7 and 8 no building. The resident did not provide rent in last 6 years and around 1-2 lakh taka was due in each of the building. As the govt, did not get any Revenue, not a single development work has been done in last 6 years (Source: Field survey, FGD and Interview, 2014). Most of the employe was bachelor when they sarted to live here. . After the time being, the situation has been changed and most of them started family. There is a shortage of room space in the neighborhoods. The population has been increasing but the floor space was not constant.

4.1 The level of satisfaction

In the present research Likert Scale has been used to measure the degree of satisfaction for selected service facility (Solid Waste management, Sanitation, Road Service, Electricity, Drainage) based on the criteria for each service. In the present research, three categories of satisfaction has been used

Degree of Satisfaction	Complete Satisfaction	Moderate satisfaction	Dissatisfaction
Likert Score	3	2	1

Source: Zikmand, 2003

Table 4.1: Average weight-age index for satisfaction of municipal service facility

Satisfaction Level	Score ($\sum f * S / \sum f$)	Weight (w)	$\sum f * S / \sum f$
Solid Waste management	1.65	.2	.33
Sanitation	2.37	.2	.33
Condition of Road Service	1.95	.2	.39
Condition of Electricity	2.27	.2	.45
Condition of Drainage	1.86	.2	.37
Total		1	1.87

Source: Author, 2014

The average weight-age index shows that the level of satisfaction was 1.87 out of 3 (See Table 4.1). It was high for Sanitation and Electricity. It indicates the residence is moderately satisfied with the existing municipal service facility. Solid waste management was unsatisfactory.

Visual identification of the study site and some issues which need to take consideration in the regeneration process

Figure: 4.1 Visual identification of the study site
Source: Author, 2014

4.2 Sustainability SWOT analyses

SWOT means analysis of strength, weakness (internal factor), and opportunities and treats (external factors). This paper tried link up sustainability with swot analysis. It provides a tentative view about the strength, weakness, opportunities and treats of community living in the sites.

Strength	Weakness
Both single and duplex system was available in the site. Low, lower-middle and higher-middle group are found in the society which makes an Inclusive Mixed Communities The cohesion between communities was high and they arrange picnic, tournament and party at regular interval The loan percentage was quite low among the residents Strong community interest and support for regeneration	Infrastructure was major issues. From the FGD, it was found that, at least two building needs immediate reconstruction. The resident provide healthy amount of money for maintenance purpose Insufficient, affordable and safe housing for all populations Long term economic decline result in a limited range of local employment opportunities
Opportunities	**Threats**
The site was built for govt. employee. So the government is responsible for the improvement of the site. The workable population was quite high the in the study site. Proper training will turn them into human resource. The site was surrounded by important landmark (School, collage, Hospital, Park). Public Transport Provision was good. It will provide the residents Town living opportunities and with a healthy environment. Regenerating the site will increase the land value. It will meet the demand for additional floor space. Providing the housing to support a growing population will increase the number of households. Providing community ownership will encourage the community to do some secondary income earning activities like fish culture, Pig farming and Poultry. It will as a boost to the local economy.	New housing stock may not be affordable to the low income group because their saving percentage was very low. Lack of finance to support regeneration/property schemes Housing projects have to go in a long time-consuming bureaucratic process of getting approval of 9 different government agencies to start a construction project The regeneration perspective between different incomes group was different. High percentage (45 %) residences are not willing to contribute in the regeneration process Large amount of rent was due by the residents and the authority haven't receive any rent in last 6 years which makes a negative investment image

SWOT

5. Regeneration barriers and priorities for future Regeneration process

Most of the lower income group use 360 and 180 sq. ft. and they need 500 and 600 sq. ft. most of the lower middle income group's use 360 and 600 sq. ft. and they needed 600 and 800 sq. ft. Most of the higher middle income groups use 600 sq. ft. and they needed 800 and 1000 sq. ft. All the income needed additional floor space which was quite significant (Source: Field survey, FGD and analysis, 2014). The correlation between additional demand with income is positive, although the value different from 0 because the p-value of 0.567 is higher than 0.10. It shows all the demand for additional floor space highly correlated with the income. The entire income group wanted higher percentage of floor space. Problem arises when lower income group wanted higher floor space even they don't have the affordability.

The neighborhoods have a range of income between 7000-40000 taka (Source: Field survey, 2014)

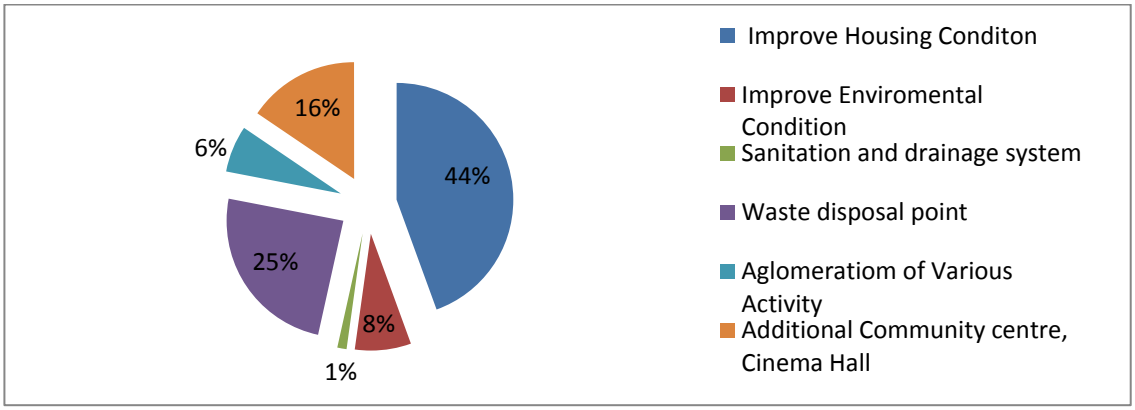

Fig 5.1: Regeneration Priorities
Source: Author, 2014

Changing family structure force the household additional demand for floor space. But most of them belong to lower income group. The new housing may not be affordable to them. Housing finance system was very limited, so financing will become a major factor. The household want their desire space with installment but the amount was not high. It will take long time to recover the cost. After regeneration, the land value will increase, which will be a threats to the lower, lower middle income group. So infrastructure, affordability, ownership should be given priority.

6. Policy framework for sustainable neighborhood regeneration for the residential sites

The policy measure for the specific study area in context of Khulna city and Bangladesh respecting the Urban Strategy and Structural Plan of KDA (2001-2020) will be known as "Policy for spontaneously developed residential area: duties and responsibilities". This policy guideline incorporates 5 major principles. These papers tend to link sustainability by urban regeneration and provide policy guidelines for creating sustainable neighborhood in the residential site of Bangladesh.

6A. Places not estates- Successful developments must address wider issues than simply building houses and create distinctive places that offer a choice of housing and complementary activities nearby.

Proposed: 6A.1 Provide housing to the resident, not just house-Housing is commodity. It directly affect to the livelihood of the resident. A successful regeneration activity depends if it create positive effect on the community with and within the surrounding area. The level of satisfaction for municipal service and facility was not satisfactory. So with other civic amenities an improvement was needed in service facilities for the comfort of the residence.

Proposed: 6A.2 Integrate technical and infrastructure solution with socio-economic measure and ensure adequate and affordable housing to all-Changing family structure force the residence, additional demand for floor space. The percentage of low and lower middle income was high. So the new housing unit may be affordable to them. Internal change in the household and infrastructure may solve some portion of this problem. The regeneration activity should focus on those issues and ensure affordable housing to all. Self-help housing and community maintenance fund may improve the situation.

Proposed: 6A.3 National Housing Policy should include regeneration policy framework - Most of the countries have regeneration policy, but there is no regeneration or revitalization policy have found in our housing policy. Urban population has been increasing but housing stock is constant, regeneration of already existing yet unlivable housing sites can be a potential solution to meet the demand for housing.
6B. Moving around easily- Places should be linked up with short, direct public routes overlooked by frontages.

Proposed: 6B. 1 Increase permeability and connectivity by walk able neighborhood, safer streets networks, cycling and parking facility - sustainable neighborhood regeneration should consider far wider area than itself. It should be well-connected to jobs and services by foot and bike as well as other modes to cut travel time and costs. Routes for pedestrian, cyclist should be integrated into transportation networking plan. Roadside tree plantation should be encouraged and Small Park for the children will help in the neighborhood to pass their leisure time.

Proposed : 6B. 2 Provide communal space and access for all – Hard aspect including community space, community center; playground will help the neighborhood to increase bonding between them. Communal space should be well managed and maintained by the community. A community fund will for the maintenance purpose and it will help them to become their own manager and regulator.
6C. Safe places, private spaces- Places must be safe and attractive with a clear division between public and private space.

Proposed : 6C.1 Introduces community ownership and promotes a stable neighborhood- Lack of homeownership is a crucial issue in providing stable residential base neighborhood regeneration. The Govt. was the owner of land and they provide lease ownership to the residence for 90 years. In this system the owner just stays in the site but have no rights to start any secondary income earning activity by using the property. If a community ownership was given to the neighborhood, they can start some activity like Poultry, Pig farming and fish culture. It can increase their income the economic condition will improve.

Proposed: 6C. 2 Design safe streets and attractive spaces ensure safety and security for the neighborhood- Lack of security is an emerging problem in most of the neighborhood. When providing new space and streets, it should be focused that the street are safe and sound (use of street light, marking on street, street side bench, landscaping elements beside streets etc.). Most of the residence use metal handle for climbing in the roof. It forces a security problem and any time accident can happened. So stair should make in each of the building.
6D. Building for the future- Buildings and spaces should be adaptable to enhance their long-term viability and built so they harm the environment as little as possible.

Proposed: 6D. 1 Respond to short and long-term demand and reduce development risks – Sustainable regeneration seeks to meet both present and future demand and it helps to create a vibrate environment for the future generation. The vertical expansion of the building should be restricted. If new housing are constructed "Building Construction Rules, 1996" should followed. But before that EIA (Environment Impact assessment) should be

carried more specifically and with safety measure so that the after effect of the development does not affect the livelihood of the inhabitants.

Proposed: 6D. 2 Designed to save resources and consider the future change – The sustainable regeneration should include "green infrastructure" like green roof, tree plantation, and rooftop gardening to promote biodiversity and reduce environmental impact as well as measures to save energy. The site has bad waste disposal system and unpaved drain which makes the environmental condition unhygienic. Building and construction materials should be checked and re-checked to ensure environmental sustainable neighborhood (installment of dustbins, proper drainage system, sanitation or sewerage system and, solid waste management system)

6E. Build on local character- Developers must consider the context and exploit and strengthen the characteristics that make an area special.
Proposed: 6E. 1 Proactively seek and encourage community involvement- Co-housing and self-build should be used not just to make housing more affordable but also to build a sense of community and to take forward innovations in saving natural resources. It will make the community more powerful and ensure bottom up participation. The percentage of workable population (45 %) was high and the site and surrounding was strong. So if some vocational training can be provided by Government or NGO, it may boost the local economy will enhance the economic condition of the community.

Proposed: 6E.2 Facilitate public-private development partnership and attract private funding for infrastructure- 93% of total housing stock was provided by private sector in Khulna city. In recent times, some joint venture companies are using public land as equity to get development moving providing sufficient infrastructure is in place. Partnerships bring together the best skills of the private sector in finance and development with the commitment of the public sectors to long-term community development and sustainability.

6. Conclusion

Housing problem is associated with various problems like employment opportunities, affordability, service facility, environmental condition etc. The housing site was built in 1960 and the physical condition was bad. The extent of the problems is such, which requires following a sustainability framework for providing regeneration guidelines for the neighborhood located in the residential areas. The opinion of different income group about regeneration was provided here. Residential site provides a land of opportunity. Only a regeneration activity will successful when it reflects the actual needs and demand of its residence. Regenerating of those sites will contribute to the existing housing stock. There is lot of similarity was found in different residential sites. This research will help the planner and policy maker when they work on different Residential sites and try to regenerating those to bring back urban image.

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Title: Evaluation of Microbial Quality of Hatirjheel in Dhaka City

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1. Introduction

Water is the most important components amongst the natural resources and fundamental for the continued existence of all living organisms. The environment, economic growth and development of Bangladesh are all highly influenced by water - its regional and seasonal availability and the quality of surface and groundwater. The inexorable rise in demand for water to grow food, supply industries and sustain urban and rural populations has led to a growing scarcity of freshwater in many parts of the world. The world is experiencing a steady decline in water quality and its availability. About 75 percent of the world's rural and 20 percent of its urban population has no ready water access to uncontaminated water (1). For many regions, water supplies are contaminated with toxic chemicals and pathogenic microorganisms. In terms of quality, the surface water of the country is unprotected from untreated industrial effluents and municipal wastewater (2, 3, 4).

Lakes and ponds are a vital part of a modern healthy city. Over the past few decades, as Dhaka started to grow into a mega-city, we began to realize how important it is to have parks, natural wetland, lakes, and open spaces. The surface water area of Dhaka city is about 10-15% of the total land area. Hatirjheel, Gulshan Lake, Banani Lake, Ramna Lake and Dhanmondi Lake are the popular relaxation spot in the city, is being polluted by Slums and Sewages, the business firms and industries operating in the area, locals and environmentalists alleged. But unfortunately, the groundwater level in many areas of Dhaka city is drastically receding from about 0.3m per year at Banani to about 1m per year at Motijheel (5). Therefore if we manage to safe our surface water in and around the city, we can reduce the demand of ground water for the city dwellers by the proper use or these lakes and ponds.

Haitrjheel is a prominent depression within Dhaka metropolitan area. The lake is about 302 acres of Tejgaon, Moghmazar, Rampura region and has been playing a vital role in maintaining the only drainage system of those areas. The open stage for cultural programmes and a number of beautiful bridges and roads attract a large number of visitors every day. The situation is getting worse clue to the lack of adequate entertainment spots in the capital. Tile Lake and its adjacent area become crowded during the weekends. Residents of the area also alleged that liquid wastes from sewages are dumped into the lake. Garbage and human faeces have made the water of the lake greenish. A research work showed that pH varied from 6.7 to 7.1, Color varied from 25 to 50 pt-Co units, Turbidity varied from o to 13 NTU, Carbon dioxide (CO2) varied from 35 to 60 mg/l, Alkalinity varied from 90 to 345 mg/l, Hardness varied from 150 to 300 mg/l, Chloride varied from 0.5 to 1.0 mg/l, BOD varied from 0.0 to 10 mg/l, COD varied from 28 to 60 mg/l at Hatirjheel Water (6).

The quality of water is of vital concern for mankind, since it is directly linked with human well-being. At present, the menace of water borne diseases and epidemics still loom large on the horizons of developing countries (7). The increasing urbanization and industrialization of Bangladesh have negative implications for surface water quality. The pollution from industrial and urban waste effluents and from agrochemicals in some water bodies and rivers has reached alarming levels (8, 9, 10). In Bangladesh, about 80% of all diseases are associated with water-borne microbes. About 300,000 children under five, die

of diarrheal diseases every year, out of which one-third of the death occurs in the city slums and squatter settlements (11). The Physicochemical features and bacterial flora of Dhanmondi Lake were investigated earlier (12, 13, 14).

Microbial safety of recreational water is one of the major human public health issues in developing countries. Water contamination occurs through contamination of streams, lakes, underground water, bays, or oceans by substances harmful to living things. If severe, water pollution can kill large numbers of fish, birds and other animals in some cases killing all members of a species in an affected area. Pollutions make streams, lakes, and coastal waters unpleasant to look at, to smell, and to swim in. People who ingest polluted water can become ill, and with prolonged exposure, may develop cancers or bear children with birth defect.

Aquatic microorganisms and their activities are of great importance in many ways. They may affect the health of humans and other animals. These organisms occupy a key position in the food chain by providing rich nourishment for the next higher level of aquatic life and may affect health of humans and other animals (15, 16, 17, 18). Water quality is a broad concept. Its maintenance means that natural waters should not be overloaded with organic or inorganic nutrients or with toxic, noxious, or esthetically unacceptable substances. They should not become vehicles of disease transmission from fecal contamination nor should their oxygenation, temperature, salinity, turbidity, or pH be altered significantly (19).

2. Aims and Objectives

The aims and objectives of this study was-

- To evaluate the microbial quality of water of Hatirjheel.
- To study the Zooplankton in Hatirjheel and
- To assessment some physicochemical parameters of Hatirjheel

Materials and Methods

6.2Isolation and enumeration of Total Viable Bacteria:

Medium: Nutrient agar (NA) medium (5.0 gm peptone, 1.50 gm beef extract, 1.50 gm Yeast extract, 5.0 gm sodium chloride, 15.0 gm agar, distilled water 1.0 liter, pH (at 25°C) 7.4 ± 0.2) was used for isolation. Medium was sterilized at 15 lbs pressure (121°C) for 15 minutes and dispersed into sterile Petri plates.

Plating and incubation: Serial dilution of water samples were made in sterile distilled water 0.1 ml 103& 105 dilutions of test samples were dispensed in to the Petri plates with sterile nutrient agar medium. Plates were incubated at 37°C for 24 hours. Enumeration was developed on colony counter.

2.2 Total Fungi isolation and enumeration:

Medium: Sabouraud Dextrose Agar (SDA) medium (10.0 gm mycological peptone 40.0 gm dextrose, 15.0 gm agar, distilled water 1.0 liter, pH (at 25°C)5.6 +/- 0.20) was used for

isolation. Medium was sterilized by autoclaving at 15 lbs pressure (121°C) for 15 minutes and dispensed in to sterile Petri plates. Plating and incubation: Serial dilutions of water samples were made in sterile distilled water. 0.1 ml of 102 dilutions of test samples were dispensed in to Petri plate with solidified medium and spreading of sample on the medium was done by using sterile glass spreader to ensure uniform distribution. Plate was incubated at 25°C for 24 hours. Enumeration of developed colonies was carried out on colony counter.

2.3 Isolation and enumeration of E. coli and Klebsiella spp.:

Medium: MacConkey agar medium (Peptones (meat and casein) 3.0 gm, Pancreatic digest of gelatin 17.0 gm, Lactose monohydrate 10.0 gm, Bile salts 1.5 gm, Sodium chloride 5.0 gm, Crystal violet 0.001 gm, Neutral red 0.03 gm, Agar 13.5 gm, distilled water 1.0 liter, pH (at 25°C) 7.1 ± 0.2) was used for isolation. Medium was sterilized at 15 lbs pressure (121°C) for 15 minutes and dispersed into sterile Petri plates.

Plating and incubation: Serial dilution of water samples were made in sterile distilled water 0.1 ml 102 dilutions of test samples were dispensed in to the Petri plates with sterile MacConkey agar medium. Plates were incubated at 37°C for 24 hours. Enumeration was developed on colony counter.

2.4 Isolation and enumeration of Pseudomonas spp.:

Medium: Cetrimide agar medium (Pancreatic digest of gelatin 20.0 gm, Magnesium chloride 1.4 gm, Potassium sulphate 10.0 gm, Cetrimide 0.3 gm, Agar 15.0 gm, distilled water 1.0 liter, pH(at 25°C) 7.2 ± 0.2) was used for isolation. Medium was sterilized at 15 lbs pressure (121°C) for 15 minutes and dispersed into sterile Petri plates.

Plating and incubation: Serial dilution of water samples were made in sterile distilled water 0.1 ml 102 dilutions of test samples were dispensed in to the Petri plates with sterile MacConkey agar medium. Plates were incubated at 37°C for 24 hours. Enumeration was developed on colony counter.

2.5 Isolation and enumeration of Salmonella and Shigella spp.:

Medium: SS Agar (Salmonella Shigella Agar) medium (Beef extract 5.0 gm, Peptic digest of animal tissue 5.0 gm, Lactose 10.0 gm, Bile salts mixture 8.5 gm, Sodium citrate 10.0 gm, Sodium thiosulphate 8.5 gm, Ferric citrate 1.0 gm, Brilliant green 0.00033 gm, Neutral red 0.025 gm, Agar 15.0gm, distilled water 1.0 liter, pH (at 25°C) 7.0 ± 0.2) was used for isolation. Medium was boiled for completely dissolved and dispersed into sterile Petri plates.Plating and incubation: Serial dilution of water samples were made in sterile distilled water 0.1 ml 102 dilutions of test samples were dispensed in to the Petri plates with sterile SS agar medium. Plates were incubated at 37°C for 24 hours. Enumeration was developed on colony counter.

2.6 Isolation and enumeration of Vibrio spp.:

Medium: TCBS (Thiosulfate-citrate-bile salts-sucrose) Agar medium (Proteose peptone 10.0 gm, Yeast extract 5.0 gm, Sodium thiosulphate 10.0 gm, Sodium citrate 10.0 gm, Oxgall 8.0 gm, Sucrose 20.0 gm, Sodium chloride 10.0 gm, Ferric citrate 1.0 gm, Bromo thymol blue 0.04 gm, Thymol blue 0.04 gm, Agar 15.0 gm, distilled

water 1.0 liter, pH(at 25°C)8.6 ± 0.2) was used for isolation. Medium was boiled for completely dissolved and dispersed into sterile Petri plates.Plating and incubation: Serial dilution of water samples were made in sterile distilled water 0.1 ml 102 dilutions of test samples were dispensed in to the Petri plates with sterile SS agar medium. Plates were incubated at 37°C for 24 hours. Enumeration was developed on colony counter.

4. Results and Discussion

Microbial quality of water is usually expressed in terms of the concentration and frequency of occurrence of particular species of bacteria. According to Ajibade et al., (2008) polluted water may contain pathogenic bacteria, viruses, protozoa or helminthes eggs. Some of the bacteria that indicate the presence of other kinds of pathogens are called indicator bacteria. They are usually present in the colon and excreted in large number by warm blooded animals. (Seawa water shed report 2009).

Table 1: Bacterial count (cfu) of water samples of Hatirjheel:

Sample	TVB on NA	Total Fungi on SDA	E.coli on MacConkey	Klebsiella spp. on MacConkey	Pseudomonas spp. on Cetrimide	Salmonella spp. on SS Agar	Shigella spp. on SS Agar	Vibrio spp. on TCBS
S-1	4.6×10^{5}	0	0	0	5.8×10^{2}	0	0	0
S-2	2.0×10^{6}	3.4×10^{2}	0	2.0×10^{2}	0	2.0×10^{2}	0	0
S-3	6.5×10^{5}	3.0×10^{2}	0	3.0×10^{2}	1.0×10^{2}	0	0	0
S-4	3.4×10^{5}	0	0	2.6×10^{2}	0	0	0	6.0×10^{2}
S-5	2.8×10^{5}	1.6×10^{2}	0	1.6×10^{2}	8.3×10^{2}	0	0	0

The outcome of microbial analysis performed on samples collected from different locations of Hatirjheel of Dhaka, Bangladesh appears in table 1. Maximum total viable bacterial load (2.0×10^6 cfu/100 ml) found in sample 2 and minimum (2.8×10^5 cfu/100 ml) found in sample 5. Total fungi count on SDA agar ranged between 0 to 3.4×10^2 cfu/100 ml. The number E.coli is found 0 on MacConkey agar in all samples. The lowest number of Klebsiella (1.6×10^2 cfu/100 ml) on MacConkey agar medium was recorded in the sample 5 while the highest number (3.0×10^2 cfu/100 ml) was in the sample 3. The highest number of Pseudomonas spp. on Cetrimide agar medium was (8.3×10^2 cfu/100 ml) and the lowest number is 0. No Shigella spp. was found in samples and the Salmonella spp. count on SS agar ranged between 0 to 2.0×10^2 cfu/100 ml. The Vibrio spp. count on TCBS agar ranged between 0 to 6.0×10^2 cfu/100 ml.

According to WHO Standards, E.coli or thermotolerant coliform bacteria must not be detectable in any 100 ml of sample.

These studies clearly reveal that the river water is loaded with bacterial species. It indicates that many species are potentially pathogenic and are able to cause a spectrum of infections in susceptible populations. Water intended for drinking and household purposes must not contain any water borne pathogens. The pathogenic groups includes bacteria, viruses and protozoa, which causes diseases that vary in severity from mild gastroenteritis to sever fatal-diarrhoea, dysentery, hepatitis, typhoid fever etc,. Apart from routine microbiological examination for evidence of fecal contamination, other pathogenic microorganisms must be tested. Absence of indicator microorganism in water body does not actually indicate that absence of infection potential. The detection of pathogens i.e., salmonella spp. klebsiella spp. and other pathogens from natural waters is still to be established due to their low concentration. (APHA 1995)

Presence of different bacterial species in Hatirjheel samples were tested by using different media. The isolates which were obtained from the Hatirjheel water samples show significant results. The isolated bacterial species were identified to be the same with those commonly encountered in water, which were also reported by Ajibade et al., (2008).

A study was conducted to evaluate the microbial quality of Hatirjheel at Dhaka. The total viable bacterial count was done to determine bacterial load in water samples. According to table 1, sample 2 was contained the highest amount that is 2.0×10^6 and all of the samples were contained bacterial load on Nutrient Agar.

The number of total fungi on SDA agar count that the highest number is 3.4×10^2 in sample 2 and no fungi were found in two samples. The number of E.coli and Klebsiella were determined on MacConkey agar, indicates the counts of E.coli and klebsiella in cfu/ml. according the data table no E.coli was found and highest klebsiella was record in sample 3 (3.0×10^2) and absence in sample 1.

The number of salmonella and shigella were determined on SS agar, indicates the number of salmonella and shigella in cfu/ml. Among the five samples, salmonella was found in sample 2 and both of salmonella and shigella was absence in all other

samples. The Vibrio spp. count on TCBS agar indicates that Vibrio spp. was found in only sample 4 and absence in other samples.

Surface waters are vital and vulnerable fresh water systems that are critical for the sustenance of all life. Social, economic and political development has been largely related to the availability and distribution of freshwaters contained in surface water systems. Surface water systems can be considered as arteries of the land supplying life giving water to an abundance of organisms whilst at the same time supporting modern civilizations (King et al., 2003). Microbiological quality of drinking water is usually expressed in terms of the concentration and frequency of occurrence of particular species of bacteria (Grabow et al., 1996).

Most water borne disease causing organisms originate in human or animal bodies and are discharged as part of body waste. Due to the relatively small number of disease causing pathogenic organism, it is very difficult to isolate and identify specific disease causing bacteria.

Microbial study revealed that the microbial quality of different location of Hatirjheel is diverse. The microbial analysis was performed to trace the presence of organisms and pathogens such as E.coli, salmonella, shigella, klebsiella and Vibrio spp. Though some organisms were absence in samples but the amount of presence of different organisms in water is not safe for drinking purposes. The presences of organisms indicate that this water is vulnerable for diarrhea, dysentery, typhoid fever, shigellosis, salmonellosis, parasitic worm infection, hemolytic uremina syndrome, hepatitis and gastroenteritis.

The present condition of Hatirjheel is very recently changed from its previous condition. But the recent studies showed that the water quality of Hatirjheel is not safe for human health. The purpose of the Hatirjheel project will not fully gained until the water pollution from different sources is controlled. So, it is need to take necessary steps to stop the pollution of water and increase the quality of water such as setup effluent treatment plants (ETP) at the sewage and waste water discharging points. Need regular monitoring to get the desired water quality, continuing the sound water quality and to restore and maintain the physical, chemical and biological integrity of water bodies to achieve the required water quality, which ensure protection and propagation of fish, wildlife, plants and also recreation in and on water.

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Title: Analysis of Female's Perception on Earthquake Risk in Dhaka City

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1. Introduction

A natural hazard is a threat of a naturally occurring event that can cause severe damage to people and the environment. Many natural hazards are interrelated with each other e.g. earthquakes can cause tsunamis and drought can lead directly to famine. It leads to financial, environmental or life losses. Natural hazards have the potential to cause large numbers of fatalities. Among them the hazards that cause the largest numbers of fatalities in one event are earthquakes. Despite the recent scientific evolution, earthquakes are still the most unpredictable and feared natural disaster ever.

Bangladesh is extremely vulnerable to several natural disasters and every year natural calamities upset people's lives in different parts of the country. The major disasters concerned here are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion, and landslide. These extreme natural events are termed as disasters when they adversely affect the environment, including human beings, their shelters, or the resources essential for their livelihoods. At present Bangladesh is concerned with another natural phenomenon that is called earthquake.

An earthquake is commonly described as a sudden individual tremor within the earth that creates shaking at the surface. Earthquakes occur when a build-up of pressure or strain between sections of rocks within the earth's crust is suddenly released, causing minor or severe vibrations on the surface of the land (1). In addition to sudden events, there are gradual effects, such as slow creeping of earth materials that are closely related to the creation of earthquakes. An earthquake happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane. The point within the earth where earthquake waves originate is called the focus, from where the vibrations spread in all directions. They reach the surface first at the point immediately above the focus and this point is called the epicenter. It is at the epicenter where the shock of the earthquake is first experienced (2). Earthquakes severity are based on some factors like magnitude, type, depth, distance from epicenter, soil conditions, preparedness of, population, time and duration.

Bangladesh is an earthquake prone country as it lies along the border of Eurasian and Indo-Australian plates, where earthquakes generate at regular intervals and of comparatively uniform in size. The Indian plate is moving northwards at about five centimeters in a year, a force that also contribute to the formation of Himalayas. This movement of the Indian plate also responsible for most of the damaging earth quake of this Indian sub-continent (3.). Bangladesh is close to the meeting point of the Indian, Eurasian and Burma plates. The movement of Indian and Eurasian plates has been locked at the foot of the Himalayas for many years, storing strain energy. When the lock is released, it will let out the strain energy, causing major earthquakes. The

potential for magnitude 8 or greater earthquakes on the nearby Himalayan front if very high, and the effects of strong shaking from such an earthquake can directly affect much of the country. Besides, there are a few active fault zones in Bangladesh for which medium-scale earthquakes could take place (4). In addition, historical seismicity within Bangladesh indicates that potential for damaging moderate to strong earthquakes exist throughout several parts of the country.

At the present time, Bangladesh is very much concerned for earthquake/seismic event because More than 40 percent of Bangladesh has the highest earthquake vulnerability and could suffer severe loss of life and property in case of an earthquake, according to the seismic zoning map the country divided into three zones on the basis of their earthquake vulnerability. Forty-three percent comes under highest, 41 percent under moderate and 16 per cent low earthquake vulnerable risk zones (5). As Bangladesh is located in a tectonically active area, so much of the country including Chittagong, Sylhet, Dhaka, Rangpur, Bogra, Mymenshing, Comilla, Rajshahi are very much vulnerable to major earthquake disaster. The geographical setting of Bangladesh makes the country vulnerable to natural disasters (5). Despite this fact there has been little or no awareness about reducing the earthquake associated risks, poor quality of construction very little quality control measures and lack of earthquake resistance building structures, makes the country (especially most of the buildings) more vulnerable to seismic hazards, even to a moderate shake.

Historical evidence reveals that in the last 250 years, eight big earthquakes occurred with magnitude >7.0 in and around Bangladesh. The Great Indian earthquake of June 12, 1897 (magnitude 8.3-8.7), whose epicenter was about 230 kilometers away from Dhaka (6) caused extensive damage in Bangladesh. According to the Bangladesh Meteorological Department, within 100 years (1918-2011) almost 130 earthquakes epicenter was in Bangladesh (7). It was also evident that, among the total earthquake 28 events occurred within 1918 to 1984 year.

In the last 100 years (1918-2011) Bangladesh experienced tremor of 2.0 to 7.6 magnitudes on Richter scale. Among these almost half of the events ranged were 4.0-4.9 magnitude on the Richter scale and 7, 6, 20, 27, and 2 numbers of events was 7.0-7.6, 6.4-6.8, 5.0-5.4, 3.0-3.9 and 2.0-2.9 magnitude on the Richter scale respectively (7). In this region earthquakes may occur at a cyclic order of hundred years and the Great Indian Earthquake of 1897 is more likely to be repeated every hundred years. Among the seven severe earthquakes of the Himalayan range, the last one occurred in1905. According to the observations of Dr. Rogar Bilhan (Earthquake Expert, U.S.A) and other specialists, a severe earthquake is overdue for Bangladesh. Repeated tremors in Chittagong and other areas of the country may be the warnings for the severe one as per opinion of the experts in this field (6).

The Meteorological Department of Bangladesh, detected about 90 earthquakes took place in the country between year 2007 to 2008, nine of them above five on the Richter scale and epicenters of 95 percent being within a 600 km radius of Dhaka city. Expert said that earthquakes with little magnitude are the pre signal of a powerful earthquake. It is high time to protect ourselves from the deathly effects of earthquake. It is feared that even any powerful earthquake hit Dhaka City with the magnitude of 6.50 on the Richter scale the figure of destruction would be immeasurable (7). Among these two earthquakes took place with the magnitude over six on the Richter scale during this period.

After 150 years of the Great Earthquake in Bangladesh, the country is once again in grave danger. This time, if earthquake take place above 8 in Richter scale, devastations will be even beyond speculations. It will be completely impossible for the government alone to handle such severe catastrophe. Moreover, for a developing nation with limited resources, Bangladesh will need decade to overcome any such loss of earthquake. However, absence of strong earthquakes in the recent past have left the present generation unaware of the possibility of a major earthquake. Lack of public awareness along with absence of legal enforcement of building code has resulted in majority of buildings in the urban areas of Bangladesh to be lacking in earthquake resistant design. This is further compounded by poor quality of buildings materials and construction. In case of a major earthquake the densely populated cities of Bangladesh may face a massive disaster. One such potential high risk area is Dhaka.

2. Aims and Objectives

This study was conducted with the aim:

e) To evaluate the level of female's knowledge about earthquake.
f) To evaluate female's awareness about earthquake.
g) To evaluate emergency response of female and their view on relief operations

3. Materials and Methods

Natural disaster risk perception focuses on how people receive knowledge and information in relation to natural disaster risks and the judgmental process of taking actions to reject or accept, fight or prevent natural disasters according to the received information. Mental activities in the field of cognitive psychology can be combined to a few elements of risk perception within behavior geography: knowledge, awareness and behavior. The level of people's knowledge about disasters reflects their abilities to deal with disaster information and further shapes the awareness and behaviors of disaster prevention and reduction. The public awareness of disasters is a state of mind after people's processing information and knowledge of disasters and it will directly influence their attitudes and behavioral tendencies. The human behaviors in emergency are the external reflection of disaster perception, which is synthetically affected by the former two factors, but on the other hand, the adjustment of emergency response promotes changes in the other two ones. Based on the theories mentioned, this thesis report was made a research on earthquake risk perception by way of questionnaire form, in which the main contents includes: the personal data of respondent, theoretical knowledge and awareness of earthquake, emergency response and the view on relief operations.

Questionnaires survey method was adopted for this study. Altogether 105 questionnaires were used consisting of 33 questions. It's a cross sectional study. In this research random sample ware taken and all the respondents were female. The survey targeted 105 Females among them 35 females were students, 35 were workingwomen and 35 females were housewives with the questionnaire. The test of risk perception involved three parts: knowledge, awareness and behavior related to earthquake. Data were manage by using SPSS 16 version and prepare the table by using the percentage of the respondent's opinion. Microsoft Office Excel Worksheet was used to prepare the graphical presentation of the findings.

4. Results and Discussion

6.3 Basic Knowledge about Earthquake

In the survey (Table 1), it was also found that the majority of female in jobs are well aware of the fact that earthquake is a natural phenomenon. Although 20% students and 42.85% housewives don't think so, 79% females considered earthquake as a natural disaster. Most respondents 70.48% correctly don't blame human being for earthquakes while some (25.71%) blame human being for earthquake. The house that one builds should be safe and strong, but 48.57% respondents think their dwelling place is vulnerable for earthquake. About 22.85% females considered their dwelling place is safe and 28.57% females have no ideas regarding this matter.

Table 1: Basic knowledge about Earthquake

		Occupation			
Issues	Parameters	Student	Job	Housewife	Total
Earthquake considered as natural disaster	Yes	28(80)	35(100)	20(57.14)	83(79)
	No	7(20)	0	15(42.85)	22(20.9)
	Total	**35**	**35**	**35**	**105**
Human being are responsible for earthquake	Yes	7(20)	5(14.28)	15(42.85)	27(25.71)
	No	27(77.14)	30(85.7)	17(48.57)	74(70.48)
	Don't know	1(2.85)	0	3(8.57)	4(3.81)
	Total	**35**	**35**	**35**	**105**
Dwelling place is vulnerable for earthquake	Yes	20(57.14)	24(68.57)	7(20)	51(48.57)
	No	5(14.28)	6(17.14)	13(37.14)	24(22.85)
	Don't know	10(28.57)	5(14.28)	15(42.85)	30(28.57)
	Total	**35**	**35**	**35**	**105**

*Note: Figures in () indicate %

4.2 Personal experience with Earthquake

We set some questions relative to attribute properties and spatial distribution of earthquake to estimate the public knowledge level. In general, public universal knowledge is not enough and there is limited understanding and misunderstanding about the knowledge related to earthquake. As seen in Table 2, understanding degrees of each attribute property of earthquake such as earthquake magnitude, earthquake intensity, seismic wave, Warning time seismic belt and Earthquake zone in Bangladesh are different. Although the public have a rough understanding of those concepts, they are not clear to the quantitative concept like magnitude and focal depth. We found that housewives respondents doubted for destructive earthquake, which is defined according to magnitude. Only 14.28% housewives have ideas about destructive earthquake while majority of working women (88.57%) and 74.28% students have clear idea about destructive earthquake. While asking about Richter scale, 88.57% working women respondents indicated that they have clear ideas about Richter scale.

Table 2: Personal experience with Earthquake

		Occupation			Total
Issues	Parameters	Student	Job	Housewife	
Ever felt earthquake	No idea	2(5.7)	0	10(28.57)	12(11.43)
	Insignificant idea	4(11.4)	4(11.4)	5(14.28)	13(12.38)
	Clear idea	28(80)	31(88.57)	10(28.57)	69(65.71)
	Wrong idea	1(2.89)	0	10(28.57)	11(10.48)
	Total	35	35	35	105
Destructive earthquake	No idea	1(2.85)	0	16(45.7)	17(16.19)
	Insignificant idea	8(22.85)	4(11.4)	14(40)	26(24.76)
	Clear idea	26(74.28)	31(88.57)	5(14.28)	62(59.05)
	Total	35	35	35	105
Knowledge about Richter scale	No idea	8(22.85)	1(2.85)	6(17.14)	15(14.28)

	Insignificant idea	10(28.57)	2(5.7)	8(22.85)	20(19.04)
	Clear idea	17(48.57)	31(88.57)	13(37.14	61(58.1)
	Wrong idea	0	1(2.85)	8(22.85)	9(8.57)
	Total	35	35	35	105
Seismic wave	No idea	10(28.57)	5(14.28)	24(68.57)	39(37.14)
	Insignificant idea	5(14.28)	5(14.28)	7(20)	17(16.19)
	Clear idea	20(57.14)	25(71.42)	4(11.4)	49(46.66)
	Total	35	35	35	105
Warning time of earthquake	No idea	10(28.57)	5(14.28)	19(54.28)	34(32.38)
	Insignificant idea	4(11.4)	3(8.57)	9(25.7)	16(15.23)
	Clear idea	21(60)	27(71.42)	7(20)	55(52.38)
	Total	35	35	35	105
The worlds three great earthquake belt	No idea	10(28.57)	7(20)	25(71.42)	42(40)
	Insignificant idea	5(14.28)	6(17.14)	8(22.85)	19(18.1)
	Clear idea	20(57.14)	22(62.85)	2(5.7)	44(41.9)
	Total	35	35	35	105
Earthquake zone in Bangladesh	No idea	7(20)	3(8.57)	7(20)	17(16.19)
	Insignificant idea	4(11.4)	4(11.4)	10(28.57)	18(17.14)

	Clear idea	22(62.85)	28(80)	12(34.28)	62(59.1)
	Wrong idea	2(5.7)	0	6(17.14)	8(7.62)
	Total	35	35	35	105

*Note: Figures in () indicate %

14.28% respondents have no ideas about Richter scale. In the survey, it was also found that the degree of respondents' concern about Richter scale Seismic wave, earthquake belts, Warning time and zones is not high, with each related question producing less than 60% correct answers. The question on the world's earthquake belts produced 41.9% correct answers and the question about Bangladesh's earthquake disaster zones 59.1% correct. The public are not concerned enough whether they are in the seismic risk.

Awareness of earthquake prevention can be reflected in the attitudes and behaviors in reducing and preventing earthquake. So some questions are designed to enquire the participants to evaluate the degree of public consciousness on disaster prevention and mitigation. Table 3 presents measurement indexes of earthquake prevention awareness. We set the proportions of all options in a question as weights to calculate the composite average score. In the survey, it was also found that almost all respondents (38.1%) had never practiced an escape route or participated in escape drill. Only (25.23%) often paid attention to fire equipment's and escape routes while (26.67%) just occasionally notice those things. When asked, "Do you know where the urban emergency shelters (e.g hospital, open space) are", (18.1%) of the respondents chose "don't know" and (33.3%) chose "know some of them". Most of the respondents (75%) had no preparation for earthquake at home or in the office. During earthquake most of the respondent be panic and (27.6%) respondents told they start running during earthquake. In addition, all respondents think Earthquake preparedness at home is very important, but most of them 18.1% responded "don't know" about that. One reason for the situation is most people have little awareness of earthquake prevention and don't care about the anti-seismic performance of houses.

4.3 Awareness of Earthquake Prevention

Table 3: Awareness of Earthquake Prevention

		Occupation			
Issues	Parameters	Student	Job	Housewife	Total
Do during earthquake	Watching TV news	2(5.7)	2(5.7)	4(11.4)	8(7.62)
	Panic	7(20)	11(31.42)	18(51.4)	36(34.29)
	Running	12(34.28)	12(34.28)	5(14.28)	29(27.6)
	Do nothing	4(11.4)	1(2.85)	2(5.7)	7(6.67)
	Puzzle	1(2.85)	4(11.4)	2(5.7)	7(6.67)
	Afraid	9(25.7)	5(14.28)	4(11.4)	18(17.14)
	Total	35	35	35	105
Evacuation plans practicing	Often	12(34.28)	20(57.14)	5(14.28)	37(35.23)
	Sometimes	9(25.7)	12(34.28)	7(20)	28(26.67)

*Note: Figures in () indicate %

	Never	14(40)	3(8.57)	23(65.7)	40(38.1)
	Total	35	35	35	105
Fire equipment and escaping routes noticing	Often	12(34.28)	20(57.14)	5(14.28)	37(25.23)
	Sometimes	9(25.7)	12(34.28)	7(20)	28(26.67)
	Never	14(40)	3(8.57)	23(65.7)	40(38.1)
	Total	35	35	35	105
Location of urban emergency shelters understanding	Know all	20(57.14)	30(85.7)	1(2.85)	51(48.57)
	Know some of them	13(37.14)	5(14.28)	17(48.57)	35(33.3)
	Do not know	2(5.7)	0	17(48.57)	19(18.1)
	Total	35	35	35	105
Earthquake preparedness at home	Make enough preparation	6(17.14)	21(60)	18(51.4)	45(42.86)
	Get a little prepared	16(45.7)	12(34.28)	13(37.14)	41(39.04)
	Do not prepare	13(37.14)	2(5.7)	4(11.4)	19(18.1)
	Total	35	35	35	105
Household staff pin well into the wall	Yes	7(20)	29(82.85)	22(62.85)	58(55.25)
	No	28(80)	6(17.14)	13(37.14)	47(44.76)
	Total	35	35	35	105

4.4 Reacting Behavior in Earthquake Emergency

Since the majority of participants are lack of experiences in disasters, emergency response knowledge instead of actual behavior is analyzed. Based on "what-if" scenarios including indoors, outdoors, in the car, emergency responses of the interviewees are investigated on the multiple-choice knowledge test. The results indicate that public understanding on what to do in different places when earthquake happened was basically right. Almost all respondents could choose one or two correct responses in each question. Overall, the respondents performed better on questions regarding reacting behavior in earthquake than basic theory of earthquake. For example, when asked, "where will you hide indoors if an earthquake occurs", a large proportion of the subjects chose the correct responses "under a table or chair" (52.38%), "in the corner" (17.14%), respectively. As seen in Table 4, only a few of them chose the other wrong options "close to the window", "behind the door", "on the bed". However, the proportion of the respondents who chose "run to the outside" is larger than the other wrong options. 82.85% respondents chose correct reacting behavior during earthquake if they are in outdoor. 74.28% respondents stops driving during earthquake although 20.95% don't know what should they do.

Table 4: Reacting Behavior in Earthquake Emergency

		Occupation*			
Issues	Parameters	Student	Job	Housewife	Total
Hide indoors during earthquake	Under a table or chair	18(51.4)	22(62.85)	15(42.85)	55(52.38)
	Close to the window	1(2.85)	0	1(2.85)	2(1.90)
	In a corner	7(20)	5(14.28)	6(17.14)	18(17.14)
	Behind the door	1(2.85)	1(2.85)	1(2.85)	3(2.85)
	On the bed	0	1(2.85)	1(2.85)	2(1.90)
	By the high and hard wardrobe	0	1(2.85)	1(2.85)	2(1.90)
	Run to the out side	8(22.85)	5(14.28)	10(28.57)	23(21.90)
	Total	35	35	35	105

Hide outdoor during earthquake	Do nothing	0	3(8.57)	3(8.57)	6(5.7)
	Close to the buildings	1(2.85)	0	0	1(0.95)
	Run to the open field	27(77.14)	31(88.57)	29(82.85)	87(82.85)
	Run to the road	7(20)	1(2.85)	2(5.7)	10(9.52)
	Jump to the water body	0	0	1(2.85)	1(0.95)
	Total	35	35	35	105
Drive the car during earthquake	Stop driving	26(74.28)	28(80)	24(68.57)	78(74.28)
	Keep on driving	2(5.7)	1(2.85)	0	3(2.85)
	Slow driving	0	1(2.85)	1(2.85)	2(1.90)
	Don't know	7(20)	5(14.28)	10(28.57)	22(20.95)
	Total	35	35	35	105

*Note: Figures in () indicate %

4.5 Requirement for Earthquake Prevention and Risk Reduction

In the question about earthquake information sources, publicity of school, government or relative departments and teachers or experts' explanations is main ways. So (59.04%) of the respondents chose all options for Earthquake information sources. In the choice of platforms, TV and Internet account for a large proportion, which is (15.23%). With the development of the modern society, electronic platforms like TV and Internet are the most commonly methods used in obtaining information, but non-electronic platforms like newspaper and magazine still occupy a certain proportion. Therefore 75.23% respondents chose all options to get information. When asked about the forms of publicity, 38.1% females chose "documentaries", 28.57% chose "disaster knowledge lectures" and 1.90% chose "quiz activities", while only (31.4%) selected "leaflets". The respondents tend to choose interesting and vivid ways to get disaster knowledge. The questionnaire asked the respondents about the effective measures for earthquake prevention and reduction. 46.66% thought the quality and shockproof level of domestic construction should be improved.

21.90% chose improving earthquake prediction ability and 31.4% considered practicing emergency escapes and strengthening the national education crisis. When facing nature disaster, the public always gives more hope to sophisticated facilities and the development of science technology than to personal improvement. Most participants are not satisfied with the present disaster prevention learning. A large proportion of the respondents thought it was necessary to open disaster mitigation courses (70.47%) and practice evacuation plans and escape drills (72.38%). They are eager to more related knowledge and experience on earthquake and other disasters to protect themselves and save the others.

Table 5: Requirement for Earthquake Prevention and Risk Reduction

		Occupation			
Issues	Parameters	Student	Job	Housewife	Total
Satisfaction with the present disaster prevention learning	Satisfied	5(14.28)	2(5.7)	7(20)	14(13.33)
	Not satisfied	20(57.14)	29(82.85)	23(65.7)	72(68.57)
	Somewhat satisfied	10(28.57)	4(11.4)	5(14.28)	19(18.1)
	Total	35	35	35	105
Earthquake information sources	Publicity of school	1(2.85)	1(2.85)	2(5.7)	4(3.8)
	Government or relative department	7(20)	9(25.7)	15(42.85)	31(29.52)
	Teacher's or expert's explanation	2(5.7)	5(14.28)	1(2.85)	8(7.62)
	All	25(71.4)	20(57.14)	17(48.57)	62(59.04)
	Total	35	35	35	105
Platforms the respondents use to get information	TV and internet	3(8.57)	7(20)	6(17.14)	16(15.23)
	News paper	1(2.85)	1(2.85)	7(20)	9(8.57)
	Magazine	0	1(2.85)	0	1(0.95)
	All	31(88.57)	26(74.28)	22(62.85)	79(75.23)
	Total	35	35	35	105
Forms of	Documentaries	13(37.14)	13(37.14)	14(40)	40(38.1)

publicity					
	Disaster knowledge lectures	12(34.28)	10(28.57)	8(22.85)	30(28.57)
	Quiz activities	1(2.85)	0	1(2.85)	2(1.90)
	Leaflets	9(25.7)	12(34.28)	12(34.28)	33(31.4)
	Total	35	35	35	105
Effective measures for earthquake prevention and reduction	Quality and shock-proof level of domestic construction should be improved	16(45.7)	15(42.85)	18(51.42)	49(46.66)
	Improve earthquake prediction ability	8(22.85)	8(22.85)	7(20)	23(21.90)
	Practicing emergency escapes and strengthening the nation education crisis	11(31.42)	12(34.28)	10(28.57)	33(31.4)
	Total	35	35	35	105
Altitudes of opening disaster mitigation courses	Need	24(68.57)	33(94.28)	17(48.57)	74(70.47)
	Don't need	3(8.57)	1(2.85)	3(8.57)	7(6.67)
	Don't know	8(22.85)	1(2.85)	15(42.85)	24(22.85)
Altitudes of practicing evacuation plans escape drills	Need	28(80)	35(100)	13(37.14)	76(72.38)
	Don't need	2(5.7)	0	4(11.4)	6(5.7)
	Don't know	5(14.28)	0	18(51.42)	23(21.9)

	Total	35	35	35	105

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Integrated Water Resources Management

Title: Application of GIS and RS to Monitoring Bar Dynamics and Channel shifting of the Padma-Jamuna Confluence in Bangladesh

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1. Introduction

Bangladesh is a riverine country with hundreds of rivers overlaying its landscape. The rivers of Bangladesh are morphologically dynamic characterized by erosion and sedimentation, which results in changes in hydraulic geometry; plan form and longitudinal profile of the rivers (Habibullah, 1987). Flood is one of the main causes for riverbank erosion and almost every year flood attacks the country (Islam, 2010). Statistically, during regular flood, about 26,000 sq. km (18% of Bangladesh) are flooded and during severe flood, it exceeds 55% of the total area of the country (Banglapedia, 2015). The natural setting of Bangladesh between the Himalayas and the Bay of Bengal, together with the meteorological characteristics of the tropical monsoon are responsible for the prevalence of flooding and river bank erosion in Bangladesh (Elahi, 1991b). The Padma and the Jamuna are two of important three rivers in the context of water navigation, irrigation, fishing and fresh water for downstream areas. Beside this, those are the rivers of erosion of riverbank and deposition of sandbank. The catchment area of these rivers is about 1.65 million km^2 of which only 7.5% lies within the borders of Bangladesh (Sarker *et al.,* 2003). This catchment annually generates 120 million ha-m of runoff, only 10% of which is generated within Bangladesh. In addition to vast quantities of water, these rivers carry about 1.1 billion tons of sediment every year (CEGIS, 2000; Sarker *etal., 2003).* The large discharges and heavy sediment loads carried by these rivers result in highly variable and dynamic channel morphologies characterized by rapid adjustments to the cross-sectional geometry, bank line positions and plan form attributes (Coleman, 1969). Year after year, erosion, deposition and extension of sandbanks cause channel migration. The Padma-Jamuna confluence is highly dynamic and constantly changing their channel, which ultimately affects all aspect of the adjacent floodplains. Remote Sensing (RS) and Geographical Information System (GIS) technologies are widely used tools for dynamic physical environment change detection and monitoring (Andrea *et at.*, 2001; Ahmed, 2002; Stabel and Loffler, 2004; Twumasi and Merem, 2006; Islam, 2009a). In this context, it is very important to investigate the effects of hydraulic parameters in the Padma-Jamuna river and how erosion and accretion cause changes on the confluence and its channel. Geographical Information System and Remote Sensing technologies are very effective to find out the river morphological change.

1.2 Aim and objectives of the Research

The main aim of this study is to investigate the bar dynamics and channel shifting of the Padma-Jamuna confluence in Bangladesh. To meet the aim of this research several specific objectives are given below:

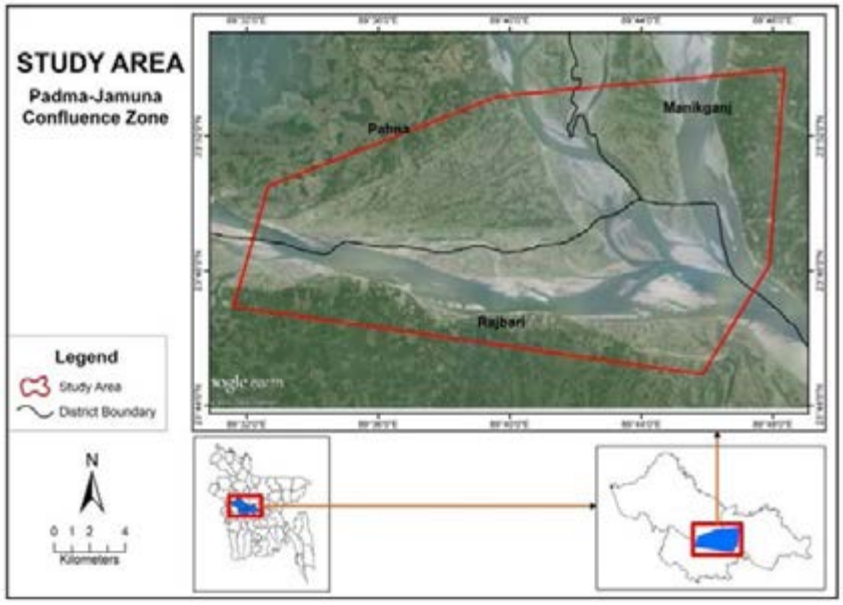
h) To find out the hydrological characteristics of the Padma-Jamuna confluence;

i) To analyze the bar dynamics of the study area; and

j) To examine the channel dynamics due to bar development in the study area.

2. Study Area

The mother river of the Padma is the Ganges that is originated at the Gangotri. The part of the Ganges that crosses to Bangladesh is called Padma. The Padma is about 120 km long and 4-8 km width. The mother river of the Jamuna is the Brahmaputra that is originated from the Chemayung-Dung glacier. The part of the Brahmaputra that crosses to Bangladesh is called Jamuna. The Jamuna is about 205 km long and 3-18 width. The Padma and the Jamuna join together at Goalanda thana of Rajbari district and then flow as Padma River until it joins the Meghna River at Chandpur in Bangladesh. The rest of the way, it flows as the Meghna River into the Bay of Bengal (Banglapedia, 2015). The Padma and the Jamuna river confluence at Chandpur is the study area of this research (Fig. 1). The study area is situated at tropical region. Average rainfall is about 15 cm to 20 cm per year. The average temperature in the dry season is 17^0C to 18.5^0C. The geology of this area is flooded and delta plain land with peat, silted, acidic brown and grey soil (Haque*et al., 2008*; Islam*, 2009).*



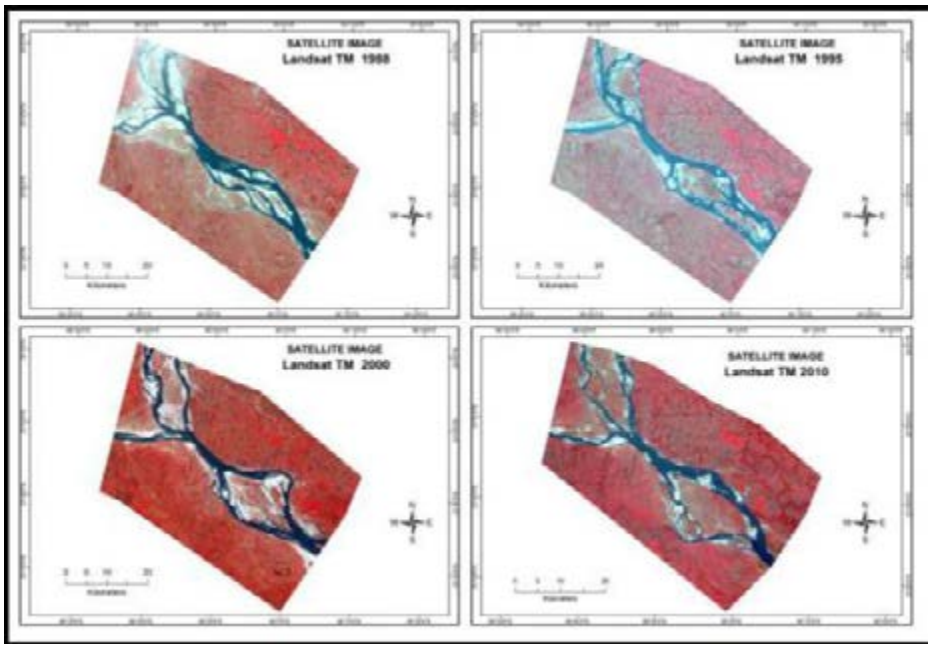
Source: Google Earth Image, 2015

Figure1: Study area of Padma jamuna confluence in Bangladesh

3. Data Source and Methodology

Landsat imagery is used in this study as main data source. The spatial resolution of Landsat imagery is sufficient for river morphological analysis particularly identify and monitor the dynamics of river systems, migration of the confluence, movement of river channels, and eroded and deposited riverbanks (Priestnall

and Aplin, 2006). Time series (1988, 1990, 1995, 2000, 2005 and 2010) Landsat TM images with 30 m resolution has been used to detect the bar dynamics and channel change of the Padma-Jamuna confluence and its adjacent areas (fig. 2). All of these satellite images are collected from USGS Earth Explorer.com. Flow regime of the Padma-Jamuna confluence is investigated by various recorded hydrological parameter data such as water level data from 1998 to 2014 and discharge data from 2000 to 2014. All the collected information and data from various sources is analyzed by different method with the help of different GIS and RS software. Accretion and erosion on the Padma-Jamuna confluence has been determined by ArcView 3.3 and ArcGIS10.2.1. Various types of physical features such as bar, bank lines, rivers, erosion, accretion etc. can be identified and analyzed by Erdas imagine 2011. Statistical analysis average, mean, maximum, minimum, range etc. have been calculated and various types of representation such as data table, line graphs, column diagrams etc. have been produced. Finally dynamics of river systems, migration of the confluence and river channel pattern are mapping and analysis.



Source: USGS Earth Explorer.com

Figure 2: Landsat TM images 1988, 1995, 2000 and 2010

4.Results

4.1 Hydrological characteristics of the study reach

4.1.1 Variation of Water Level Data

The Jamuna and the Padma are the rivers with peculiar characteristics i.e. heavy water flows in the monsoon but less in the dry season (winter). The Jamuna has a lot of islands which are inundated in the monsoon in normal water level. Due to the heavy water flow in the monsoon and flood, the locations of the Jamuna River channel are always changing. The same phenomenon is also observed for the Padma (Islam, 2010).This research focused on the hydrological parameters (water level and discharge) which are related with the dimension of river, spatial and temporal shifting of the bank lines and the changes of associated bars due to geomorphic processes (erosion and accretion).Water level and observed discharge was analyzed by the time series of statistical data from 1998 to 2014. Data was collected from the Bangladesh Water Development Board (BWDB).Water level and discharge data at two stations, Aricha in Jamuna River and Baruria in Padma river has been analyzed yearly, monthly and season wise. In the (table 1 and table 2) has shown the season wise data.

Table 1: Season wise water level at Aricha gauging station

Year	Dry season	Pre monsoon	Monsoon	Post monsoon	Average
1998	3.54	3.81	8.98	6.56	5.72
1999	3.36	3.43	8.42	6.88	5.52
2000	3.09	3.77	8.64	5.74	5.31
2001	2.97	3.23	8.04	6.41	5.16
2002	2.98	3.99	8.25	5.95	5.29
2003	3.25	3.63	8.59	7.10	5.64
2004	3.36	2.86	8.18	6.50	5.23
2005	3.30	4.28	7.90	6.58	5.52
2006	3.19	3.72	8.31	6.01	5.31
2007	3.25	3.73	8.65	6.26	5.47
2008	3.31	3.71	8.37	5.95	5.33
2009	3.07	3.35	7.27	5.80	4.87
2010	3.01	4.42	8.39	6.46	5.57
2011	3.23	3.78	8.22	5.97	5.30
2012	3.35	3.89	8.07	6.20	5.38
2013	3.31	3.76	8.03	6.21	5.33
2014	3.10	3.51	7.70	5.73	5.01

Source: BWDB, 2015

Water level and discharge have a great impact on erosion and accretion of river and adjacent floodplain. More erosion occurs in the river bank when river go on with high water level, energy increases and high water discharge. There is progressive correlation between water level and discharge with erosion. Reduce of water level and discharge show negative contact on erosion. On the other side accretion takes place while river drop energy. Low energy, low discharge and low water level conduct large scale accretion on the river bank and floodplain. Mainly more deposition occurs because of low discharge and low water level. As a result, decrease of water level and discharge in the river show positive impacts on river bank accretion and increases of water level and discharge in the river show negative effect on accretion. Season wise average water level at Baruria gauging station has shown in (table: 2)

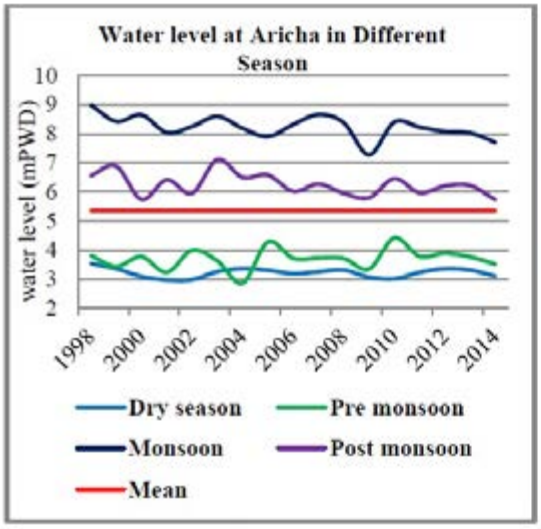
Table 2: Season wise water level at Baruria gauging station

Year	Dry season	Pre monsoon	Monsoon	Post monsoon	Average
1998	2.76	3.21	7.90	6.05	4.98
1999	2.65	2.66	7.39	5.97	4.66
2000	2.38	3.01	7.60	4.99	4.49
2001	2.21	2.48	6.93	5.44	4.26
2002	2.14	2.70	6.97	4.95	4.19
2003	2.35	2.67	7.36	5.93	4.58
2004	2.56	3.93	7.73	5.45	4.92
2005	2.30	3.29	7.04	5.43	4.52
2006	1.97	2.54	6.94	4.76	4.05
2007	2.08	2.62	7.54	5.41	4.41
2008	2.23	2.64	7.33	4.92	4.28
2009	2.34	2.64	6.28	4.94	4.05
2010	2.26	3.60	7.41	5.46	4.68
2011	2.44	2.89	7.04	5.01	4.35
2012	2.52	2.97	7.10	5.19	4.44
2013	2.50	2.87	6.95	5.17	4.37
2014	2.43	2.90	6.64	4.88	4.21

Source: BWDB, 2015

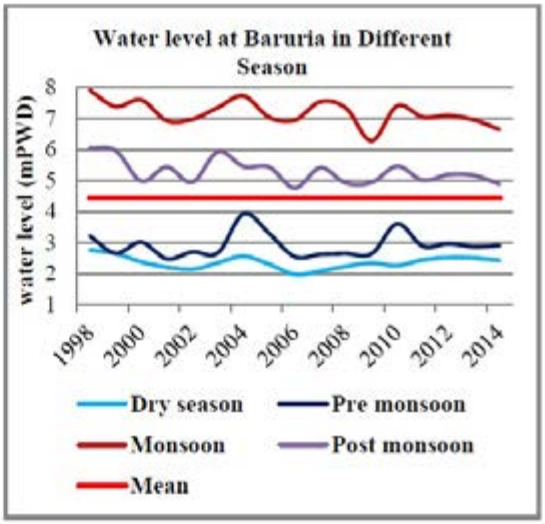
Based on the data peak water level can be found in monsoon season and low flow observed in dry season in all year. Maximum water level has been found 8.98 mPWD all over the year at two stations that observed in 1998 at Aricha gauging station and minimum water level has found 1.97 mPWD all over the year that

observed in 2006 at Baruria gauging station. On the other hand at Baruria gauging station highest water level peak has found 7.90 mPWD in august 1998 in monsoon season and the lowest water level is 1.97mPWD in February 2006 which found in dry season. In the Aricha gauging station minimum water level has found 2.97 mPWD in the year of 2001. Average water level at Aricha and Baruria gauging station in different year has shown in (fig: 3 and 4).



Source: BWDB, 2015

Figure 3: Water level at Aricha in different season



Source: BWDB, 2015

Figure 4: Water level at Baruria in different season

Mean water level of Aricha station has found 5.35 mPWD. On the other hand mean water level of Baruria gauging station has found 4.44mPWD. Maximum water level has found 9.86mPWD among all over the year it was occurred in 1998 and minimum water level was 2.45 mPWD all over the year that observed in 2001 at Aricha gauging station. Maximum water level at Baruria gauging station was 8.74 mPWD among all over the year it was occurred in 1998 and minimum water level was 1.51 mPWD all over the year that observed in 2006. The analysis shows the variation between both of the two stations. In every year water level of Aricha was more than the water level of Baruria (fig: 5) and (table: 3).

Table 3: Average water level at Aricha and Baruria

Year	Average Water level at Aricha	Average Water level at Baruria
1998	5.92	5.14
1999	5.65	4.78
2000	5.55	4.71
2001	5.30	4.39
2002	5.62	4.36
2003	5.77	4.70
2004	5.87	5.11
2005	5.63	4.77
2006	5.50	4.24
2007	5.67	4.59
2008	5.54	4.48
2009	4.99	4.16
2010	5.73	4.85
2011	5.49	4.52
2012	5.30	4.60
2013	5.48	4.52
2014	5.17	4.49

It has occurred because Aricha is situated upstream than the Baruria. Comparing the values for both stations at upstream and downstream with a common denominator water level is remarkable. From the hydrographs it

is clear that monthly and yearly water level of Aricha is very high than Baruria. Respectively Aricha and Baruria revels 5.54 and 4.61 average water level in 1998-2014.

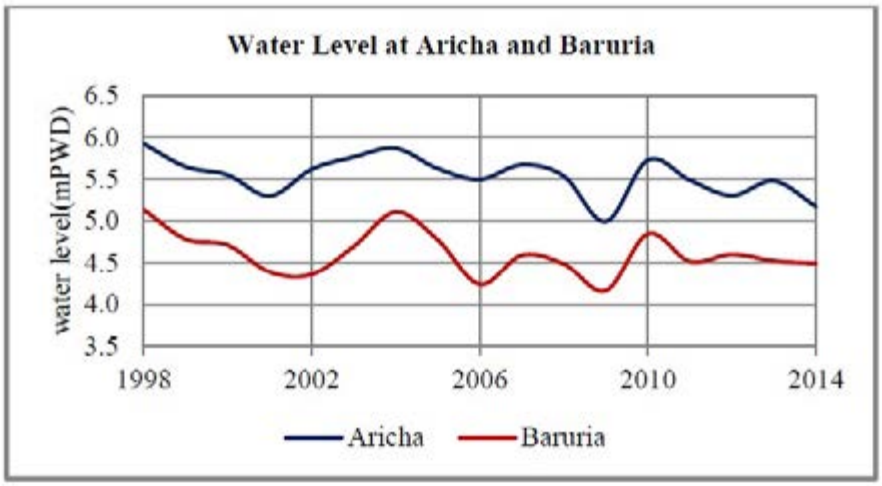


Figure 5: Comparison of average water level between Aricha and Baruria Gauging Station

4.1.2 Dynamics of the discharge data

The average of every year discharge data of Baruria transit exposes that discharge gradually increases in the month of July, August and September. Discharge data has been analyzed monthly, yearly and season wise. In the table 4 season wise average discharge has shown.

Table 4: Season wise average water discharge at Baruria gauging station

Year	Dry season	Pre monsoon	Monsoon	Post monsoon	Average
2000	9655.00	9212.83	57552.39	21484.21	24476.11
2001	7690.88	6776.92	52678.98	44022.92	27792.43
2002	9322.88	10783.07	60278.22	27896.49	27070.16
2003	7018.83	8914.69	64701.69	39823.38	30114.65
2004	8290.08	11012.54	48239.61	36583.12	26031.34
2005	7949.54	12609.06	57268.36	35577.64	28351.15
2006	6869.83	9132.30	45639.45	21149.01	20697.65
2007	4597.12	10966.26	34329.77	*	16631.05

2008	9481.25	9457.42	68946.63	25254.23	28284.88
2009	8077.83	*	45780.85	25010.65	26289.78
2010	7256.25	16424.97	56817.93	25968.13	26616.82
2011	6398.83	10003.71	63010.90	*	26471.15
2012	7103.51	10607.47	57737.95	37072.58	28130.38
2013	*	4796.12	58750.58	32012.56	31853.09
2014	7363.87	9293.12	48472.03	21348.45	21619.37

*missing data

Source: BWDB, 2015

Based on the data it has found that season wise average discharge very low in the year of 2007 and it is 4597.12m³/sec, in 2008 we can see the maximum water discharge. In 2008 water discharge is68946.63m³/sec, in the year of 2000 to 2003 discharge start to increase rapidly and then it was fall in the year of 2006 and 2007. The average discharge was 26073.39 m³/sec; .Seasonally water discharge also varied. The variation of discharge within the year and month of the confluence is unbalanced (fig: 6).

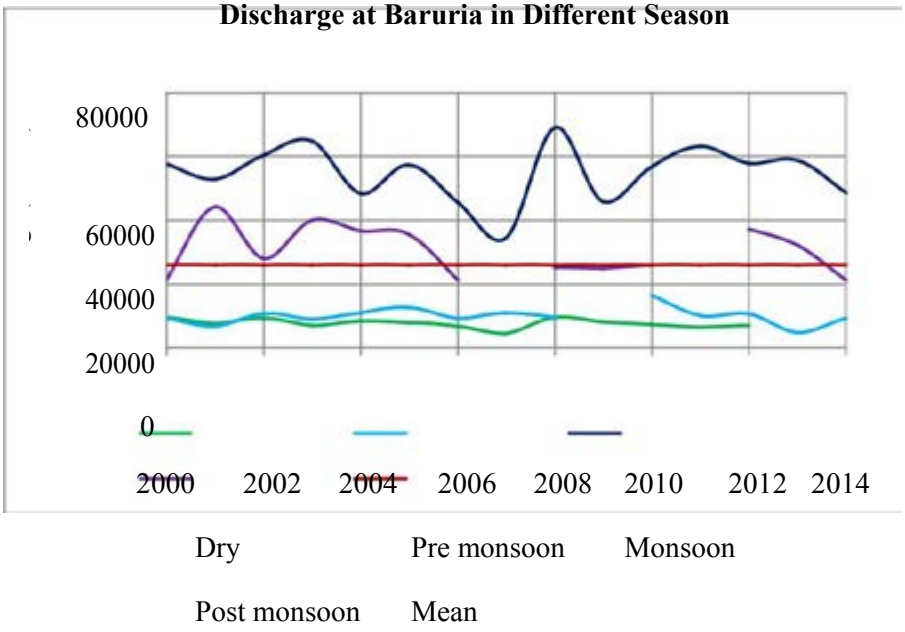


Figure 6: Season wise water discharge at Baruria in 2000-2014.

4.2. Bar dynamics of the study site

Bars are bed forms with lengths or spacing that scale with channel width (A.S.C.E. Task Force 1966; Bridge 1985, 1993; Carling, 1999). A comparative study in between 1988-2000, 2000-2005, 2005-2010 and 1988-2010 has been done to analyze bar development of the study(fig:7).

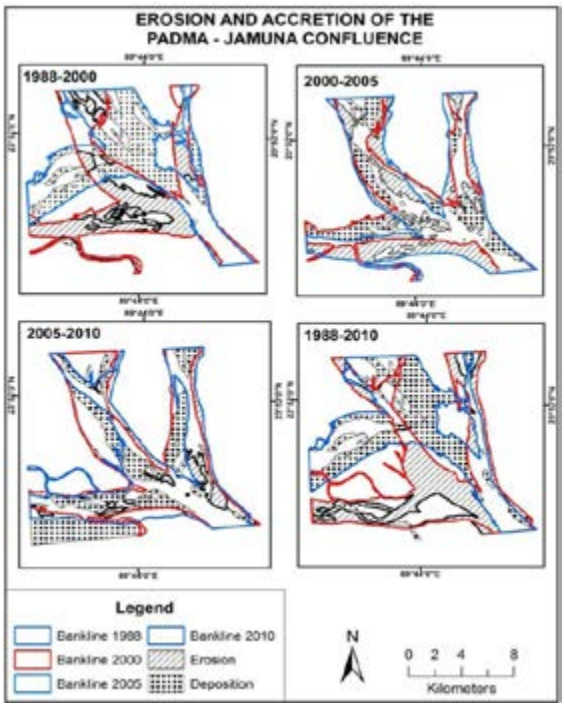


Figure 7: Erosion and Accretion of the Padma jamuna confluence in different years.

Braided and meandering jamuna and Padma River is intermediates dynamic with bar and flood plain development, mainly young floodplain surfaces. Erosion and accretion can observe through the spatio temporal variation of the study reach. Accretion and erosion areas have identified by overlapping river banks.

River channel width decreases because of accretion. Channel width increases when erosion occurred. Padma Jamuna confluence is relatively large in relation to the present flow regime. Disconnection and reconnection of former channels to the main channel bring the major changes of the development of the bar or island. The river channel may be changed and the bar or island may be periodically modified by floods and discharge. Bars are not stable and stationary. Long term floodplain evolutions are determined by discharge and channel morphology (lane and Richards, 1997). Table 5 shows the erosional and depositional features of the Padma Jamuna confluence.

Table 5: Erosion, accretion and difference of the bar development

Year	Erosion (sq.km)	Deposition (sq.km)	Difference
1988-2000	35.72	39.8	+4.08
2000-2005	35.35	26.36	-8.99
2005-2010	13.55	47.58	+34.03
1988-2010	39.71	43.6	+3.89

Because of various morphological and hydrological causes some where it eroded and somewhere sediment deposited in the bank. In this table it was observed that in different years erosional and depositional features are different.

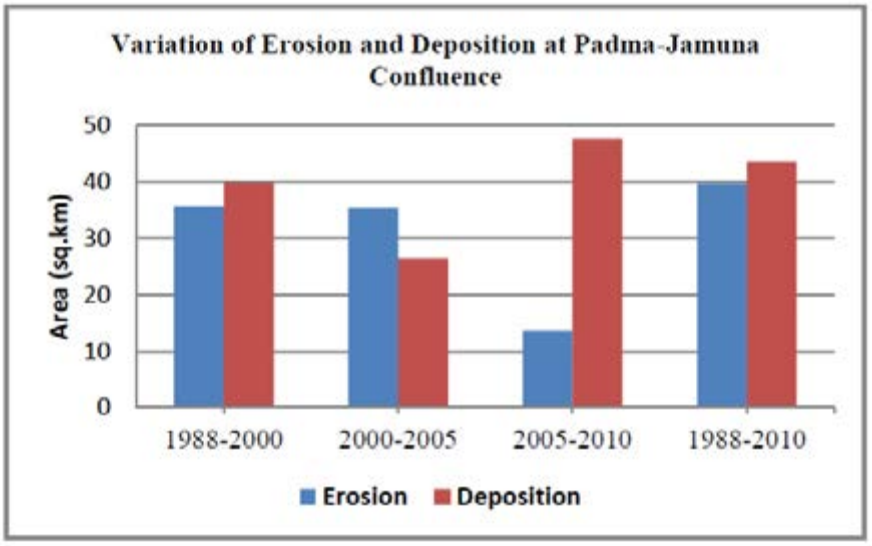


Figure 8: Dynamics of erosion and accretion in different years

In the table 5 it was observed that maximum erosion occurred in the year of 1988 and maximum deposition was occurred in the year of 2010.erosion and accretion difference more in the year of 2005-2010 and it was +34.03. Negative difference was found in the year of 2000-2005 and it was -8.99. Minimum erosion was occurred in the year of 2005 and minimum deposition was occurred the year of 2005 and it was 26.36 sq. km (Table 5).

4.3. Channel Shifting due to Bar Development

Continuous shifting of the thalweg from one position to another has been occurred within backlines. Observation of satellite image for 1988, 1990, 1995, 2000, 2005, and 2010years are usually used to compare the channel shifting from the study reaches. For the each of morphological analysis total study reach is divided in to five cross sections and these are XS-1, XS-2, XS-3, XS-4, and XS-5. All of these cross sections

are located at different absolute and relative location. The bank line of different year's interval from has drawn from satellite images. The natural channel pattern varies over a larger range of time and space scales. The analysis of the bank line shifting from different cross section exposes that Padma jamuna Confluence continuously changes its plan form through shifting of the channel. It also indicates the erosion and accretion level at different cross section (Fig: 9 and 10).

Due to the erosion and deposition on the channel of Padma jamuna confluence is considered as a braided pattern. Braided rivers are characterized rapid rates of erosion and deposition and frequent channel and braid belt avulsion (Bridge, 1996). Satellite images provide a comprehensive spatial and temporal analyses and coverage of channel change, related hydraulic processes in large braided river (Bristow, 1997 and Thorne *et al.,* 1993).

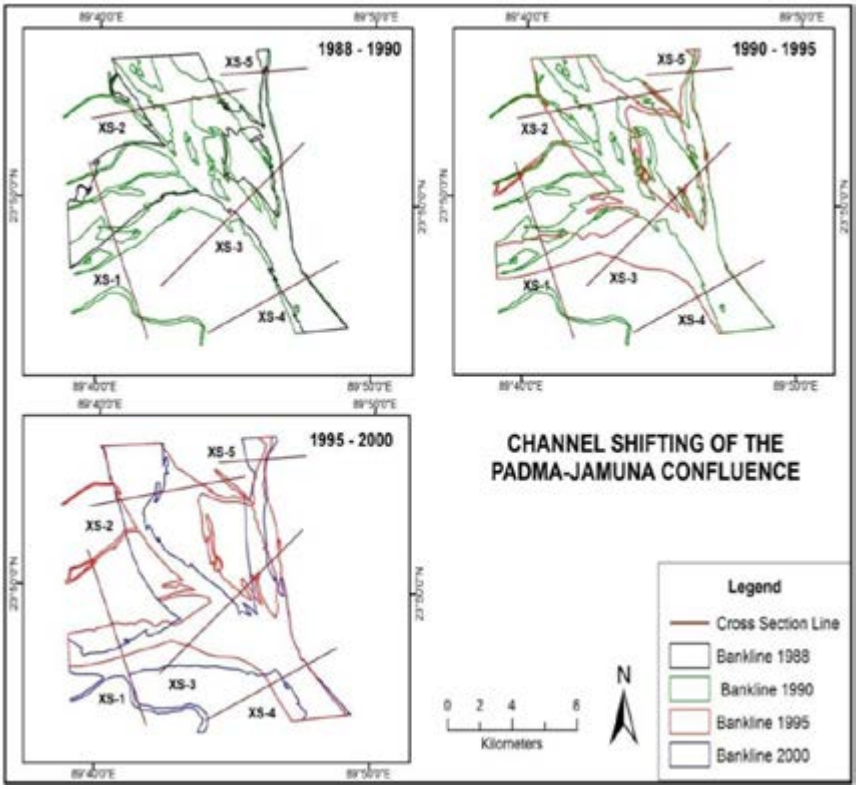


Figure 9: Channel shifting of the Padma jamuna confluence in different years

Study reach of the Padma jamuna confluence changed along the cross section at different time period. Again it can also say that river channel has changed in a particular time period at different cross section. Due to natural processes bank erosion, down cutting and bank accretion an alluvial river has changed.

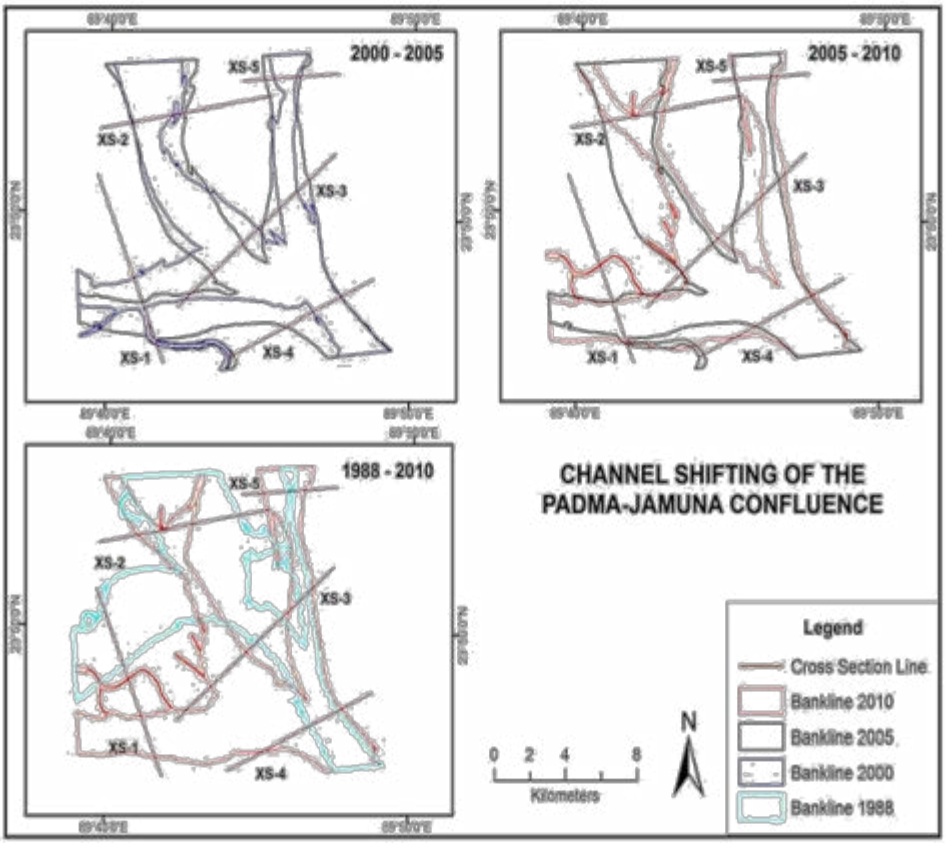


Figure 10: Channel shifting of the Padma jamuna confluence in different years

4.3.1. Confluence Shifting at a Glance

The Padma jamuna confluence has been shifted in the context of local space and time frame. This shifting occurred due to various hydrological and morphological reasons. Regular erosion, deposition, sedimentation and flow variation in a natural river channel occur a spectrum of time and spatial scales. Various fluvial processes are associated with the development of river pattern and configuration. Regular erosion, deposition, sedimentation and flow variation in a natural river channel occur a spectrum of time and spatial scales. Various fluvial processes are associated with the development of river pattern and configuration. Channel widths at different cross section are given below in the (table: 6)

Table 6: Channel width at different cross section in different year

Cross Section	Channel width (km)				
	1988	1995	2000	2005	2010
xs-1	3.17	1.82	1.58	1.97	2.1
xs-2	4.84	5.25	2.84	2.9	3.12
xs-3	3.76	7.36	8.18	8.42	9.2
xs-4	1.73	2.5	1.74	3.46	4.89
xs-5	0.4	0.3	1.22	2.14	2.15

In the table 6 it was observed that in different year channel moved in the different direction in the Padma jamuna confluence. Because of channel movement confluence also moved in different direction in different year. In the cross section 3 channel width increases gradually, and in the year of 2010 channel width is maximum (table 6).In the cross section 5 channel width gradually increases from 2000-2010. Similarly in the cross section 4 channel width also increases gradually (Figure 11).

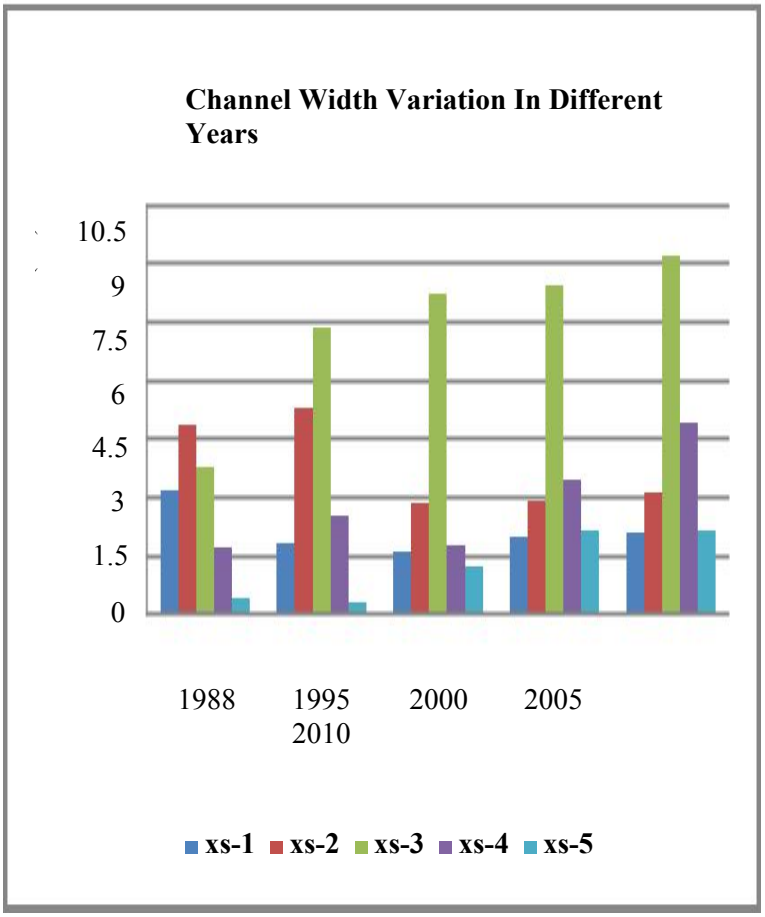


Figure 11: Channel width variation in different years

5. Conclusion

Bangladesh is situated at the downstream of the Padma and the Jamuna with flood plain flat land. So migration of river channel of the Padma and the Jamuna is quite normal phenomenon. But river channel migration of the Padma and the Jamuna is occurred too fast. The movement of river channel of the Jamuna is faster than the Padma that is shown in this study since 1988 to 2010 using RS and GIS. This causes lot of cost, destroy land property, damage agricultural products, disrupt water navigation etc. River channel migration, erosion and deposition of riverbank are one of the foremost natural disasters responsible for poverty of Bangladesh. It has the great impact on rural unemployment in Bangladesh. Regular monitoring of riverbank line, understanding the trend of river channel migration and strategies setting for adaptation on probable effect could minimize potential risk and loss.

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Title: Salinity Problem in Groundwater in Shariatpur District, Bangladesh

Arpan Paul, Dr. M. A. Matin

1. Introduction:

Bangladesh is a tropical riverine developing country of South-Asia having 158.5 million people, out of which the percentage ratio of male and female is 104.5:100. The population density of this country is one of the highest in the world which is almost 1035 persons per square kilometer.(Source- Bangladesh Bureau of Statistics Report-2015,BBS)Bangladesh has a tropical monsoon type of climate, with heavy summer rain and high summer temperatures. People of Bangladesh are made up of an ethnically mixed society with a vibrant and living heritage descending from the 3000 year old Indo-Aryan civilization. (Source-Banglapedia). Water supply is the provision of water by public utilities, commercial organizations, community endeavors or by individuals, usually via a system of pumps, pipes or point sources. It is one of the vital needs of people in their day to day life and is different for Rural and Urban areas. The people of Bangladesh are facing a lot of problems among them availability of fresh, pure drinking water is most important. (Source-Annual Report-2014,DPHE). Based on a case study on Rural Water Supply in Shariatpur District- salinity problem in groundwater has identified as one of the major issue in the field of fresh drinking water supply to local people. The source of pure drinking water is mostly deep tube well. Water of deep tube well is saline which is aesthetically unacceptable. But many of the village people have to drink that saline water as no other options is nearby which is not susceptible.

2. Methodology:

This study was done mainly based on Data collection and analysis of them based on field visit to study area for questionnaires survey and Focus Group Discussion for primary data collection and secondary data is collected from Department of Public Health and Engineering(DPHE) Local office and Website.

2.1. *Study Area Selection*:

Shariatpur – a district in Dhaka Division of central Bangladesh has six Upazillas. Goakhola and Kailara village of Darul Aman Union and Sidya village of Sidya Union of Damudya Upazilla was selected as study area. The reason behind this selection is Kailara is my village and I came to know about the salinity problem in deep tube-well water while staying there.

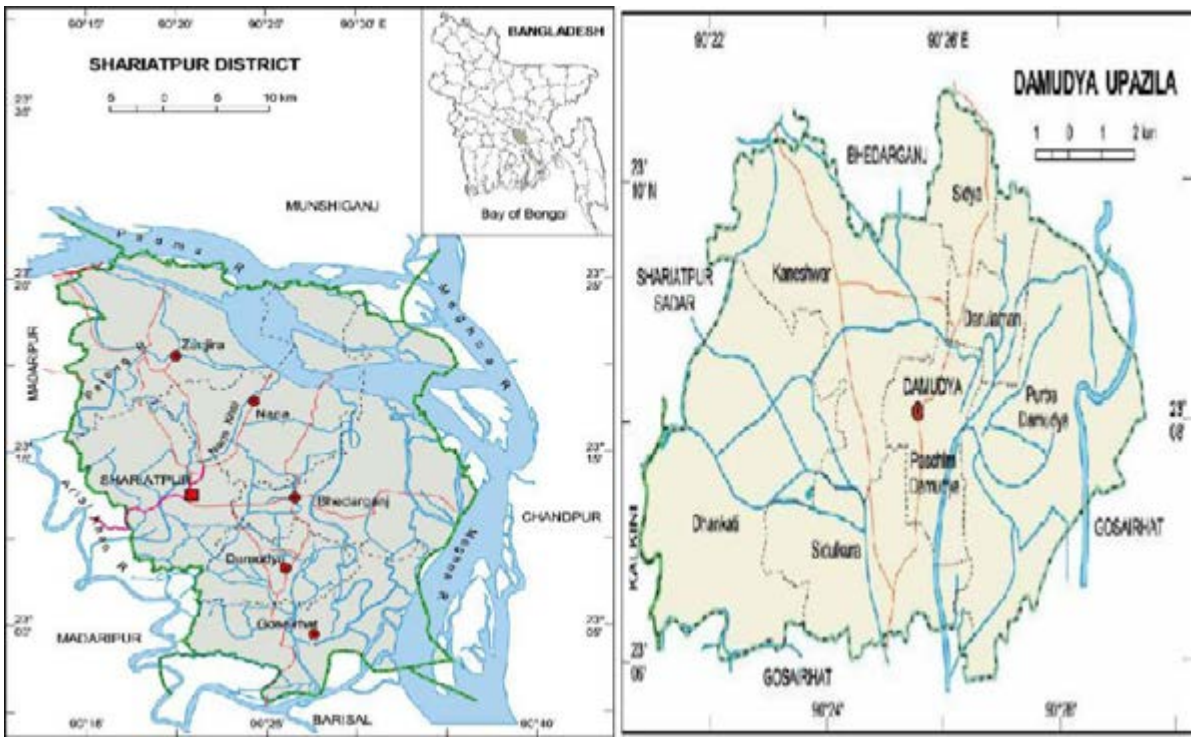

Fig-1: Study Area Damudya Upazilla of Shariatpur District

2.2. *Field Visit and Primary Data Collection:*

20th February, 2014, I reached my study site in a quest to collect necessary information and primary data collection. The source of water is surface water (e.g. pond, khal, river) and groundwater (e.g. deep tube-well no. 6, Tara tube-well, shallow tube-well). Village people depend on this source of water for irrigation, domestic and drinking purpose.

Fig-2: Source of Surface Water (photos taken during field visit)

Fig-3: Source of Groundwater (Deep Tube well No. 6)

Questionnaires survey had been done among the local people to know about their problems, their needs in respect to drinking water supply. People were very friendly, very spontaneous and discussed about my questions elaborately while taking personal interviews.. They spoke and discussed about their needs and wants and gave their suggestions to find out the necessary solutions of their existing problems for drinking potable water supply.

Fig-4: Taking Personal Questionnaires Interview from Different Classes People

Focus Group Discussion (FGD is an important social technical tool of collection and assessment of primary data during and field survey) was done among people which is essential after Questionnaires Survey to individuals. Discussion and Debate among people on certain issues cleared my view about their problems and wants for drinking water supply.

Fig- 5: Focus Group Discussion (FGD) during field visit

2.3 Secondary Data Collection:

Secondary data was collected from Department of Public Health Engineering(DPHE) Local Office and Website (http://www.dphe.gov.bd) . From Rural Water Supply database of DPHE website the information about point sources(Deep Tube well) like Point Source ID, Owner's Name, Location of Point source, Depth of installation, amount of Chloride(Cl-) which is the indicator of salinity, geological log record of a point source, Technological Option Map, Lowest Water Table Map were collected. Most of the Point sources are installed by DPHE with the help of UNICEF.

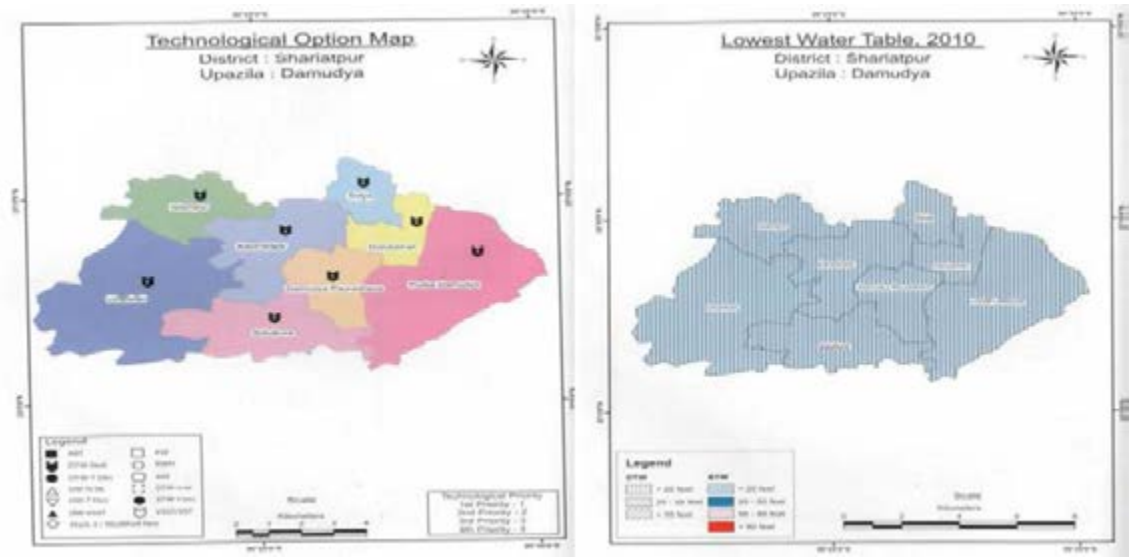

Fig-6: Technological Option and Lowest Water Table Map of Damudya Upazilla (Source-DPHE)

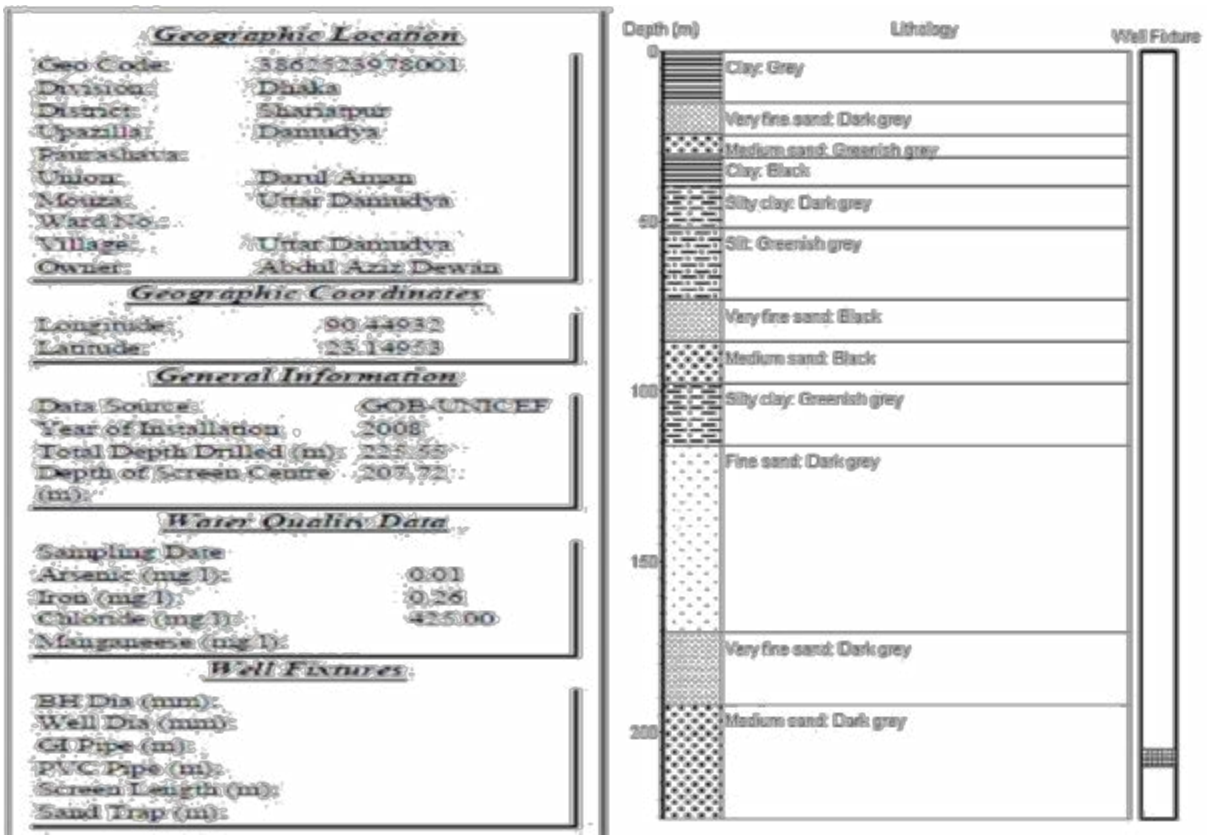

Fig-7: Geological Log Record of a Point Source with Geographic Location, General Information and Water Quality Data (Source-DPHE)

3. Results and Discussion

Based on analysis of primary and secondary data the problems identified are enlisted below:

5. Shallow Tube well water is contaminated with arsenic, as a result it cannot be as drinking water.
6. Deep Tube well water is saline which is not suitable for drinking.
7. Location of point source of water is not close for some villagers and people especially women facing difficulties in fetching water.
8. Surface water source(like pond, canal etc) is not clean, used in fish culture mostly, aesthetically not suitable for drinking purpose to some villagers.
9. Surface water source is not available in dry season.

10. Point source of water remains inactive due to careless use of it resulting breaking parts of tube well. From questionnaire survey and Focus Group discussion an important point came out which was- Deep tube well was not installed deep enough as per installation instruction. They mentioned it as a form of corruption but office of DPHE strongly ignored it. Depth vs. salinity was plotted in graph and it was seen that concentration of chloride decreases with the increase of depth. The salinity of groundwater is less where Deep Tube Well is installed at more depth, approximately greater than 225m So, it is one of the major findings of this case study.

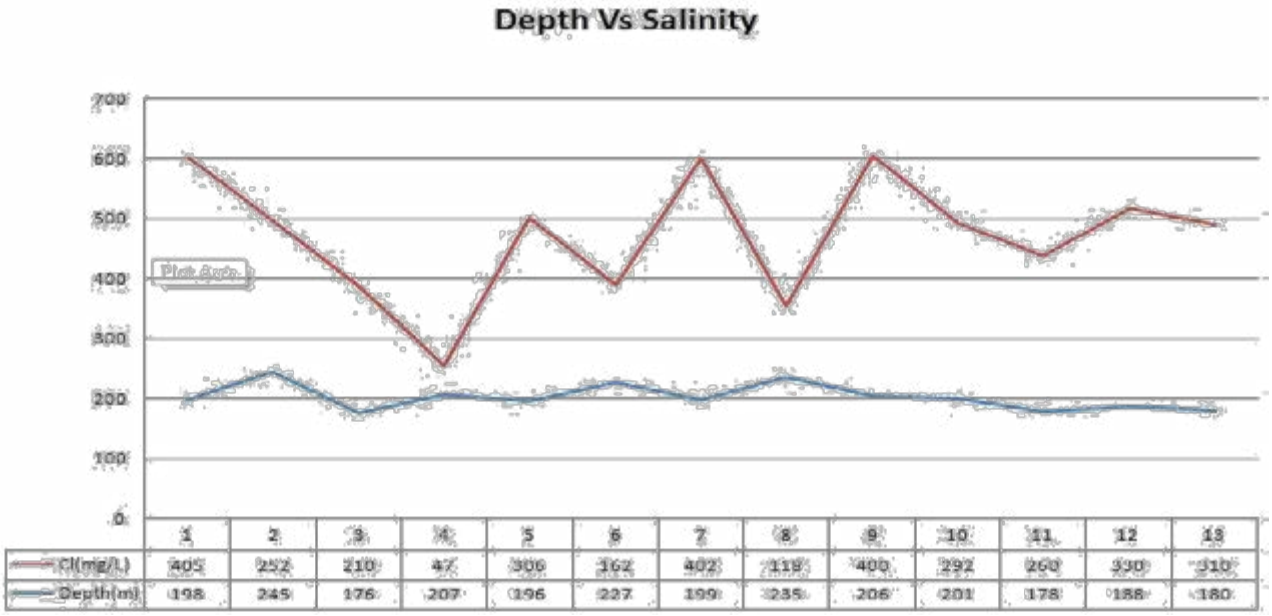

Fig-8: Depth vs. Salinity Graph for Kailara Village, Damudya Upazilla

From the collected water quality data of different point source of water (tube well) -it is found that the concentration of Chloride ion in water varies from 45-420 mg/L. The standard of Chloride ion concentration in Bangladesh for saline water is 150-600 mg/L according to DPHE. So, it can be mentioned that water extracted from Deep Tube well is very saline and it is not suitable for drinking.

The solutions of the existing problems wanted by local people according to my personal assessment is enlisted below:

1. Deep tube well should be installed as per installation depth assessed by UNICEF and DPHE.

2. More Tube well should be installed as per villagers demand. At least one tube well should be installed in a radius of 25m. Then it will be easier for women to fetch water.

3. Proper care should be taken of the tube wells while using it and it should be used as per user manual to avoid any interruption or inactiveness of those point sources of water. Local schools can give lessons on this to the students.

4. Costing of water should have to be implemented and collected properly from the consumers.

11 Saline water treatment plant should be implemented and installed by the Government , Non-government Organizations.

- Rain Water Harvesting project should be implemented in nuclear basis for individual use.
- Union/Mouza based Development Plan and project should be taken in personal level for better rural water supply.
- To use shallow tube well water -arsenic reduction plant and filter should be provided to people.
- Proper Groundwater recharge should have been ensured for availability of water in the dry season by following a well assessed and planned groundwater and aquifer management.
- The local Government bodies have to play an important role to provide sufficient and potable drinking water to the rural people.
- Desalination of water is needed for the betterment of saline water quality.

Desalination of water is mentioned as cost ineffective in respect to Bangladesh. Low cost based desalination plant should have to be implemented for the sake of fulfilling the demand of fresh sweet drinking water for villagers of Damudya Upazila. A sketch of combined desalination and rainwater harvesting plant proposed by myself is enclosed here:

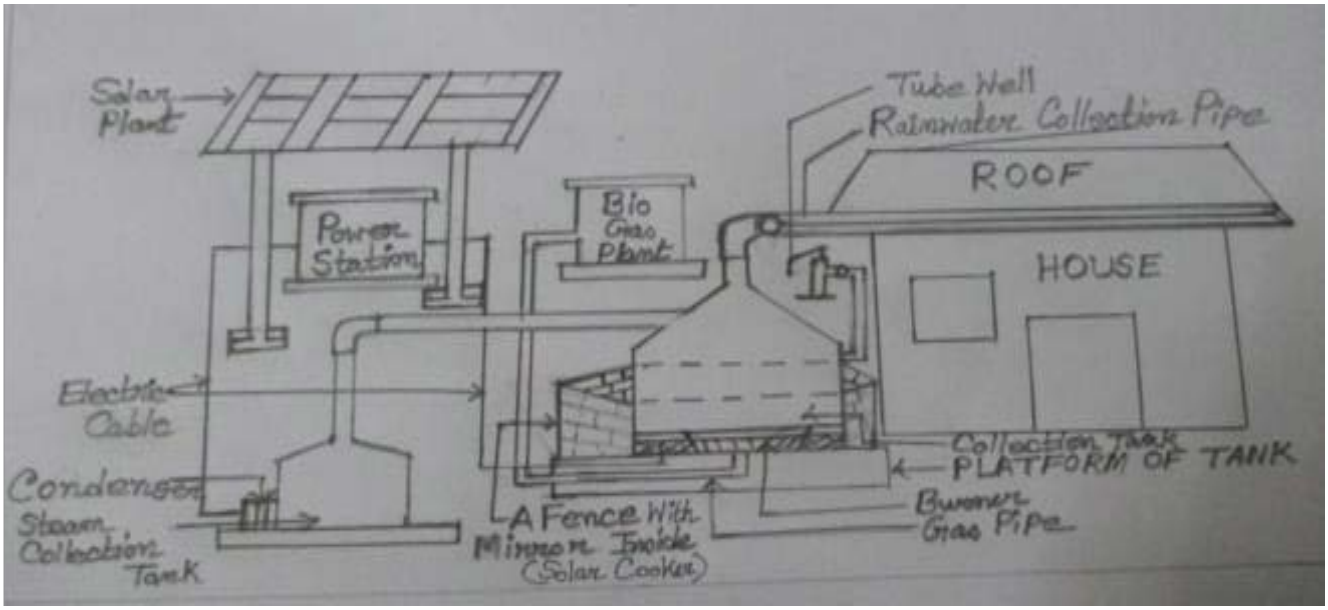

Fig-9: Combined Desalination and Rainwater Harvesting Plant

4. Conclusion

Rural water supply is very important for rural people as water is one of the basic needs for everyone. Rural people need water for their domestic and irrigation purpose, most important is drinking purpose which cannot be a issue of compromise. This case study of Rural Water Supply in Damudya Pavia of Sharaitpur district is very effective to find out the present problems of water supply and probable solutions given are only suggestions for better rural water supply. Study has given clear idea of sources of water and technologies used for water supply of in Sharaitpur District. Similar Study can be done in other districts of Bangladesh to identify the problems and solutions need to be found out for rural water supply. Technologies used for rural supply in Sharaitpur district and Bangladesh are traditional. New technologies should provide for better rural water supply. Most of the people of Sharaitpur district are not aware of using water properly. Government, DPHE, LGED, N.G.O.s and local people of Sharaitpur district have to work together and proper. Planning and Projects have to be taken to improve the rural water supply according to the need of rural people for sustainable development.

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Title: Groundwater Depletion and Its Impact on Life and Livelihood: A Study of Textile District of Bhilwara, Rajasthan

Ujjwal Dadhich

1. Introduction

Groundwater, located underneath the surface in soil pores and fractures of rock, in its meteoric-juvenile form constitutes a substantial proportion of freshwater reserves of the globe. Owing to an easy availability at the point of use and effortless procurement, groundwater has been drawn incalculably in last few decades for augmenting anthropogenic activities. Although, distinct topography and rainfall pattern marks an uneven distribution of groundwater reserves, the evolution of terrain specific technology has facilitated resource extraction regardless of the depth of accessibility (Kumar, 2007).

Renewed majorly through seasonal rainfall but being increasingly abstracted throughout the year; groundwater is now a rapidly depleting most consuming "fossil"[1] on scale (Struck Meier, Rubin, & Jones, 2005). This fossil on account of its convenient yet differential physical-economic accessibility, however, entails a complex socio-ecology. The coalesced strands of social dynamics become more visible in India – the largest consumer of groundwater in the world (both in magnitude and density of coverage) (UNICEF, FAO and SaciWaters, 2013) and more specifically country's arid and semi-arid urban centers and their periphery, one of which is the study area of this paper.

In view of limited availability of surface water reserves, its skewed distribution and increasing financial costs to procure, refine, transport and distribute freshwater from a distant location (Shaban, 2008), urban areas are increasingly relying on groundwater. The magnitude of this reliance depends largely on the collusion of geography, economic and agricultural affiliation, population concentration, nature and rate of expansion of urban areas (Patel & Krishnan, 2009).

Taking this into account, it has been observed that metropolitan regions of the country are increasingly devising distant surface water resources to meet the stipulated demand and thereby avoid future exigency. This usually has multi-dimensional impacts on the sites facilitating surface water arrangement. Small and medium urban areas, on the other hand, with relatively less financial capacity are increasingly using regional groundwater resources. For example – The State administration in arid and semi-arid urban centers resorts to cost-effective groundwater for supplying drinking water to urban residents (74th Constitutional Amendment Act, 1992). This "soft approach of demand management" (International Federation of Surveyors, 2004) is also largely practiced by increasing number of varied institutions and individual households. The concentrated extraction of groundwater, owing to its trans-boundary impact, results in drastic depletion of groundwater table in other neighboring regions (Shaban & Sattar, 2011). The glimpses of this geological interconnection are much more visible in surrounding rural areas which in midst of depleting and degrading groundwater reserves often struggle or their drinking and agricultural needs.

[1] Except for first few layers of subsurface which gets recharged through annual rainfall and condensation, the water saturation in deeper static layers is the result of prolong seepage. The zone of saturated layers is termed as aquifer. The increasing extraction of groundwater from static reserves is therefore a resource annihilating non-renewable process exceeding the rate of its natural replenishment. The other two most consuming fossils are sand & gravel and hard coal respectively (Chattopadhyay, 2006; Struckmeier, Rubin, & Jones, 2005).

Each system and individual now seems to exercise its proprietary rights over the appropriated land and freshwater resources optimally. This carves out a complex politics of groundwater extraction. The essential feature of this is consensual participation of people at different levels. Institutions are employed in a manner to (re)organize rationalities. A major belief thus produced is freshwater scarcity and its fugacious technological management. Resource extraction and appropriation mechanisms are constructed as a necessity (Baviskar, 2008). The larger implication of this organized understanding is the commodification of freshwater (Appadurai, 1992). That is, to use freshwater, one now has to go through an exchange process, which essentially involves money as an intermediary. These interactions taking place in accordance with the imagined or real economic gain within an inequitable social order, however, deprive a significant proportion of population of their Fundamental Human Right to have equal access to safe clean water and sanitation (Resolution adopted by the UN General Assembly on 28 July 2010, 2010).

16. Overview of Groundwater Depletion

In addition to above stated social dynamics, the numeric documentation of the phenomena further validates the gravity of near future crises. With a low Environmental Performance Index of 31.23 (out of 100), India is recently ranked 155th of 178 countries. A low baseline freshwater stress of nearly 3.6 (SiliconIndia, 2013) suggests qualitative-quantitative resource scarcity. World Water Development Report, 2004, ranked India 120th among 122 countries in terms of water quality and 130th among 180 countries in the resource availability (Chawan, 2005).

Expeditious population growth since independence, expanding urbanization, increasing life and livelihood activities, have resulted in the depletion of national average per capita availability of freshwater from 6008 cubic metre in 1947 to 1902 cubic metre in 2010. This is further estimated to decline to 1401 cubic metre in 2025 (MoEF and US Aid 2009). Further, there has been increasing use and dumping of toxin elements. Chromium, zinc, sulphate and phosphorus percentages have increased substantially in the soil and thereby contaminated groundwater reserves. Central Groundwater Board (2011-2012), estimated nearly fourteen states of the country to be affected with fluoride contamination and seventy-one facing saline intrusion. Also, it was illustrated that the major river basins of the country, Ganga, Krishna, Cauvery and Godavri, have been depleted by around 32 percentage in the last decade. The potential risks of life is maximum in Ganga-Brahamputra-Meghna river basin affected by high arsec concentrations. With twelve major river basins constituting nearly 690 Billion Cubic Metre (BCM), surface water reserves continue to facilitate majority of demands. However, groundwater on the other hand has also emerged as a favorable option for sustaining assorted progression[2]. The dependency is much more visible in North-Western region of the country. Characterized by unconsolidated aquifers, the rate of groundwater extraction is more than 100 percentage in agricultural states of Rajasthan, Punjab and Haryana. The unsustainable extraction has resulted in a loss of nearly 115 Billion Cubic Metre of groundwater in last five years (CGWB, 2012; UNICEF, FAO and SaciWATERs, 2013). The increasing rate of groundwater extraction in these states can be attributed earlier to agriculture and now on urban and industrial expansion. Groundwater, as is more mineralized and pure, offers 65-70 percentage of more productivity to that offered by surface water (World Bank, 2010). Also, the access to surface water in majority of cases is political. Realizing its democratic access (Patel & Krishnan, 2009) and possible role to foster agricultural production, government policies were devised to herald the use of energized wells. Farmers have increasingly been given free electricity and subsidy over pump installation. This resulted in a tremendous increase in net irrigated area over a period of time (Table I) (Kumar, 2007).

[2] Surface water in 2010 contributed to nearly 61.2 percentage (nearly 396 BCM) of the total demand by different sectors. Groundwater facilitated 38.8 percentage of this (nearly 251 BCM) (Water Profile of India , 2014).

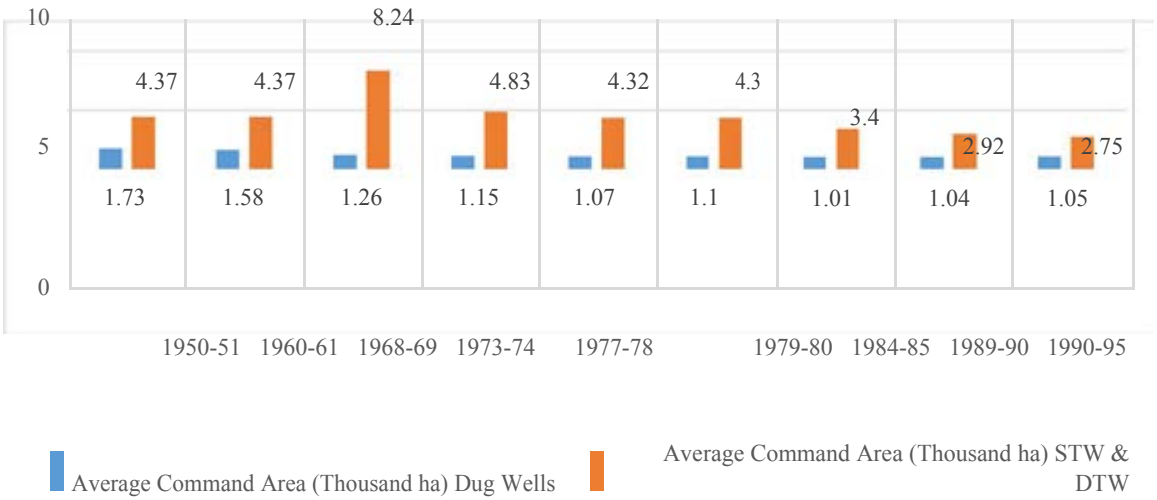
Table I: Growth of Energized Wells and its Contribution in Irrigated Area

Year	Total Number (in thousand)			Total Irrigated Area (thousand ha)		Percentage of Energized Dug Wells
	Dug Wells	STW & DTW	E & D Pumps	Dug Wells	Tube Wells	
1950-51	3860	5.40	87	6661.4	23.6	2.1
1960-61	4540	30.90	430	7155	135	8.8
1968-69	6100	374.70	1810	7714	3087	23.5
1973-74	6700	1160.00	4180	7679	5604	45.1
1977-78	7435	1770.00	5650	7943	7641	52.2
1979-80	7786	2165.30	6615	8557	9307	57.2
1984-85	8742	3405.20	9259	8828	11566	67.0
1989-90	9487	4817.40	12781	9837	14049	83.9
1990-95	11198	6517.40	16203	11803	17894	86.5

Note- STW and DTW refer to Shallow and Deep Tube wells respectively which in the recent past have been increasingly powered by Electric & Diesel Pumps (E & D Pumps). Source- Data from Kumar, 2007.

Energized wells facilitated an increase in the command area until 1970s'. The increasing concentration of pumps and fertilized intensification of agriculture later contaminated groundwater reserves. Average command area under energized wells since then showed a considerable decline (Figure I).

Figure I: Average Command Area under Wells and Pump Modes of Irrigation



Source- Data from Kumar, 2007.

While irrigation consumes the maximum proportion of groundwater, burgeoning urbanization has also put an enormous stress on regional groundwater reserves. In a span of forty years, 2010-2050, freshwater consumption is forecasted to increase by nearly 98.21 percentage (Table II). The stipulation stands at 118.9 percentage for industrial activities. Majority of Class II-III urban areas and industrial activities rely on groundwater for their production activities (Ministry of Water Resources, 2006; Singh, 2006; NCIWRD, 2008).

Table II: Sectorial Water Demand in India

Category	Estimated Water Demand (Billion Cubic Metre)			Percentage Share in Water Demand			Percentage Increase in Demand
	2010	**2025**	**2050**	**2010**	**2025**	**2050**	**2010-2050**
Irrigation	688	910	1072	80.56	78.92	74.17	55.81
Drinking Water	56	73	111	6.55	6.33	7.68	98.21
Industry	37	67	81	4.33	5.81	5.61	118.9
Energy	19	33	70	2.22	2.86	4.84	268.42
Others	54	70	111	6.32	6.07	7.68	105.56
Total	854	1153	1445	~100	~100	~100	69.20

Note- In the above table maximum projected demands have been taken. Source - Ministry of Water Resources , 2006.

It is with these multi-sectorial uses all over the country that the groundwater table shows a considerable decadal fluctuation in different states. The maximum is in the North-Western region, parts of Gujarat, Maharashtra and Tamil Nadu (Table III) (Central Ground Water Board , 2011).

Source- Central Ground Water Board , 2011.

Table III: Groundwater (GW) Availability and Sectorial Utilization in Selected States

State	Net GW Avail. (BCM)	Annual GW Draft (BCM)			Projections 2025 (BCM)	
		Irrigation	Dom. & Ind.	Total	Dom. & Ind. Use	Avail. For Irrigation
Andhra Pradesh	30.76	12.61	1.54	14.15	2.69	15.89
Delhi	0.29	0.14	0.26	0.40	0.26	*0.01*
Gujarat	17.35	11.93	1.05	12.99	1.47	5.32
Haryana	9.80	11.71	0.72	12.43	0.74	*-2.70*
Karnataka	14.81	9.01	1.00	10.01	1.26	6.18
Madhya Pradesh	32.25	16.66	1.33	17.99	1.83	13.76
Maharashtra	33.81	15.91	1.04	16.95	2.00	16.32
Punjab	20.35	33.97	0.69	34.66	0.95	*-14.57*
Rajasthan	10.79	12.86	1.65	14.52	1.89	*0.75*
Tamil Nadu	20.65	14.71	1.85	16.56	1.97	4.70
Uttar Pradesh	68.57	46.00	3.49	49.49	5.36	17.72

Note- Avail., Dom. and Ind. refer to Availability, Domestic and Industrial respectively.

Source- Data from CWGB, 2011-2012.

Table IV: Major Overexploited (O.E) States of India, 2011-2012

State	No. of Assessed Units	Categorization of the Block					O.E Percentage
		Safe	Semi-Critical	Critical	Over Exploited	Saline	
Andhra Pradesh	1108	867	93	28	*84*	38	8
Delhi	27	2	5	0	20	0	74
Gujarat	223	156	20	6	27	14	74
Haryana	116	18	9	21	*68*	0	59
Karnataka	270	154	34	11	*71*	0	26
Madhya Pradesh	313	224	61	4	24	0	8
Maharashtra	353	224	61	4	9	0	3
Punjab	138	23	2	3	*110*	0	80

Rajasthan	239	23	2	3	*166*	1	69
Tamil Nadu	386	31	16	25	*139*	11	36
Uttar Pradesh	820	605	107	32	76	0	9

Note –The categorization of area is on the basis of stage of ground water development; safe (<=70 per cent), semi-critical (>70 per cent but <=90 per cent), critical (> 90 per cent but <= 100 per cent) and over-exploited (> 100 per cent).

Source- Data from Central Ground Water Board , 2011-2012.

In between this grim scenario, the role of Central and States government and more specifically Ministry of Water Resources and Central Ground Water Board remain highly ambiguous and debatable. The same data is presented in the annual reports of the two institutions since 2004[3]. Moreover, the replicated data has been used by a number of other agencies for the analysis of multifarious issues.

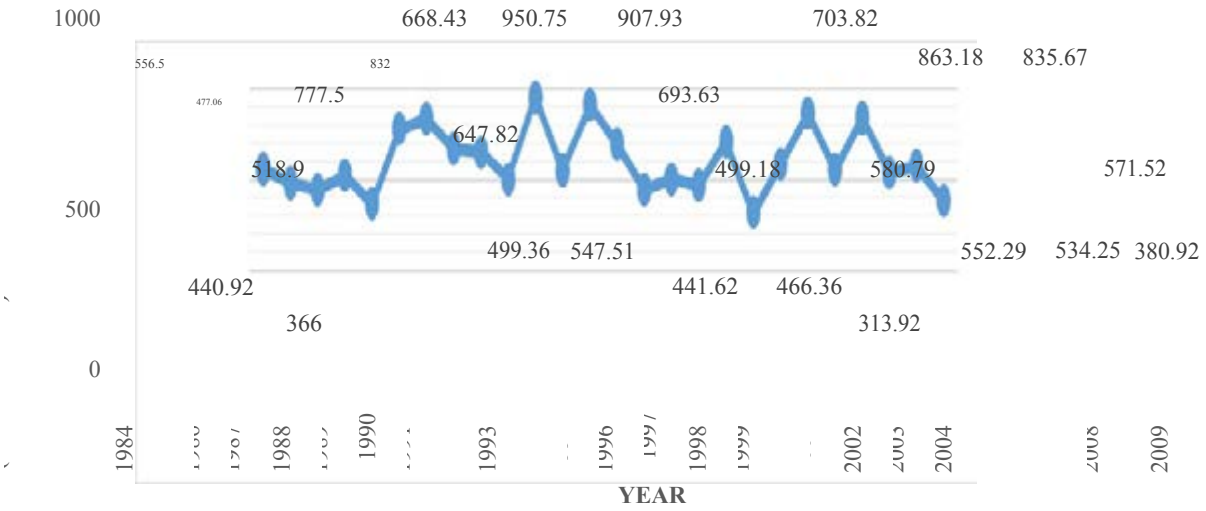
Scarcity of freshwater has cascading effects. It affects all natural, social and economic systems. Freshwater and particularly groundwater stress is already high in India and the poor who are largely most vulnerable are likely to be affected. In a context of escalating conflicts over land and freshwater, worsening food security, increase in energy shortages, spread of diseases, growing migration, ecosystem degradation; groundwater management becomes critical to the propounded idea of sustainable development.

11. Geohydrology and Spatial Distribution of Groundwater Reserves in Bhilwara

Characterized by semi-arid precipitation regime and moderate coefficient of variation, nearly 30 percentage respectively (1984-2009), Bhilwara district receives low but highly erratic rainfall (Figure I) (CGWB Western Region, 2007). The mean annual rainfall of the district is 619.05 millimetre (1901-2012) (CGWB Western Region 2013). A large part of the district comes under Banas river basin (9157.2 square kilometer i.e. 87 percentage of the total geographical area of 10,455 square kilometer). In addition to this Chambal (1164.9 square kilometer) and Luni (133 square kilometer) river basin also drain the district. These rivers are however seasonal. In majority, the district geology is characterized by gneises and schist. Together with phyllite, slate, limestone and shale, these geological formations entail a total of 428.18 Million Cubic Meters of replenishable groundwater resources (CGWB Western Region, 2009). Groundwater in these formations occur from unconfined to semi-confined conditions at varying depth, nearly 3.00 metres to 23.00 metres below ground level.

[3] The recent Central Ground Water Year Book 2011-2012 has finally updated statistics after 2004 but the report has many ambiguities in terms of the overexploited blocks which are now shown to be 802 compared to 839 in the Ground Water Year Book, 2010-2011; a substantial decrease shown particularly for the states of Andhra Pradesh, Gujarat, Punjab and Rajasthan.

Figure III: Average Annual Rainfall of Bhilwara District (1984-2009)



Source – Data Obtained from Water Resources Department, 2011.

On account of block span, modulating rainfall and regional geo-hydrology, the dynamic ground water reserves of the region show a significant spatial distribution within eleven administrative blocks of the district (Table V; Figure IV)

Table V: Spatial Distribution of Net Groundwater Availability, 2009

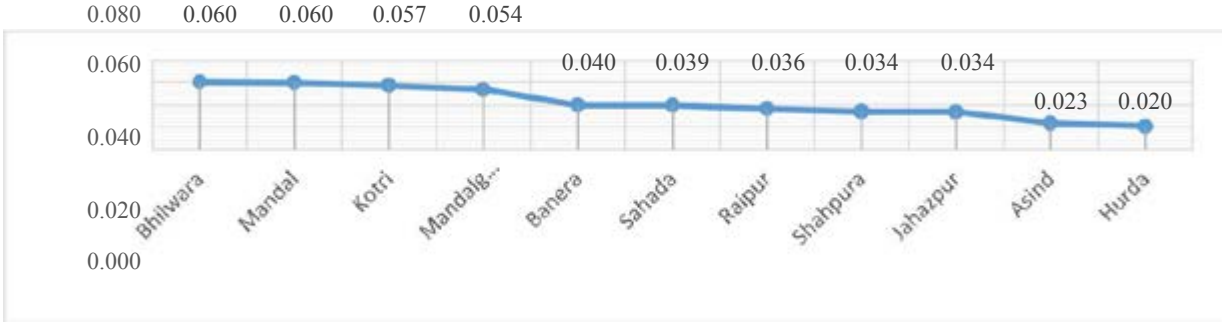
Block	Potential Area of GW (sq. km)	**Net Ground Water**		Average Annual Rainfall (mm) (1990-2009)	Percentage Deviation From the Average Annual Rainfall
		Availability (MCM)	**Rank as per Availability**		
Asind	1294.3	74.53	7	339.92	-31.93
Banera	725.3	62.25	8	497.29	-0.42
Bhilwara	674.8	46.23	4	524.47	5.02
Hurda	962.2	68.43	9	419.05	-16.08
Jahazpur	1248.6	42.28	3	519.92	4.11
Kotri	686.8	66.58	6	568.20	13.77

Mandalgarh	1156.5	49.78	1	620.44	24.24
Mandal	668.4	47.73	5	458.58	-8.17
Raipur	533.5	41.23	11	433.25	-13.24
Sahada	494.9	53.09	10	444.96	-0.54
Shahpura	1313.6	34.51	2	481.92	-3.49
Total	**10,455**	**677.1407**	**---**	**499.38**	

Source – Data Obtained from Water Resources Department, 2011.

Mandalgarh on account of highest rainfall and largest basin coverage has largest groundwater availability of 49.78 Million Cubic Metres. Shahpura though receives relatively less rainfall has largest basin area and therefore a relatively higher groundwater availability. However, this spatial distribution only gives a partial picture. An adequate understanding of groundwater availability is presented by average available volume of ground water per square kilometer (Figure IV).

Figure IV: Net Groundwater Availability per Square Kilometer, 2012



Blocks of Bhilwara District

Source- Data from Table V.

The cumulative effect of basin area, alluvial span and annual rainfall can be seen in Bhilwara and Mandal which have larger availability of groundwater per square kilometer. These are also the industrial centers of the district.

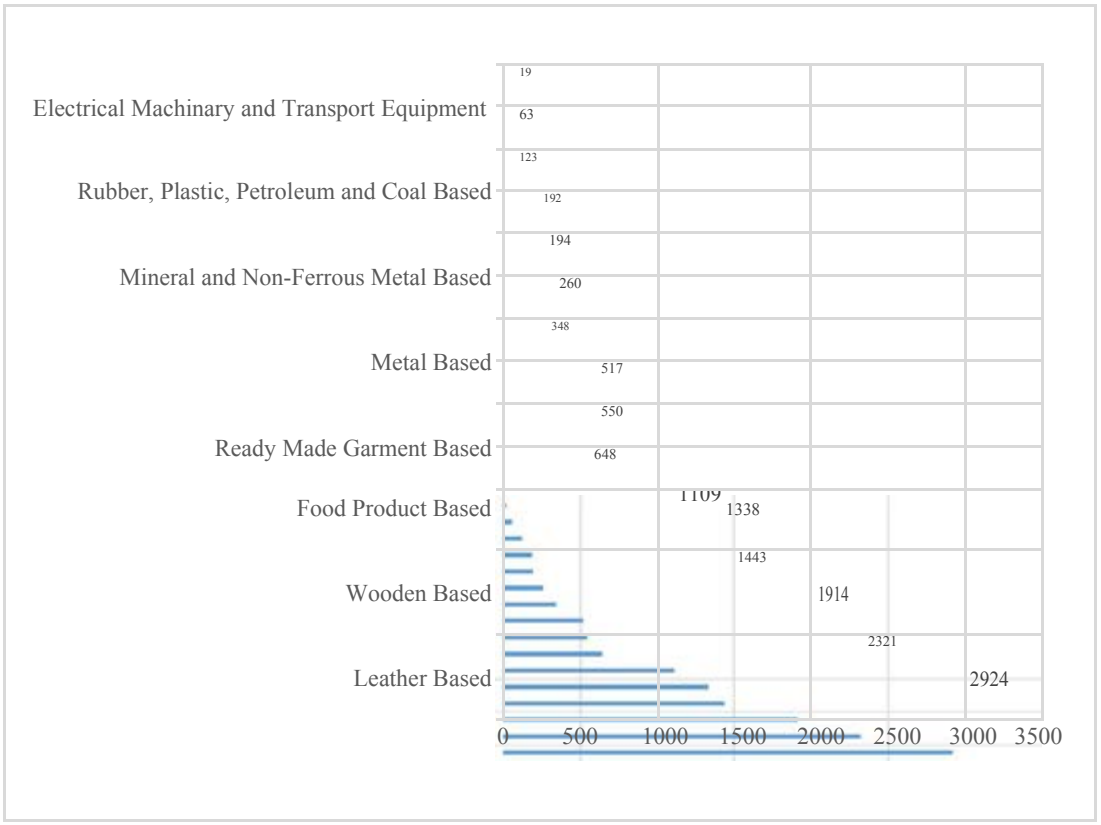
1. Groundwater Depletion in Bhilwara District

Contributing nearly 50 percentage in nation's polyester and viscose fabrics production, Bhilwara has now transformed into textile city of the nation. The inaugural imprint of economic expedition commenced in 1938, with the setting up of first spinning and knitting unit, Mewar Textile Mill. The unregulated industrialization of the rain shadow district is now characterized by 50 large scale spinning and dying, 400 weaving, 20 large scale process houses and a total of 4000 medium and small scale enterprises, within the periphery of the city (Figure V and Figure VI) (Mewar Chambers Of Commerce, 2009).

Figure V: Yearly Number of Registered Units in Jaipur

Source- Data from Ministry of Small Scale and Medium Enterprises , 2012.

Figure VI: Type and Number of Small and Micro Scale Enterprises in Jaipur Urban Area



Source- Data from Ministry of Small Scale and Medium Enterprises , 2012.

These spinning and weaving process houses produce nearly 650 million metre (65 crore) cloth annually. With reference to the process involved, it consume 40,000 cubic metres of water every day i.e. 14.6 Million Cubic Metre of water annually. Also, 1.8 Million Cubic Metre of water is used by dye houses of spinning units and thermal power plants installed to facilitate production. This makes an aggregate of 16.4 MCM of water per annum, a figure which has never been shown by any of the published government report. The figures are contradictory to the data shown by water resource department in comparing the use of water by irrigation and domestic-industrial sector in the district (Refer Table IX).

In an application dated 11/06/2009, the Textile Chambers of the region requested water resources department to allocate water. Being a prerequisite for textile production,

these industries need an uninterrupted supply of water every day. Receiving no legal water from the government, the regional federation of industries, has urged the authorities to allocate water in accordance with the priority of National Water Policy 1987 and 2002, after Drinking and Domestic sectors. In a formal application, the amount of water used erstwhile was reported to be mere 3 Million Cubic Metre annually. Together with large and medium scale enterprises, small scale enterprises are also significant to regional economy. They together consumer nearly 2.5-3 Million Cubic Metre of water yearly. With low annual rainfall (average rainfall 624.55 millimetre) and costly procurement of surface water from distant sources, these textile industries located in three major industrial growth centres, namely Hamirgarh Growth Centre (Bhilwara Block), Mandal Growth Centre (Mandal Block) and RIICO Industrial Area (Bhilwara Block), depend entirely on groundwater. The inevitable dependency of industries on groundwater has led to the installation of bore wells both by the industries and potential private players (getting benefitted from the sale of this common property resource).

Table VI: Groundwater (GW) Extraction by Different Sectors in the District, 2009

Block	Net GW Availability (MCM)	Existing GW Draft (MCM)			Stage of GW Development (in per cent)	Category
		Irrigation	Dom. & Ind.	Total		
Asind	30.24	47.886	2.68	95.76	167.16	Over Exploited
Banera	28.84	36.076	2.27	72.14	132.92	Over Exploited
Bhilwara	40.73	40.73	3.99	96.6	109.79	Over Exploited
Hurda	19.70	23.371	1.98	46.74	128.68	Over Exploited
Jahazpur	41.92	59.886	2.13	119.76	147.92	Over Exploited
Kotri	39.44	45.7824	1.33	91.56	119.44	Over Exploited
Mandal	40.14	40.61	3.53	81.22	109.96	Over Exploited
Mandalgarh	62.11	62.11	4.03	148.59	106.48	Over Exploited
Raipur	19.35	19.35	1.76	50.09	109.07	Over Exploited
Sahada	19.52	19.52	1.90	166.5	109.73	Over Exploited
Shahpura	44.5	44.54	2.26	88.98	105.07	Over Exploited
Total	386.59	386.59	27.86	1057.04	135.55	Over Exploited

Source – Data from CGWB Western Region, 2009.

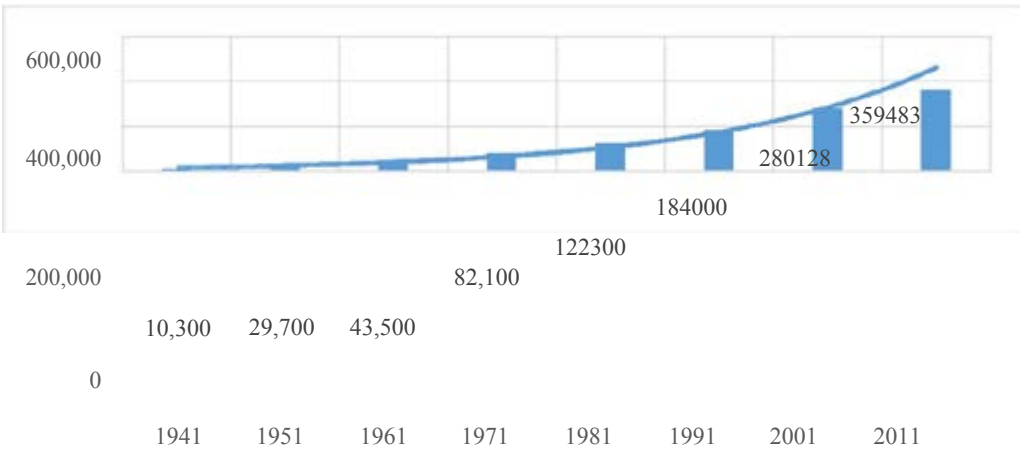
Figure VII: Percentage Stage of Groundwater (GW) Development in Different Blocks, 2009

Blocks of Bhilwara District (Rank as per Stage of Groundwater of Development)

Source – Data from CGWB Western Region, 2009.

Emerging as a progressive industrial centre, Bhilwara urban area witnessed a phenomal urban growth rate of 28.32 percentage in 2011. This was third highest growth rate after Jaipur (63.38 percentage) and Udaipur (43 percentage). The population density in the urban area has also increased from 193 to 230 per square kilomtere in 2011(Figure IX) (Directorate of Economics & Statistics, 2011).

Figure VIII: Percentage Stage of Groundwater (GW) Development in Different Blocks, 2009



Source – Data from Directorate of Economics & Statistics, 2011.

Citing the stage of ground water development in Bhilwara, Mr. M.S.Shekhawat [4], a senior researcher at Institute of Development Studies, Jaipur illustrates *"...the unregulated industrialization in Bhilwara has led to the exhaustion of regional groundwater reserves. There is not much left for the future..... Large scale industries and their ancillary units, particularly textile and dying process houses consume nearly 45-50 Million Cubic Metre of water annually. This figure is never disclosed by any of government reports till now. Also most of the reports show a very large irrigation draft in these blocks but in reality irrigation is practiced only on a small percentage of urban land"*

[4] In an attempt to maintain the confidentiality, the name of all the interviewees has been changed.

Discussing on the same issue, Mr. Sanjay Sharma, Senior Officer at Irrigation Department, Bhilwara puts his view "*….along with industries , construction activities of a number of infrastructure projects consume a large amount of groundwater but there is no account of them. Over a past few years, a large number of residential projects have been completed and more are being proposed. Most of these residential projects and particularly elite projects, offer 24x7 water supply. From where they are getting water? All are using groundwater. Most of them do not have registered bore wells. Even if few of them have registered bore wells, either the depth or actual number of functioning bore wells is much more than the granted permission…..also, Bhilwara being one of an important business destination has a large number of hotels. While large hotels have their own deep bore wells, other normal hotels order private water tankers but all are using ground water.*

There is no account of such draft…."

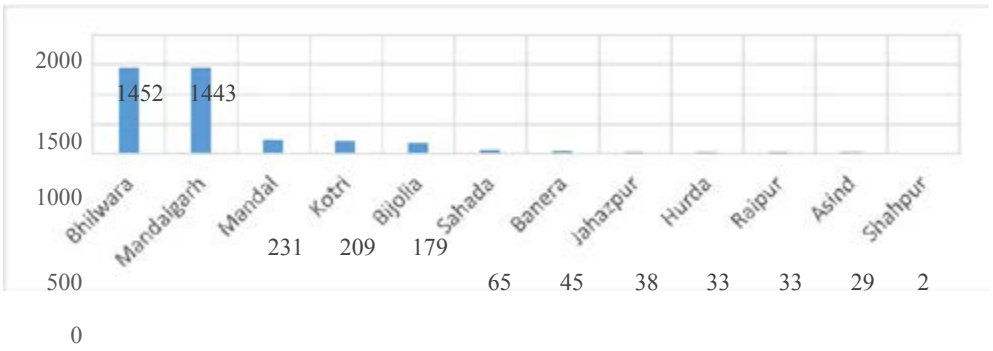
While researchers and senior officials are able to give more in-depth view of the causes of ground water depletion, Chandu a wage earner at one of medium scale dying plant in Mandal illustrates"*…yes our unit has three bore wells, of around 400-450 feet. They run for 12-15 hours daily….water is getting exhausted in entire Bhilwara but let us suppose all industries get closed then what will happen……a number of people are getting employment from these industries…."*

Speaking on the discrepancies in the estimation of the groundwater draft by different sectors, one of the senior official of Central Ground Water Board, Western Region elucidates "*....first of all you should understand that the groundwater draft is an estimate and is not an actual correct figure. It is an estimate that Central and State Ground Water Boards calculate on the basis of the depth of water table in their monitoring wells. There would be nearly lakh of bore wells in Bhilwara district but we calculate it on the basis of our monitoring wells and the actual draft percentage is always higher. The estimation of groundwater depth and draft are much more accurate for rural areas as we had a larger number of monitoring wells in these locations.*

But within the city we have only few and therefore estimate is unreliable. ….and in wake of the complex varying geo-hydrology and human constraints we still are not technologically advanced to calculate the exact draft figure…."

The above views largely cite industries as responsible for unsustainable groundwater draft. These opinions tend to get conformity if one looks look at the total number of registered tube wells for domestic purpose. The number of these tube wells are maximum in Bhilwara urban area i.e. in blocks of Bhilwara, Mandalgarh and Mandal (Figure IX). In rural areas, piped water supply still has not been employed. Also, bore wells and tube wells are used for irrigation purposes. But in urban area, a large presence of tube wells raises some skepticism. It is to be noted that the total number of energized wells listed in Figure IX are for domestic purpose.

Figure IX: Number of Registered Tube wells in Blocks, 2006

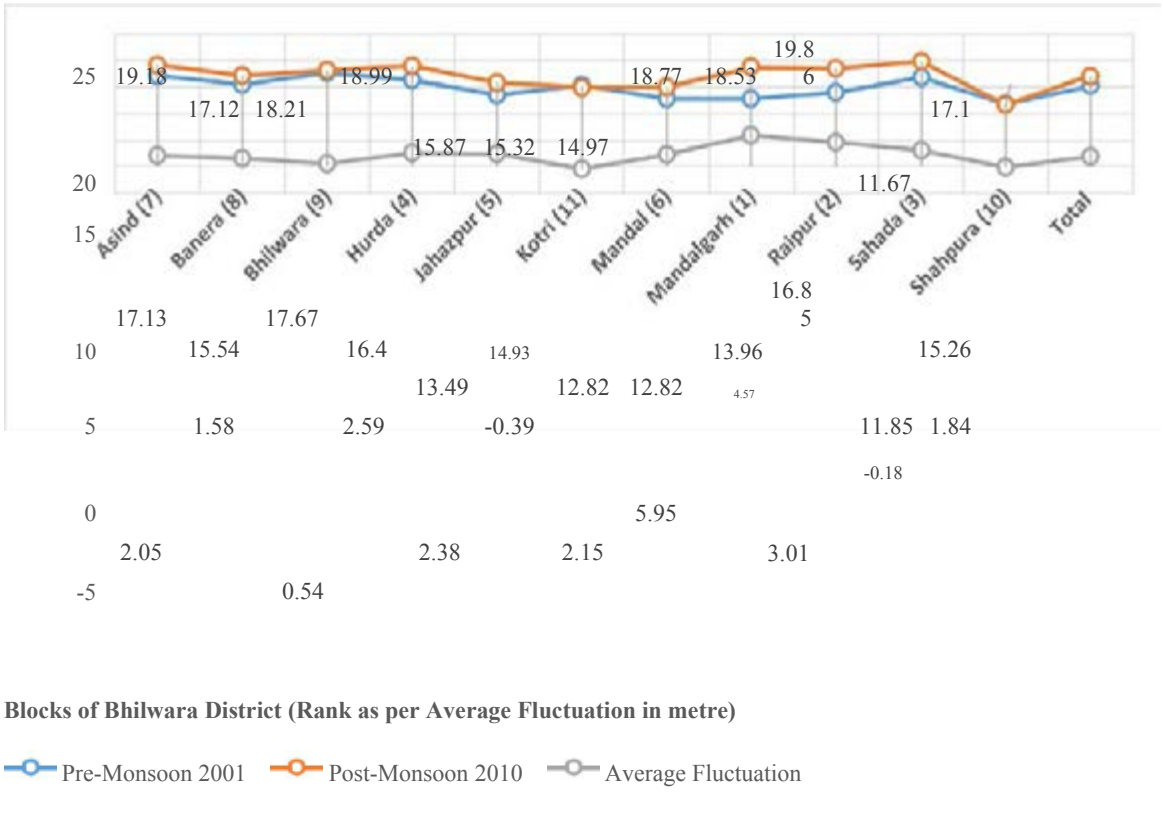


Source – Data from CGWB Western Region, 2009.

12 Groundwater Fluctuation in Bhilwara District

The above discussed dynamics have resulted in drastic depletion of regional groundwater table. In a span of nine years, 2001-2010, the groundwater table depleted by nearly 1.84 metre. The rate of depletion is maximum in Mandalgarh (5.95 metre), Raipur (4.57 metre), Sahada (3.01 metre). It is to be noted that the blocks of Bhilwara and Mandal have reported minimal (0.54 metre) and moderate fluctuation (2.15 metre) (Integrated Water Management Plan, 2011). The reported figure raises some dual skepticism. First, the two blocks are most industrialized and as such groundwater depletion cannot be at such level. Second, the level of groundwater may have reached to depth which may not be permitting further extraction. This has brought reserves of other blocks to be used by industries.

Figure X: Groundwater Fluctuation in Bhilwara District (in metre)



Source- Integrated Water Management Report, 2011.

In addition to quantitative depletion, effluent dumping of wastes have degraded regional groundwater reserves. There has been a substantial increase in percentage of fluorides, nitrates and total dissolves solids. This poses a greater risk on health and thereby total well-being of individuals.

As per World Health Organization guidelines, fluoride content should be optimally between 1.00 ppm and 1.5 ppm for drinking water (Ibrahaim, Asimrasheed, Sumalatha, & Prabhakar, 2011). The concentration of fluoride ranges from 2.0 ppm to 2.5 ppm in industrial areas of Mandal and Bhilwara (Geological Survey of India, 2007). The increased presence has a profund impact visible through the frequently reported respiratorty failures, skeletal and dental fluorisis, anorexia and a number of impaired effects both in human beings and animals. Raju, 23 years old and a resident of Barantiya, explains *" this was third time I went for police selection and despite being good aptitude I am always rejected , I cannot run even 5 km , my bones start paining even at this age…..this is mine and the situation of many others of Sanganer…..you should come and watch by yourself….*

- **Bhilwara Urban Water Supply**

With a coverage of nearly 92.35 percentage of total population, Bhilwara urban households depend primarily on Public Health and Engineering Department (PHED) piped water supply[5]. Bhilwara receives nearly 70-80 lpcd of water in a span of three to four days. This is much less than that of Million Plus cities in India (Table X). The government claims to supply 25.064 Million Cubic Metres of Water to a total population of 24, 54,030 of the district. This assures per capita availability of 10,213 litres (way ahead the national per capita availability of 1200 litre). The coping lifestyle of the residents however seems to disagree with it. Kamla Naagar, resident of Chandra Shekhar Azad Nagar, Bhilwara explains "...water comes only for one hour with a span of four days. With such a less supply how we can manage drinking, cooking, washing clothes and utensils.... The depleting groundwater resources forced PHED to even use static water resources of the region. Also, on the verge of exhaustion, the district now receives drinking water from Water Train. It carries water from Chambal River in Kota district, nearly 160 km away from Bhilwara.

Table VII: Drinking Water Supply in Selected Million Plus Population Cities

City	Supply Area Population Coverage			Domestic Water Production	
	In Million	Percentage	Rank	Prod. (lpcd)	Rank
Ahmedabad	4.49	74.5	16	168	16
Amritsar	0.80	75.7	14	213	12
Bangalore	5.36	92.9	3	185	14
Bhopal	1.44	83.4	8	182	15
Chandigarh	1.15	100.0	1	332	2
Chennai	5.32	89.3	6	131	19
Coimbatore	0.99	76.1	13	286	4
Indore	2.20	77.3	12	108	21
Jabalpur	1.05	75.2	15	222	9
Jaipur	2.97	87.35	7	125	20

[5] To avail piped water supply, an individual household has to show a permanent residency proof in urban area. Slum residents do not possess this and are therefore not eligible.

Jamshedpur	0.49	74.4	17	808	1
Kolkata	4.00	79.0	9	246	8
Mathura	0.24	70.0	19	160	17
Mumbai	13.00	100.0	1	264	6
Nagpur	2.30	91.5	5	267	5
Nashik	1.35	92.6	4	248	7
Rajkot	0.98	98.1	2	146	18
Surat	2.95	77.4	11	188	13
Varanasi	1.49	77.7	10	217	11
Vijayawada	0.68	70.5	18	220	10
Vishakhapatnam	0.92	49.2	20	305	3
Average	---	*81.5*	---	*239.0*	---

Source- Source- Integrated Water Management Report, 2011

Mrs. Sonali Sharma, Section Engineer, PHED, Jaipur expresses her concerns on groundwater depletion as "*.....this is a very complex issue and we are just a small part of it. ....while industries and irrigation are doing for profit, we are doing by the enshrined responsibility. .....also what can be the solution if we will not extract groundwater? From where drinking water will come? Because of deficit rainfall we frequently have to use bore wells installed in different areas…..as I said this is a very complex issue and it requires multiple intervention in terms of planning and implementation. Bhilwara does not have any freshwater resource …we have a number of projects in line to conserve rainwater and also recycle waste water…the situation is tense….left with no choice we have resorted to water train from Chambal but this is also not a permanent solution".*

While the access to safe drinking water is a Fundamental Right, the domestic supply by the government violates all the prescribed rules. Water is transparent, tasteless and odorless but the tapped supply of city is characterized by black-greenish water (most of the times) smelling as if the water is supplied not from the government water reservoirs but from municipal sewage drains. It was recently in 2010, that such contaminated water was supplied to the households in the city (including mine), for over a month where people cannot even drink a drop of it. While government officials say it was a leakage problem which led to the intermixing of sewage and domestic water, some people claim that the fresh water was supplied to the industries at the expense of the households.Confronting with both qualitative and quantitative aspect, people are forced to spend a substantial part of their earning in accessing safe water, which includes the element of

"affordability". A large proportion of the urban household are now equipped with water filter mechanisms.

Those who cannot afford, buy water tankers on a collective basis.

Jamuna Lal, resident of Bapu Nagar explains "*...water is so much contaminated that even it is not suitable for bathing. My monthly salary is Rs 12000, but a substantial amount of Rupees 1000 goes in procuring water through tankers...*"

Shashikala, resident of Azad Nagar elucidates "*...forget about washing clothes and bathing, we don't have water to drink. We and our neighbourhood earn only Rupees 6000-8000 per month and cannot afford to buy individual water tankers. The adjoining four families comprising nearly 13 members buy nearly 5 water tankers per month, and then only we could manage".*

6.1 Methodology for Sample Selection

PHED procures freshwater from available surface water reservoirs, gawdi dam, water harvesting structures, water train and groundwater resources. The procured water is refined and distributed. The water distribution network categorizes urban Bhilwara into four zones – North-I, South-I, North-II, South-II. Each of these zones is further divided into subdivisions. In an attempt to explore and understand socio-spatial dynamics of groundwater depletion across the urban area, four subdivisions were selected randomly from each zone. From each of the subdivision, individual households were selected on the basis of built up area. Also, the collective habitat environment of individual households[6] was taken into notice. With this empirical understanding, individual households were further stratified as Higher Income Group (HIG), Middle Income Group (MIG) and Lower Income Group (LIG), Slum[7] population and the apartment residents.

Table VIII: Categorization of the Households on the Basis of Income and Super Built-Up Area [8]

Category of the Household	Annual Income (in lakh)	Super Built Up Area (square feet)
Higher Income Group	>4	> 1200 sq. ft.
Middle Income Group	2-4 lakh	600 -1200 sq. ft.
Lower Income Group	0 -2 lakh	Up to 500 sq. ft.
Slum Population	-	-

Note: Lower income group category is as per the income given by Ministry of Housing and Urban Poverty Alleviation (2013) while the others are based on individual estimation.

[6] The composite term individual household here refers to the individual(s) who dwell under the same roof and eat from the same kitchen (Shaban, 2013;Dictionary and Thesauraus Merriam-Webster Online, 2014)

[7] Census, 2011 defines slum as residential areas not suitable for human habitation on account of the absence of basic qualitative-quantitative amenities and facilities that are to be present in the individual households and the complete habitat.

Although there were other important parameters such as education, profession, years of residence in the area determinging the socio-economic status of the sample but pertaining to research only one more element of number of family members proved to be useful in the aanalysis.

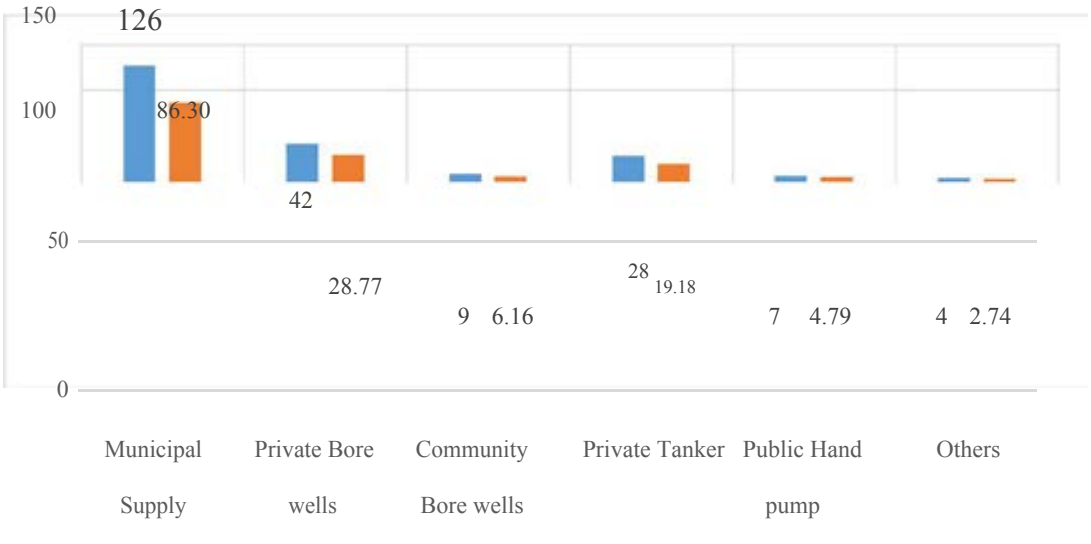
Table IX: Number of Family Members in Household Categories

Household Category	Family Members and Number of Households					
	0	1-4	5-7	8-10	11 or more	Total
HIG	0	10	10	6	6	32
MIG	0	18	8	3	3	32
LIG	0	14	10	8	0	32
Slum	0	0	12	12	4	28
Apartments	0	3	10	7	2	22
Others	3	0	0	0	0	3
Total	3	65	40	26	15	149

Note- The others in the sample individual housholds are three luxury hotels with two in near to core area of Durgapura and one in core area of Bani Park area.

Conforming to macro-statistics, the field survey shows a greater dependency of sample households on municipal supply. 101 (79.45 percentage) of 146 households are using municipal supply. 51 households (32.19 percentage) consume freshwater through bore wells (42 private and 9 community). 28 households (19.18 percentage) order private tankers as per necessity (Figure XII). The adherence to multiple sources in turn reflects the dual perspective of maintaining freshwater security in wake of abrupt supply, particularly in summer season.

Figure XI: Supply Sources in Sample Individual Households (Including Multiple Use)



Source- Primary Data, 2011.

The above statistics can be further segregated in terms of primary and secondary dependency. This is again maximum in case of municipal supply with 96 households being dependent on it. Private bore wells largely subordinate domestic needs at second place followed by community owned bore wells.

Table X: Primary and Secondary Source of Freshwater in the Sample Individual Households

Supply Source	Dependent Households			Per cent Share in Total Sample		
	Primary	Secondary	Total	Primary	Secondary	Total
Municipal Supply	96	30	126	65.75	20.55	86.30
Private Bore well	35	7	42	23.97	4.79	28.77
Community Bore well	9	0	9	6.16	0	6.16
Private Tanker	3	25	28	2.05	17.12	19.18
Public Hand pump	3	4	7	2.05	2.74	4.79
Others	---	4	4	---	2.74	2.74
Total	146	70	---	100	47.94	---

Note- Out of the total sample, 76 households do not use any secondary source. Source- Primary Data, 2011.

[8] Super Built Up area in the simplest understanding refers to the aggregate area of a premise enclosed within the external walls (Ministry of Housing and Urban Poverty Alleviation, 2013).

Table XI: Spatial Distribution of Primary Sources of Freshwater

Primary Supply Source	Type of area, Number and Percentage of Dependent Households				
	Core	Near to Core	Near to Periphery	Periphery	Total
Municipal Supply	20 (30.30 %)	19 (28.79%)	20 (30.30%)	7 (10.61%)	66 (100%)
Municipal Tube well	0 (0.00%)	0 (0.00%)	9 (52.94%)	8 (47.06%)	17 (100%)
Municipal Tanker	4 (30.77%)	3 (23.08%)	3 (23.08%)	3 (23.08%)	13 (100%)
Private Bore well	6 (17.14%)	12 (34.29%)	7 (20.0%)	10 (28.57%)	35 (100%)
Community Bore well	2 (22.22%)	4 (44.44%)	1 (11.11%)	2 (22.22%)	9 (100%)
Private Tanker	0 (0.00%)	0 (0.00%)	0 (00.00%)	3 (100.00%)	3 (100%)
Public Hand Pump	0 (0.00%)	0 (0.00%)	0 (0.00%)	3 (100.00%)	3 (100%)

Source- Primary Data, 2011.

6.2 Physical and Economic Accessibility of Bore Wells

The ownership pattern of private bore wells, show largely a proportional relationship between financial capabilities. Out of the 42 private owned bore wells in the total sample, the maximum of 19 (45.24 per cent) are owned by apartments inhabited largely by Higher Income Group (HIG). This is same household category but residing in individual bungalows. Only one household of the Lower Income Group (LIG) family residing in the periphery owns bore well, while there is no slum resident being able to afford the abstraction machinery. Also, within the sample individual households, one HIG and nine apartments own two bore wells to meet the needs of large family and maintain the aesthetics of super built up area comprising of gardens and swimming pool (Figure XIV).

Figure XII Ownership Pattern of Private Bore wells in Urban Jaipur

Source- Primary Data, 2013.

The skewed ownership pattern of bore wells becomes more complex with its drilled depth. With higher investments it is maximum in apartments with five of them having it up to 600 ft. The HIG families own bore well within a range of 250 to a maximum of 450 ft. and in case of MIG it is within 201-300 ft. The existence and depth of the abstraction machinery in case of individual households is also dependent on combination of the number of family members they support, financial capabilities and subjective needs of the same. For example – a HIG bore well of the same depth of 250-300 ft. supports the domestic needs of four in

one case and 12 in another, which in case of MIG is around 23 members resorting on bore well of 350-400 ft. as a primary source. The role of income and purchasing power becomes more visible in case of two HIG household with three and four members respectively having 450 ft. depth of abstraction equipment and also apartments as one among them with a depth of 400-450 ft. supports 20 families at one hand and 50 on the other. But most of these apartments maintain a supply of 24x7 and even buy private water tankers in case of exigency.

Table XIV: Depth of Privately Owned Bore Wells

Depth of Bore well	HIG	MIG	LIG	Apartments	Total
Don't know	4	---	---	---	---
101-150 ft.	1	---	1	---	2
151-200 ft.	---	---	---	---	---
201-250ft.	---	3	---	---	3
250-300 ft.	3	2	---	---	5
301-350 ft.	2	---	---	---	2
350-400 ft.	2	1	---	3	6
400-450 ft.	4	---	---	5	9
451-500 ft.	---	---	---	4	4
501-550 ft.	---	---	---	2	2
550-600 ft.	---	---	---	5	5
Total	16	6	1	19	42

Source- Primary Data, 2013.

Dheebu and Rakesh, security guard at Tulip apartments narrate "*Our village is nearly 19 km from Bhilwara and we don't not have even a single drop of water in the ground. There are nearly 800-900 houses in the village and not a single house, a single house whether of rich or poor now practices agriculture…..only drinking water is there…..but here in apartment, water is there for entire day ….there is no shortage and there are two bore wells of 600 ft. each….as soon as water tank gets empty we just on the bore wells….everything is about money …..Everyone one here is a millionaire….*"

In addition to the financial resource which can overcome any physical constraint through terrain specific technology, the geology of the place also plays a very important role. The example of this was experienced in two households one HIG and one LIG having water in their bore well at around 120 ft. (Table XIV). Mr. Chittar, categorized under LIG household and residing in the peripheral area of Azad Nagar expresses his happiness for groundwater at such a low depth "*What is actually inside the ground nobody can tell……we have water at only 120 ft. but many people in this area have dug bores up to 400-500 ft. but there is no water…in our case it is God's and ancestors' bliss …we run bore well for nearly 4-5 hours every day…..*"

6.3 Groundwater as Social Capital

The individual financial constraints, augmenting needs, subjectively insufficient Municipal Supply and environmental concerns (as was seen in one case) have led to the collective alliance for pumping ground water through community owned bore wells. Constituting 6.16 per cent of the total primary source, the nine community bore well in the sample households are scattered throughout the urban area – two being in core areas, four in intermediary areas near to core, one in area near to periphery and two in peripheral areas.

Dr. O.P. Kalia, retired Vetrenary doctor and a resident of Mahesh Nagar (near to core area) gives insight "*…We installed bore well around 1975 in the area and earlier there were 20 beneficiaries in the starting……..with time more residents got connected with the supply and at present nearly 110 are getting benefitted……..the level of water has gone down significantly and we had to increase the depth from time to time with the contribution from all …..there are nine to twelve families that are not economically well-off and accordingly they give amount as per their convenience……..though more households approached us for availing the qualitative facility recently but the association has not allowed to add further members as it will affect the supply quantity for all families and more particularly in summer ….."*

Mr. Nilesh Jain, retired banker enumerates "*...In our colony almost all the domestic bore wells started drying up around 2004 and the water level significantly went down to nearly 350-400 ft. ...there were some well off households who could still bar the cost and dug their bores further but majority of colony residents were struggling and mainly depended on a hand pump at that time for drinking water…while we were continually urging administration to provide pipe lines but it could have taken time…seeing all this all of us together decided to dwell a collective machinery for pumping water…..even the well-off residents co-operated us and abandon their view to further deepen bore wells….today we have only one bore well in the locality of*

70 households since 2004 and every week on Sunday the locality residents devote time in constructing the collective rain water harvesting structures……"

6.5 Availability, Consumption and Mitigation Mechanisms in Socio-Economic Category

With different primary sources, varying supply duration (within the areas and also with seasons) and subjective consumptions, it was extremely difficult to quantitatively measure the amount of freshwater consumed in each household. With empirical observations and informal-formal discussions, a largely "qualitative" consumption pattern can be traced which corresponds to maximum usage of water in few of HIG and apartment households (but not true in all cases).

While the basic activities like bathing tend to show largely the same consumption of fresh water, 15-20 litres per person in one bath (93.2 per cent households), and domestic consumption increases with the addition of assets in the family. This includes household members, built-up area of house, gardens, swimming pool, washing machine, flush mechanism, water purification systems, coolers etc. All the material assets seemed to increase with the categorized categories but as such a pattern again could not established owing to large degree of heterogeneity involved. The increasing consumption within the categories is to some extent reflected through the number and type of secondary source used by the households. While all the apartments rely on their private bore wells, 15 of them are having multiple connections to use the supply as a supplement. The high resort to secondary sources is seen in case of HIG households, 13 of which order private tanker and 8 have taken Municipal supply of 120 lpcd as addendum.

Table XV: Secondary Sources in Socio Economic Category

Category	Municipal Tap Water	Hand Pump	Bore well Private	Private Tanker	Total
HIG	8	0	4	13	31
MIG	6	0	2	8	14
LIG	0	0	0	2	2
Slum	1	4	1	0	5
Appartment	15	0	0	2	8
Total	30	4	7	25	60

Source-Primary Data, 2011.

The rate of consumption is also reflected partly by the mitigating mechanism used to secure the household from real or perceived qualitative-quantitative scarcity. It is to be noted that among the total 83 households dependent primarily on municipal supply, 75 .90 per cent (63 households) do not use any purification mechanism, largely implying the good and reliable quality of delivery. The maximum users of the purifier are those using private bore wells (23.97 per cent in total sample) and within the socio-economic categories HIG and apartment residents. Of the 32 and 22 sample residents in the two, 59.38 per cent of HIG and 100.00 per cent of apartment residents avail the "better quality" purified water through the machineries, compared to zero per cent in case of slums and 3.13 per cent of LIG households.

Another important element of maintaining the security is the storage capacity of overhead and underground tank which of the 94 households (63.7 per cent) possess. Of all the household categories HIG sample households have the maximum number of owners among which also the majority of them have the tanks in the range of 3000-7500 litre capacity. Also out of the total 22 apartment residents 15 have the storage tanks of more than 1000 litre storage capacity while the other residents of the category use their private bore wells to directly fill the overhead tanks.

Figure XIV: Number of Households with Storage Tanks

Source- Primary Data, 2011.

Table XVII: Variation of Storage Capacity with Household Categories

Category	Capacity of Underground Tank (in Litre) and Number of Households							Total
	>500	501-1000	1001-3000	3001-5000	5001-7500	7500-1000	>10000	
HIG	0	4	2	12	10	2	0	30
MIG	0	0	12	9	6	1	0	28
LIG	2	4	11	4	0	0	0	21
Slum	0	0	0	0	0	0	0	0
Appartment	0	0	0	0	1	1	13	15
Total	2	8	25	25	17	4	13	94
Percentage	2.13	8.51	26.60	26.60	18.09	4.26	13.83	100

Note- Of the Total Sample of 146 households, 52 households do not possess storage tank among which – 2 are HIG, 4 MIG, 11 LIG, 28 Slum and 7 are apartment residents. Source – Primary Data, 2011.

6.6 *Rural Scenario*

The situation is even worst in villages. There are villages like Attoon, Kherapad, Mandal, Bilia (Owing to their geography), which have emerged as the prominent sites for ground water draft, both by industries and large farmers. While the large farmers earn a significant income through the sale of water to both industries and urban households, small farmers of the region are slowly giving up traditional agriculture and most of them are employed as labourers in the industries.

The objective of textile industries is to make profit at any cost through the optimal use of resources till the last drop. Glimpses of such greed are seen in the villages of Guadi, Kanyakhedi and Gadarmala, where industries pumped out water for decades and later utilized the same dried up bore wells as dumping sites for toxic effluents. The agricultural practices in these villages have been completely ruined with all the sections of the farmers, (rich, small and marginal), struggling very hard for the sustenance. The continuous waste disposal has contaminated all the ground water reserves of the village and there is no suitable drinking water in wells and hand pump. In an environment of high resentment, industries being sole responsible for scarcity, are now supplying drinking water to these villages via industrial water tankers.

With the continuous illegal waste disposal resulting in soil depletion and ground water quality, villagers of Mangrop, Ratanpura, Jhopdiya and Siyar united in 2006 and headed a mass movement against this illegal disposition. The movement lasted for about three and a half years and it yield a positive result marked by improvement in quality of ground water and better agricultural production. The dumping which was stopped for about three years has started yet again. Residents of these villagers say “These industries with their financial and political power can buy everything and even the moral of person”. Some of the heading the movement are no more interested in continuing the struggle.

While the entire village in the absence of piped water seem to be more vulnerable, but it is the lower caste community which is facing the paucity at every level of life. Subjected to caste dynamics, the lower caste inhabitants live at the mercy of higher caste to withdraw water from "community wells", pertaining to caste hierarchy in the authority over the resources. Though the government and industries supply water for the village but the first claim over the tanker is of the higher castes.

Many times higher caste households do not show generosity in giving water to the lower castes, the same households are engaged in water trade within and outside the village. Water is no more a Common Property Resource but has transformed into a "property" subjected to an individual ownership.

While industries and government assert that the water scarcity is mainly due to the cultivation of water intensive crop mainly wheat, the argument was not supported by the ground realities of the visited villages (Located on periphery of the city). Low rainfall with the existing ground water scarcity and contamination of water reserves has reduced the soil fertility and the corresponding yield by nearly 60 per cent. While large and few medium farmers, with powerful water pumps are still continuing wheat as the main cultivation crop, small farmers have shifted towards low water intensive crop like barley, sorghum, millet, and maize.

The agriculture production is highly conditioned by the rainfall pattern and varies accordingly. A factor which is noteworthy is that the textile production, despite of years of low rainfall and 2008 drought, has shown an exponential growth with the limitless ground water exploitation. The past year of 2010 was significant in the economy of the region, with most of the large scale industries proposed blue print to increase their existing capacity to 1.5-2 times . These units include RSWM Gulabpura and Bilwara), Sangam Suitings, Tiwari Processors, Kanchan Spinners, BSL Suitings. While the industries crying for decreased margin of profit, the balance sheet of these units reveal a different story. While the urban area is facing water scarcity at the level of household in terms drinking, the villages of the district are encountering it at a much broader level of both life and livelihood, both of which are entirely dependent on this gift of nature.

6.7 Struggle for Drinking Water

Water traditionally has been an essential element of rural society but contamination and depletion of water table to a depth of hundreds of metres, has now heralded a new dynamics where even drinking water is not easily available. A Case study of village Barntiya was carried out. This village lies on the banks of River Banas and in the vicinity of Industrial Centre.

The village consists of four hand pumps, two of which are in high cast Rajput hamlet, one in that of Vaishnav and Darogas and one in the Bhil habitation. There is no tapped water supply and continuous disposal of waste in the western side of the village has entirely contaminated the existing small proportion of the remaining ground water. The polluted water from hand pump is not suitable for drinking and is used for other domestic purposes like washing clothes and utensils. Traditional village setting of village Barantiya is marked by open wells more than hundred years old, which can be seen after every fifty metres of distance while walking through the fields. Continuous pumping on the east side has reduced the water table considerably but the open wells on the western portion of the village still possess water at a depth of 30-40 metres. The distinguishing feature of this well water is complete black colour, chemical odour and high toxicity, which cannot be used even for household purpose.

The village also possess five panchayat wells two of which have been dried up and remaining three are not enough to support everyone. While the low powered pumps of the Bhils are unable to withdraw qualitative water from greater depths, quenching thirst has now become a matter of caste subjugation as the lower hierarchy majority population has to depend on Rajputs to procure water from their hand pumps and even farms. The amount to be given for drinking water and domestic use is not in accordance with the needs of the people but on the mercy of powerful landlord Rajputs. Many a times these high caste household do not agree to give water free of cost but demand a few of hours labour in their agricultural fields.

The water scarcity takes the form of exigency in the summer when every drop of water means a lot for Bhil household. Requesting again and again in the village panchayat resulted in a positive result, when water tankers were assured for the community. Against the decided supply of eight water tankers a week, villagers receive four tankers, first claim on which is of Vaishnavs and Daroga. An interesting fact to notice is that, all the tankers are supplied by the Rajputs of the same village and the panchayat pays to them.

Water scarcity has most bearing on the women of the village. In face of urgency, Bhils have to go to Swaroopganj, crossing one kilometre of hot river bed to procure water through the common hand pump. Facing an extreme paucity for almost four years, it was in 2010 that Bhils surrounded the industrial pumping station in the villages and demanded water from them, seeking them as the main culprit in disturbing the water balance of the village. Facing amid protest, Bhils are now supplied with two water tankers by industries in a week.

While, the Bhils are managing in a better way (as compared to previous years) to cope with scarcity in quantitative manner, the qualitative aspect of the scarcity still remains unaddressed. Within the sample, Gagan(32 years) and Pawna(43 years) (Bhil) were suffering from typhoid while Leela (14 years) was suffering from malaria. Water borne diseases are common in this village but there is no primary health centre.

While drinking water is everyday requirement for human existence, the differential aspects and extent of this water scarcity puts a question on human survival involving the political social dynamics of industries, government and caste system.

7. Conclusion

Facilitating an enhanced circulation of capital(s) in a post-industrial and polycentric environment, contemporary urban areas now entail much complex socio-spatial processes. Cited as epicentre for human progress, urban areas constitute an uneven social-geography that essentially emerges out of regional culture, resources, and differential stakes in global production-consumption processes. The material form of these class-ethnic dynamics manifests itself noticeably in terms of changing built environment, and constituting living spaces. Though interdependent and in continuous interaction with each other, these living spaces play a deterministic role in (re) enforcing and (re) producing inequalities at multiple levels and in spectral realms.

Acknowledging the consequentialist role of social-spatial configuration in accessing decimating natural resources and urban amenities, the present paper focuses on socio-ecology of the groundwater depletion in Textile City of Bhilwara and its surrounding peripheral region.

Increasing sectorial demands and differential physical-economic accessibility of various resources in the region, have resulted in territorialisation of land by varied institutions and even communities. With each individual and system attempting to appropriate its rights over the freshwater resources optimally, Bhilwara is witnessing multi-inter-trans disciplinary politics that constitutes groundwater markets and inequitable water distribution networks. In addition to this, the present groundwater extraction rate of nearly 230.14 per cent (in 2014) in the region and the extrapolated negative future availability of dynamic resource further aggravates the gravity of the issue. It is in the midst of these dynamics that the paper illustrates the differential usages of groundwater by various institutions and interest groups.

Segregating individual households on the basis of built-up area and their locations from the city core, this paper presented subjective experiences in accessing groundwater and freshwater for daily consumption. The major findings of the study reveal that social-spatial differences play an important role in determining the extent of resource use. While most industries and higher income group residents violate Central and State Groundwater Board guidelines in extracting groundwater, slum residents do not even have a prescribed supply of 40 litres of water per capita a day. Variation is also seen in terms of accessibility, as slum residents in majority of cases procure freshwater from a distant government source, resulting in loss of physical labour, opportunity cost, compulsion for open defecation and thereby stress (and also loss of dignity) for women and elderly. In between these two extreme class habitats, the middle class of the city seems to either adapt itself to the government supply or are devising community bore wells for collective use. These approaches though do not take sustainability of the depleting resource into account, yet reaffirm the role of groundwater as social capital.

An important observation to be made here is that though social-spatial elements play an important role, yet these do not transcribe a pattern, thereby asserting subjective nature of felt scarcity and associated perceptions. The interfusion of geological, spatial, economic and cultural elements, along with the number of family members and lifestyles, sets a transient equilibrium between needs, availability, accessibility, consumption and coping mechanisms. It is with these observations that this paper provided a comprehensive account of existing social-spatial inequalities and administrative lacunas that have further perpetuated inequitable usage-distribution of freshwater among different interest groups and individual households in the Bhilwara urban area.

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Migration and Flood in Char Areas, Pabna, Bangladesh

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Char area is the flood-caused reclaimed land with silt. Char dwellers rely on the flood conveyed fertile soil and monsoon rain for agriculture. The livelihood in char area is affected by flood every year. Flood causes erosion, low yield of crops and food shortage, as a result, seasonal migration is needed for char dwellers. Seasonal migration is an adaptation strategy to attenuate seasonal deprivation. Usually they migrate to neighboring urban cities temporally. Sometimes char villagers migrate to other neighboring chars together. Because of the increasing population and extreme river flood caused by climate change, people who live along the river / char area have more possibility to lose their house and living land recently. In addition, duration of food shortage becomes longer because of extreme river flood. As a result of losing their jobs and land in addition to the shortage of food, internal migration is growing very rapidly. Usually they migrate to big urban cities like Dhaka.

In this research, livelihood, migration issues and needs of a char area in Pabna are analyzed based on the semi-structured survey and questionnaire survey implemented in 2014. The local people know the annual flood disaster risk reduction. As the major way of disaster preparedness, it is encouraged to elevate their houses. Their main disaster response is placing sand bags along the eroding bank. If their farm land and/or living place are damaged or eroded, they find places to evacuate / move. They negotiate boat / vehicle owners to move with their assets. It became clear in the survey, though information of evacuation places or temporary living places are their most interest during and after floods, these information are not provided, therefore they migrate / move based on their experience. This traditional way is less effective to extreme floods, since the scale of flood / erosion is bigger and the duration of flood / inundation is longer. However, people still try to respond to the extreme flood with the same way.

Based on the result, it can be said that living in a same place for a long time will secure agricultural jobs and food. Since char dwellers do not know which char exist longer, they are not able to choose the longer existing char. As a result, technology intervention for predicting longer existing char is considered to be a way to reduce the migration issues.

1. Introduction

Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009 rightly weighted the linkage of the climate change and disaster potentials that climate change is considered to change the nature of floods, influencing not only the intensity, but also the duration and magnitude in the world. Social change is also considered to affect the damage of flood disasters. Due to population pressure and scarcity of land, many poor communities are obliged to live in river flood area such as char area. People who live in river flood area are able to utilize the flood-conveyed fertile soil for agriculture, however extreme floods destroy their living places and farm lands.

In this research, local people's livelihood is reviewed first, then issues on extreme flood disaster risk reduction are analyzed based on the result of questionnaire survey. Lastly one possible technology intervention is suggested.

2. Background

Almost every year, Bangladesh experiences floods because of its topography and climate. Bangladesh is a deltaic country located at lower part of the basins of the three mighty rivers - the Ganges, the Brahmaputra, and the Meghna which is commonly known as the GBM river system ranking as one of the largest river systems in the world **(Figure 1.1)**.

Figure 1.1 The Ganges, Brahmaputra and Meghna basins (Mirza and Monirul 2002)

Almost half of the area is within 10 meters above mean sea level, and 80% of the country is the flood plains. Humid, warm and tropical climate are also the triggers of flood. There are four prominent seasons, namely, winter (December to February), Pre-monsoon (March to May), Monsoon (June to early October) and Post-monsoon (late October to November). Heavy rainfall in monsoon is a cause of flood in Bangladesh. The annual rainfall is at least 2000 mm in most parts of the country except relatively dry western region with annual rainfall about 1600 mm. In addition to the rainfall in Bangladesh, rainfall in India, Nepal, China and Bhutan flows into Bangladesh through three mighty rivers, their tributaries and distributaries. As a result of monsoon and flat topography, floods are annual phenomena.

2.1 Climate change -impact on agriculture

Climate change is expected to increase the frequency and magnitude of many types of extreme events, including floods, droughts, tropical cyclones and wildfires (IPCC 2007). Both sea-level rise and other climate-induced changes could submerge one-fifth of the current land of Bangladesh (Stern, 2007), and sea level rise has already caused land erosion, increased salinity in coastal areas, and affected biodiversity leading to reduction of food production and fisheries in Bangladesh (Khatun 2013). Mirza et al. (2003) examined the implications of climate change induced floods in the GBM rivers and predicted that a mean temperature rise of 6^{o}C will lead to an increase in the mean flooded area of 20-40%, and about 55% of the flooded landscape will be under deeper water.

The frequency of above-normal / above-common floods is showing an increasing trend since 1950 (Hofer and Messerli, 2006). According to (NPDM 2010), approximately, 37%, 43%, 52% and 68% of the country is inundated with floods of return periods of 10, 20, 50 and 100 years. However, roughly one-third of the country gets severely affected by floods once in every 10 years, while catastrophic yeas such as 1988, 1998 and 2004 more than 60% of the country was inundated (Brouwer et al, 2007). (GoB, 2009) also estimated Bangladesh faces serious flooding that may submerge over 60% of the country every 4 to 5 years, at present.

Floods convey silt and keep the soil fertile. Rice is the staple of Bangladesh and the traditional rice agriculture is dependent on the monsoon rain and river flood. However, the increased volume of rainfall caused by climate change during the past decades has intensified the flood problem in Bangladesh (Brouwer et al., 2007). Almost 74% of the country is cultivated, and a significant proportion of the agricultural output comes from the fertile basin of the GBM rivers (Brammer and Khan, 1991). Yu et al. (2010) have demonstrated that there will be increased flow in the GBM rivers up to 20%, resulting in declining national crop production with a pronounced detrimental economic impact. Thus, climate change is likely to pose problems on food supplies also, because agriculture is so dependent on the monsoon (Shukla 2003). Food production is being disrupted by flooding more frequently and more severely than before due to climate change (Douglas 2009).

In addition to the climate change, social changes also affect the damage of floods. One of the social changes is expanding population. More and more people are forced to live in flood prone area.

2.2 Social change -Population pressure and migration

More people, houses and infrastructure are likely to be affected by floods as an increased number of people will be living in floodplains. Its population density makes it especially vulnerable to high rates of mortality and morbidity (Cash 2013). Bangladesh has 166 million people (in 2014) and has high population density, 1,277.4 persons / km^2 (CIA World Fact Book, 2014). Bangladesh is a country with great geographical vulnerability, with 70% of the population living in regions at risk of floods and 26% in regions at risk of cyclones (Disaster Management Bureau 2010). According to the Bangladesh Water Development Board about 1,200 km of river banks are actively eroding and about 100,000 people living on the river banks are affected (Zimmermann 2010). Most low-lying areas may remain under water for three to four months during the annual floods (Younus 2014). People who live in close to GBM rivers had no alternatives but to move to a new place for resettlement or for temporary shelter due to loss of land by riverbank erosion. Increased river bank erosion and saline water intrusion in coastal areas are likely to displace hundreds of thousands of people who will be forced to migrate, often to slums in Dhaka and other big cities (Ministry of Environment and Forests 2009). People who live in river flood area also forced to migrate especially during floods.

3. Annual and extreme river flood in Bangladesh

Table 3.1 shows the differences between annual common and extreme river floods in Bangladesh. Annual common floods occur every year for about two months and affect approximately 20% of the country, and the flood brought fertile soil is effective for farming.

Table 3.1: Differences between common and extreme river floods in Bangladesh

	Annual common floods	Extreme floods
Duration	Two months from July to August	More than two months
Affected area	20%	60-70%
Frequency	Every year	Once in 10 years (1988, 1998, 2004)
Indigenous knowledge	Effective	Relatively less effective
Farming	Effective	Destructive

Since people know how to utilize the characteristics of annual floods, annual floods are not harmful. Indigenous knowledge is effective for annual flood risk reduction. It is rare to lose their lives because of flood, however they have possibility to lose their lives because of hunger caused by low yield of crops and food shortage in case of extreme flood. In addition, in case of extreme flood, they may lose their lands. Extreme floods cause social disruptions.

4. Livelihood of char dwellers in river flood area

In this research char area in river flood area is focused. Char areas are lands formed by the continual process of erosion and deposition in floodplain and riverine areas. It is estimated that 6.5 million people live on chars and erosion and flood prone areas, which are 5% of the total population of Bangladesh, and 5 million live on the main river char lands and the rest (approximately 2 million) live on the coastal chars (Kabir 2006). More people, houses and infrastructure are likely to be affected by floods if the number of people who live in floodplains is increased.

1.1 General Issues for the Char Dwellers

Annual blessed rain-induced flood keeps the soil fertile and secures the traditional monsoon farming there, hence char dwellers rely on the traditional farming. Char dwellers manage to maintain their livelihood mainly by engaging in agriculture, fish farming, small businesses, riding rental rickshaws, day labors, and other miscellaneous daily jobs (Union Disaster Management Committee 2012). As a result, their livelihood is affected by environmental conditions such as floods, drought and river erosion. Every year char dwellers endure living in flood for a few months in flood season. Most low-lying areas may remain under water for three to four months during the annual / common floods (Younus 2014). In addition to the physical risks associated with environmental conditions, char dwellers has social issues.

Followings are the summary of general issues in char area

- They are vulnerable to land erosion by the river, floods, droughts, and storms.

- Lack of physical security even at home.

- Char areas are isolated from the public and private services, such as education, medical care, security, bank and information, etc., because of the poor communication networks. Boat is the only transportation method in most char areas (Union Disaster Management Committee 2012).

- While char dwellers seem to expect many public or private services and assistance, public services are few and poor quality and the linkage with the local government officials are weak, except during emergencies.

- Usually, there is no state agencies' support for migrants to move and settle to new places, except during emergencies (Martin et al., 2013).

- Frequent movement, mostly by boat, makes char dwellers difficult to increase their physical and financial assets.

- Employment and income generation opportunities are limited.

1.2 **Structural measures**

The local people know how to confront the annual flood. Their indigenous knowledge such as elevating houses **(Figure. 4.1)** is effective for annual common floods. It is a major way of disaster preparedness. Their main response to flood/erosion is placing sandbags along riverbanks for preventing erosion **(Figure 4.2).**

Figure 4.1: Living in elevated houses next to flooded river (Sundarganj, Gaibandha in Aug. 2014)

Figure 4.2: Sandbags for preventing erosion (Fulcchari, Gaibandha in Dec. 2014)

1.3 **Non-structural measures -Seasonal migration and internal migration as an adaptation strategy**

Migration is the major non-structural measure in char areas. In case of flood in char areas, it is rare to lose their lives directly because of flood, however they have possibility to lose their lives because of hunger. Therefore they migrate for food. Flood is one of the main reasons of migration from one place to another in Bangladesh (Khatun 2013). In addition to the seasonal migration, they move several times in their lifetimes because of food shortage and/or losing

their land by erosion. The erosion takes away not only people's homes but also often their farming land (Zaman 1989). In addition, because of the increasing population and extreme river flood caused by climate change, which scale is bigger and duration is longer than annual flood, people who live along the river / char area have more possibility to become food shortage and lose their houses and lands recently. Riverbank erosion displaces 50,000 to 200,000 people in Bangladesh every year (Mehedi 2010), and internal long distance migration to urban areas is showing a sharp increase (Planning Commission 2010).

4.3.1 Seasonal migration for annual flood

Annual cycle of monsoon and drought is a part of their lives and they adopt strategies of seasonal pattern. Flood causes low yield of crops and food shortage, as a result, seasonal migration is needed for char dwellers. Usually the villagers evacuate or migrate by themselves since they consider their experience to tell the timing of evacuation is more reliable than any other information. When the flood water levels go down, they come back to their char and repair their damaged homesteads, plinths, houses, kitchens, toilets, tube-wells, etc. This seasonal / circular migration is an important strategy for char dwellers. If their char land is totally inundated and they lose their place to go back, communities get displaced together to other neighboring chars.

Since char dwellers are the poorest people in Bangladesh (Kabir 2006, Ministry of Environment and Forests 2009), they do not have enough money to purchase or borrow stable land. Therefore, they move to another not expensive newly developed or vulnerable char again. In addition, since they evacuate or temporary migrate mostly by boat, it is difficult to carry all assets including livestock, hence it is difficult to increase their property. Over 50% of the people who live below the poverty line are deprived of their basic needs. People often become poorer after they lose their households, croplands, and other valuable assets encountering flood and erosion (Khatun 2013). Decision to live in the char areas made them extremely vulnerable to floods (Asian Development Bank, 2008). Thus, char dwellers are trapped in the vicious cycle of poverty.

The poorest char dwellers, who cannot pay for land, may live in government provided char lands without buying land or paying rent to anyone. Instead of the duty exemption, they may lose opportunity to get official services such as medical care and education.

4.3.2 Internal migration for extreme flood

In addition to the seasonal migration, internal migration is also seen because of population increase and extreme flood. Due to population pressure and scarcity of land and food many people give up to live as farmers and migrate to urban areas for getting daily income.

Flooding is not a strong driver of the long-term and long-distance migration in Bangladesh if it is compared to crop failure. If the land-lost char dwellers are not able to find the new place for farming in neighboring chars, they move to urban cities and often become wage labors. Food shortages are already prevalent in the rural areas, particularly in the char lands, every year males in these areas migrate to cities and better-off villages for work (Siddiqui 2009). Rural poor migrants to Dhaka city generally settle in slum and squatter settlements (Afsar, 1999).

4 Semi-structured interview and questionnaire survey

Semi-structured interview and questionnaire surveys were implemented in 2014 at a char area along Ganges River in Pabna District for perceiving the char dwellers' livelihood, issues and

perception of flood. The result is analyzed for transferring Japanese technology.

4.1 Pabna District

Pabna District was selected for questionnaire survey considering the high coverage of char land. It locates in the west part of Bangladesh (**Figure 5.1**), which is in the mid char region. Two mighty rivers, Ganges and Jamuna rivers are flowing next to Pabna. Floods and river erosions regularly strike this district due to its geographical location. Total area is 2376.13 sq. km, with land area 2215.97 and riverine area 160.16. The elevation is 8 m and most of the land area is flood plain and marsh land. Average maximum temperature of Pabna District is 36.8 °C, minimum is 9.6 °C; annual rainfall is 1872 mm. The total population of Pabna is 2.5 million in 2011 census, and density increased 1.47%/year from 2001 to 2011. Average literacy rate for male is 51.8% and female is 31.5%.

4.2 Survey in Bharara union, Pabna Sadar Upazila, Pabna District

The survey was implemented at Ratonpur hat village in a char area, Bharara Union. The area is about 80 sq. km. According to the census 2001, the population is 45,245 and the literacy rate is 28.87%. Nowadays, the frequency and severity of these disasters are increasing due to the climate change.

Figure 5.1: Pabna District and selected area, Bharara

The number of respondent is 50 with 30% male and 70% female. 24% are farmers, 18% are laborers and 62% are others in the surveyed area. **Figure 5.2** is their basic information. The dominant age ranges are 20s (30%), 30s (32%), and 40s (20%). 58% are illiterate. Regarding education, many of the mainland teachers commute to primary schools in the char, however it is impossible to have teachers in school regularly, especially during flood season due to security reason. Thus children in char area are not able to get even primary education satisfactory.

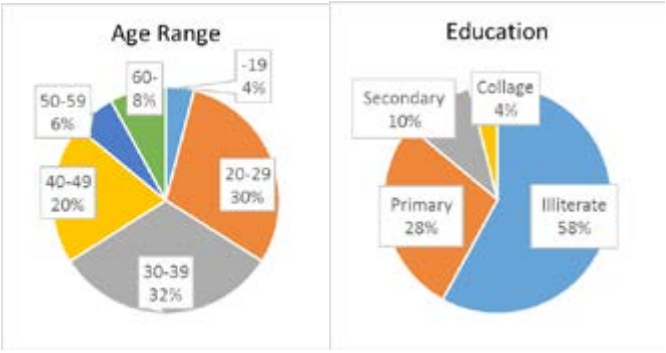

Figure 5.2: Basic information for 50 respondents in Ratonpur hat

It is asked "what is the challenges to overcome flood risk", and all respondents choose "very poor", 28 respondents choose "no support" and 16 respondents choose "frequent moving" **(Figure 5.3)**. Most of the respondents had moved for several times **(Figure 5.4)** because of flood / erosion induced issues such as losing land, losing job, food shortage etc.

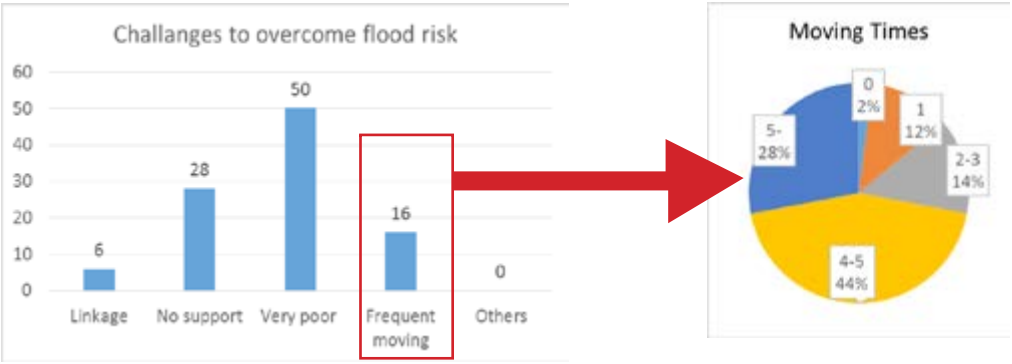

Figure 5.3: Challenges to overcome flood risk (multiple answer allowed) **Figure 5.4:** Frequency (times) of moving since they are born

The next question is about the issues due to floods "Which types of problem do you face due to flood?" and the respondents are able to select three. As the result shows, "Food" (31 respondents), "Hardship of woman" (25 respondents), "Domestic work disturbance" (25 respondents) and "School dropout" (25 respondents) are the major issues due to floods **(Figure 5.5)**. "Food" and "Domestic work disturbance" are the answers which is common in char areas. It is considered that since their working places, farmlands, are damaged or lost, they are not able to obtain food from their farmlands and not able to work at their farmland. Regarding "school dropout", if the school is located in a char, the school and the road to the school may be damaged by erosion. Even if the school is not damaged, the mainland teachers have difficulty to access the char. If the school is located outside the char, students who live char have difficulty to access the mainland.

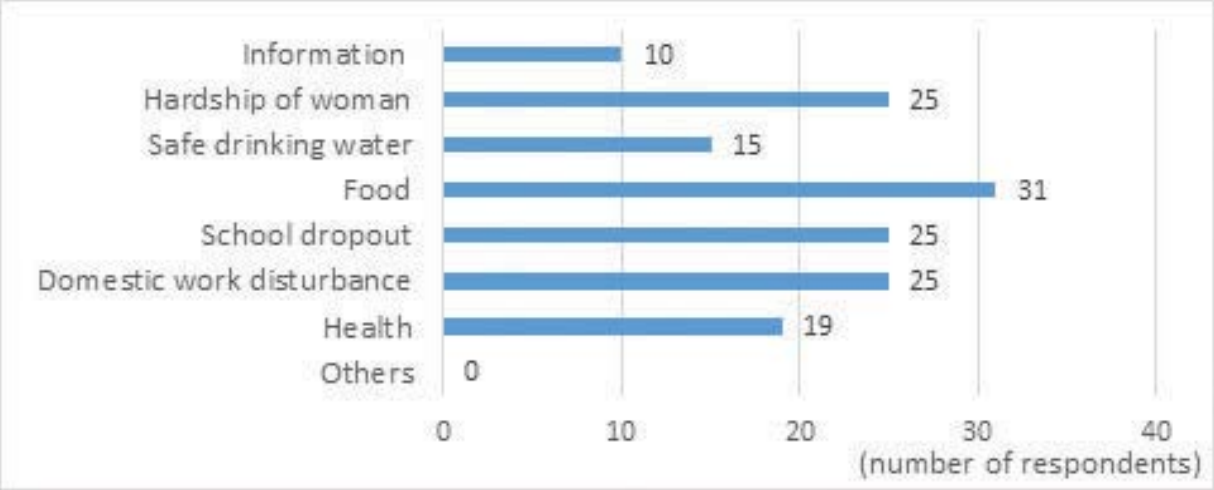

Figure5.5: Issues due to flood

Then necessary information during flood is also asked. The question is "What kind of information did you need during floods?" and the respondents are able to select three. Since the recent serious flood occurred in 2010, respondents answered thinking about the flood. They are interested in getting information about "Available safe area to move" and "Road condition" **(Figure 5.6)**. 38 respondents chose "Available safe area to move". As Figure 5.4 shows, 72% of the respondents moved more than four times, and 14% of the respondents moved two to three times because of floods since they are born. Though migrating / moving is an indigenous knowledge for flood disaster risk reduction, moving makes them poorer. The result shows information of the available area to move / migrate is not provided. If longer existing area is informed, it is effective for them to reduce the frequency of moving and increase their assets more.

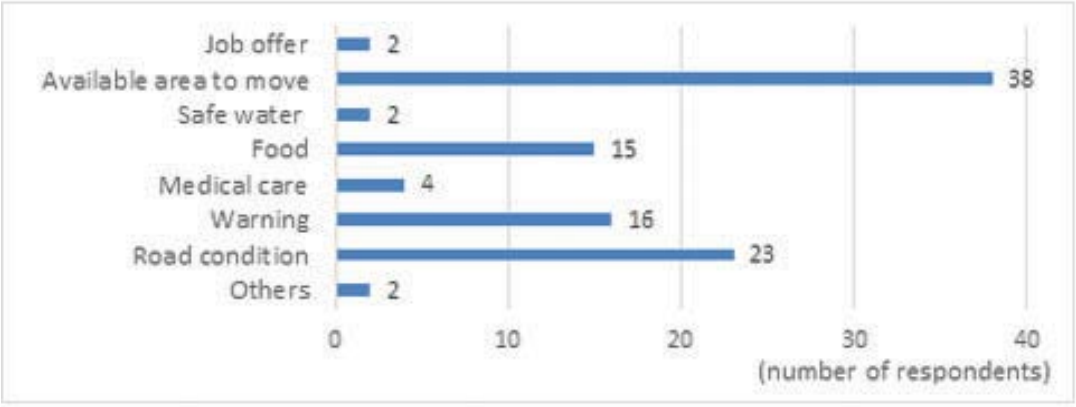

Figure 5.6: Necessary information during flood

Question about how they obtain information is also asked. The question is "How did you get necessary information during the recent flood?". The respondents are able to select three. As the result shows in **Figure 5.7**, they rely on the neighbors' information the most.

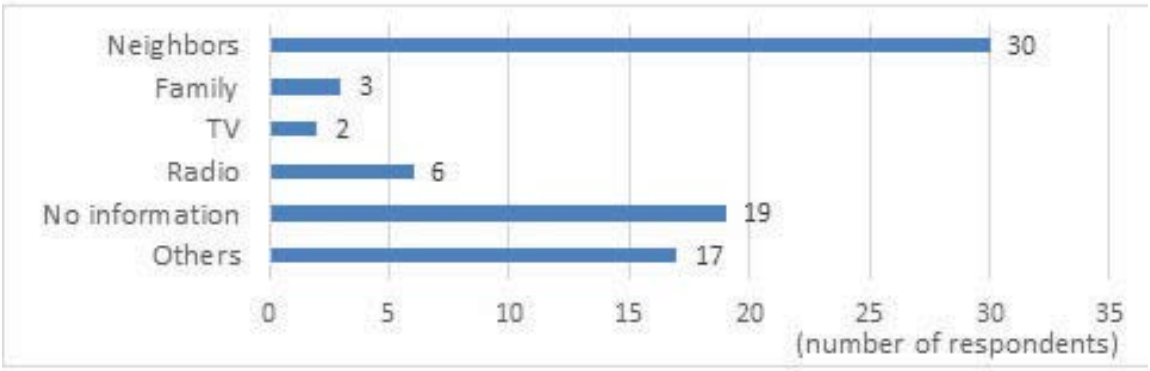

Figure 5.7: flood information resource

5 Discussion

In char areas, indigenous knowledge is effective for annual common floods. As a preparedness measure, it is effective to raise / elevate their houses with plinth. They response to flood / erosion by placing sandbags on the vulnerable riverbank and migrating. In case of river floods, people try to stay their houses as long as possible even their houses are partially inundated, because they would like to protect their assets from robbery. It takes several weeks until their houses are fully inundated, therefore, they have enough time to evacuate and they are able to decide the timing for evacuation by themselves usually. Usually the villagers evacuate or migrate together based on their experiences. Though it is effective for saving their lives, repetition of seasonal migration makes them difficult to increase their assets and properties and to continue education. Therefore, reducing the frequency of migration is considered to be important to improve their livelihood.

This traditional seasonal migration is less effective for extreme floods. However, people still try to respond to the extreme flood with the same way. Instead of short-term seasonal migration, they give up to live in char area and migrate to urban cities to get jobs.

Not only for annual flood, but also for extreme flood, evacuation places are important for saving their lives. Though evacuation places / migration places are their most interest during and after floods, information of the available area to move / migrate is not able to be managed by themselves. During the flood and evacuation, they are able to get support of safe drinking water, food and medical care by NGO, local government and so on. However, the information of available (safe) area to move is not provided.

Hazard mapping technology has possibility to tell the safe / long existing area. Hazard map has developed for destructive flood disaster risk reduction. It shows the possible place of inundation in case of flood and tells the route and temporary place of evacuation. Since this is effective for evacuating in a short term and not suitable to the char areas, the possibility of transferring hazard mapping technology is needed to be analyzed. Though hazard mapping technology is already introduced in Bangladesh, it is not used in the same way in char areas and it is not effective. However the hazard mapping technology is considered to be useful also in char areas, if it is used differently. There are three major reasons that the hazard map is difficult to be used directly. The reasons are, (1) the rivers and their village shapes change often and difficult to update maps every after flood (2) local people are not able to read maps and (3) though there

is enough time to evacuate, the duration of evacuation / migration is long. The technology to simulate the high possibility of the occurrence of erosion in the near future is useful for char dwellers to know the longer existing place. As a result, a hazard map in char areas is suitable to be used like land use map, which predict the longer existing areas. Since the result of the survey shows, there is few external information resources, Support by officials or experts, who are able to interpret the map, is essential for utilizing the map and introducing the longer existing areas.

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Title: Climate Induced Migration and Urban Vulnerability in Eastern Himalayas
Dr. Sohel Firdos

Introduction

Climate-induced migration is a highly complex issue which needs to be understood as part of global migration dynamics. Migration typically has multiple causes, and environmental factors are intertwined with other social and economic factors, which themselves can be influenced by environmental changes. Environmental migration should not be treated solely as a discrete category, set apart from other migration flows. Countries and populations of Asia and the Pacific will be affected in different ways, leading to various migration patterns and scenarios. While most environmental migration will occur within countries, an increase in cross-border migration can also be expected. These migration flows are tied up with the broader trend of rapid urbanization in Asia; mega cities will struggle to accommodate additional arrivals driven primarily or in part by environmental factors.
Many deliberations around the impact of the environment on migration have focused on humanitarian assistance and legal protection, without addressing the need to set the policy debate within a development context. Yet climate-induced migration needs to be addressed as part of the development agenda given the major implications of migration for the sustainable economic and social development of Asia. This paper recommends interventions both to address the situation of those who have migrated, as well as those who remain in areas subject to environmental risk. To reduce migration compelled by worsening environmental conditions, and to strengthen resilience of at-risk communities, governments should adopt policies and commit financing to social protection, livelihoods development, basic urban infrastructure development, and disaster risk management. Though every effort should be made to ensure that people can stay where they live, it is also important to recognize that migration can also be a way for people to cope with environmental changes. If properly managed, and efforts made to protect the rights of migrants, migration can provide substantial benefits to both origin and destination areas, as well as to the migrants themselves. However, migrants – particularly low-skilled ones – are among the most vulnerable people in society and are often denied basic protections and access to services. More targeted, policy-relevant research is needed on the interaction between the environment and migration, both on the qualitative and on the quantitative side, and on a sex-disaggregated basis. In many countries, the capacity to undertake and analyze research must itself be strengthened.
The displacement of people due to environmental events has received increased attention in recent years, yet much uncertainty remains about the way populations will actually react to long-term environmental change. The relationship between climate change and migration flows is often thought to be of a deterministic nature, where all populations living in regions affected by climate change would be forced to relocate. Many empirical studies show, however, that this relationship is far more complex, and is compounded by a wide range of social, economic, and political factors (Foresight 2011; Jäger et al. 2009). Environmental changes in general, and those associated with climate change in particular, are increasingly recognized as growing drivers of migration across the world. Because of the unavoidability of these impacts, mitigation alone will not suffice to fight climate change; it needs to be complemented by adaptation measures. Adaptation seeks to alleviate the impacts of climate change by increasing the resilience of people and communities to these impacts. Though mitigation and adaptation measures once used to be seen as two possible alternatives, it is now recognized that both will need to be implemented in order to fight climate change. In Asia and the Pacific, large numbers of people are displaced every year due to floods, droughts, soil degradation, typhoons, and cyclones. Poor people suffer a disproportionate

share of deaths, displacement, and damage associated with such events. Forced by poverty to inhabit the low-lying coastal deltas, river banks, flood plains, steep slopes, and degraded urban environments where the impact is most severe, they are least able to rebuild when their homes and communities are battered by extreme weather. Though the region is expected to be profoundly impacted by climate change in the coming decades, it is also expected to undergo other significant social, political, and economic transformations. Thus, migration behaviors are likely to be influenced by this wide range of transformations, ranging from climate change to cheaper travel. Public policies, including adaptation strategies and migration management, will also play a determining role in the nature and extent of the movement of people.

We consider long-term environmental change as a growing driver of migration. Climate change will accentuate the impact of the environment on human displacement. Migration flows associated with the environment will be intertwined with broader migration dynamics, and therefore should not be considered in isolation. Understanding environmental migration as part of a global transformation process constitutes a major ambition of this work, as well as a necessary condition for sound migration and adaptation policies. Changing weather patterns such as less predictable seasons, increasing events of erratic rainfall or prolonged droughts are the most important factors threatening the sustainability of agriculture and food security (IPCC, 2001). Dwindling agricultural productivity interacts with a range of escalating stresses on rural livelihoods, that is, land pressure, soil erosion, deforestation and depleted water resources that would otherwise exist regardless of the climate change (Iglesias et al., 2007). When livelihoods are subjected to continuous stress, farmers and farm labours might migrate either seasonally, temporarily or permanently and consider it as the most immediate coping strategy (Afifi, 2011; Afifi & Warner, 2008).

Theoretical Approaches to Climate Induced Migration

Among social scientists seeking to model human migration theoretically and study it empirically, attention has generally focused on economic, social, and to a lesser extent, cultural factors. Neoclassical economists specify geographic discontinuities in wage rates as the driving force behind both internal and international migration, whereas those subscribing to the new economics of labour migration attribute it to failures in local markets for capital, credit, and insurance(cf. Todaro and Maruszko 1987; Stark 1991). Institutional theorists view migration as a response to structural shifts experienced by societies as they move toward markets and integrate within global regimes of trade and investment, which leads to population displacements that produce both internal and international mobility (cf. North 1981; Sassen 1988). Sociologists have emphasized the embeddedness of decision-makers within social organizations(Portes and Sensenbrenner1 993), notably migrant networks that yield social capital to facilitate movement (Massey 1990). Anthropologists, as well as sociologists, have sought to incorporate culture into the analysis (Kearney 1986), the former by considering the subjective meanings of migration to individuals and groups (Rouse 1991, 1992) and the latter by hypothesizing a "culture of migration" that contributes to the cumulative causation of migration over time ,most notably in the case of international migration (Kandel and Massey 2002). In none of these disciplinary accounts do environmental conditions figure as salient determinants of migrant decision-making. To the extent that environmental conditions are mentioned, they are either assumed to be a consequence of market expansion (e.g., the consolidation of landholding and the mechanization of production- see Massey et al. 1998) or they are addressed under the rubric of "population pressure" (whereby demographic growth increases demands on natural

resources to cause environmental deterioration -see Massey and Taylor 2004). Moreover, despite historical evidence indicating a lagged correlation between population growth and emigration (see Thomas 1973; Hatton and Williamson 1998), contemporary social scientists generally downplay "population pressure" as a fundamental cause of migration (Massey et al. 1998), noting that rates of natural increase are uncorrelated with rates of international out-migration around the world today (Zlotnick 2004). Despite the lack of credence given to environmental factors among social scientists, there is a growing body of evidence that both the gradual deterioration of local environments(through deforestation, aridity, desertification, and loss of biodiversity) as well as natural calamities and disasters (earthquakes, tsunamis, hurricanes, and typhoons) are fundamentally related to out-migration (Adamo and Crews-Meyer 2006; Ezra 2000; Findley 1994; Hermsmeyer 2005; Henry et al. 2004). The term "environmental refugees" was first introduced by Lester Brown (1970) and later defined by El-Hinnawi (1985) to describe people displaced through natural disasters or gradual environmental degradation. Based on his review of global conditions, Jacobsen (1988) estimated the number of environmental refugees to be 10 million in the mid-1980s, a figure that Myers (1997) put at 25 million by the mid-1990s. More recent estimates are even gloomier, suggesting a rapid increase to numbers closer to 50 million by the end of year 2010 and 150 million by the end of 2050 (Myers 1993, 2002; United Nations University 2007).

The concept of environmental refugees has been criticized for it's vagueness and lack of specificity and such numbers are often derided as inflated (see Black 1998, 2001), and Bates (2002) suggests" environmental emigrant" as an alternative. Nonetheless, the concept remains popular among environmentalists, ecologists, development activists, and some scholars(Suhrke 1994). Indeed, recent studies suggest that gradual changes in environmental conditions because of rising sea levels, drought, siltation, salinization, deforestation,and desertification often impair the ability of people to earn livelihoods, forcing them to leave places of origin and become environmental refugees(Myers and Kent 1995; Henry e t al. 2004; Adamo and Crews-Meyer20 06). As Adamo (2009) has pointed out, "frequently environ-mental 'push' factors are intertwined with economic issues." We therefore conceptualize environmental refugees to include people who are forced to move to secure their livelihood because of hardships stemming from environmental changes. One reason for the lack of consensus about environmental effects on migration is the scarcity of good data on the subject. In his review of the evidence, Castles (2002) points out that whereas Myers and Kent(1995) list millions of people at risk of environmental displacement, they do not offer counts of people who actually moved for environmental reasons. Nonetheless, specific case studies do appear to link population growth, environmental deterioration, and political violence to migration (see Henrye t al. 2004; Homer-Dixon1 991, 1994), a combination of forces that Lee (2001) calls the "environment-security nexus." However, these studies also show that environmental conditions are but one factor in a complex of causally interconnected variables whose mutual influence can not be sorted out in qualitative accounts (see Adamo and Crews-Meyer 2006; Castles 2002; Wood 2001).

Climate Change Impacts in the Eastern Himalayas

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he Eastern Himalayas extend from the Kaligandaki Valley in central Nepal to northwest Yunnan in China -- encompassing Bhutan, the North East Indian states and north Bengal hills in India, southeast Tibet and parts of Yunnan in China, and northern Myanmar – a total area of nearly 525,000 sq.km. The region spans a wide spectrum of ecological zones and contains parts of three global Biodiversity Hotspots. The five countries traversed by the Eastern Himalayas (Bhutan, China, India, Myanmar, and Nepal) have very different geo-political and

socioeconomic systems, and contain diverse cultures and ethnic groups. The region is the meeting place of three realms, namely, the Indo- Malayan, Paleoarctic, and Sino-Japanese. The region's complex topography and extreme altitudinal gradients – from less than 300 m (tropical lowlands) to more than 8000 m (high mountains) over a few hundred kilometres – have contributed to the highly varied vegetation patterns. The complex mountain topography has created diverse bioclimatic zones (near tropical, subtropical, lower temperate, upper temperate, subalpine evergreen, alpine evergreen, and alpine shrubs and meadows) and 'island-like' conditions for many species and populations, making them reproductively isolated. This isolation has given rise to genetic differences among populations, thereby contributing to the exceptionally rich array of biodiversity.

Climate change: Present and projected scenarios in Eastern Himalayas

In the Eastern Himalayas, a substantial proportion of the annual precipitation falls as snow. Climate controls river flow and glacier mass balance and varies considerably from west to east. The monsoon from the Bay of Bengal, which develops over the Indian subcontinent, produces heavy precipitation – predominantly in the southeast – and primarily synchronous summer accumulation and summer melt in the east. With rising temperatures, areas covered by permafrost and glaciers are decreasing in much of the region. In many areas a greater proportion of total precipitation appears to be falling as rain than before. As a result, snowmelt begins earlier and winter is shorter. Whereas snow masses have acted as a natural form of storage, releasing moisture slowly into the ground or rivers, water is increasingly only available at the time of precipitation. This affects river regimes, natural hazards, water supplies, people's livelihoods, and overall human wellbeing (Xu et al. 2007; Erickson et al. 2009). The Himalayan region, including the Tibetan Plateau, has shown consistent warming trends during the past 100 years (Yao et al. 2006). However, little is known in detail about the climatic characteristics of the Eastern Himalayas both because of the paucity of observations and because insufficient theoretical attention has been given to the complex interaction of spatial scales in weather and climate phenomena in mountain areas. Long-term data sets are needed to determine properly the degree and rate of climate change, but there are none available for most of the region. Despite the limitations, studies of climate in the past and projections based on climate models have increased in recent times, albeit on various spatio-temporal scales, some of which cover the Eastern Himalayas in part or as a whole. This analysis of the spatial distribution of annual and seasonal temperature trends indicates that a large part of the region is undergoing warming. Annual mean temperature is increasing at the rate of 0.01°C per year or higher. However, there is a diagonal zone from the south-west to the north-east of the region that is undergoing relatively less or even no warming. This zone encompasses the Yunnan province of China, part of the Kanchin State of Myanmar, and the far eastern part of India. The zone to the upper left of this area, including eastern Nepal and eastern Tibet, is undergoing relatively higher warming. The warming in the winter (DJF) is at a much higher rate and over a more widespread area. The analysis shows progressively greater warming rates with increasing elevation. The zone of low warming is significantly small and limited to Yunnan and Arunachal Pradesh. Overall, the analysis indicates that the Eastern Himalayas are experiencing widespread warming of generally 0.01 to 0.04°C per year; the highest rates of warming are in winter with the lowest, or even cooling, in summer; and there is progressively more warming with elevation, with areas above 4000 m experiencing the greatest warming rates (up to 0.06°C). Past trends and change projections suggest that temperatures will continue to rise and rainfall patterns will become more variable, with both localised increases and decreases. The figures for the Eastern Himalayas do not present a drastic deviation from the IPCC outcomes for South Asia, but they reinforce the scientific basis for the contention that the region is warming. The results also suggest that

the seasonal temperature fluctuations are changing in both timing and extent and the rate of change of temperature with altitude is becoming less (ie, higher altitude areas are warming faster than lower areas so the difference in temperature between them is becoming less). Annual mean temperatures are projected to increase on average by 2.9°C by the middle of the century (the projected rates of increase are much higher than the rate of increase observed up to 2000) with an average range (places/ seasons) of 2.9 to 4.3°C by the end of the century.

Projections suggest an increase in winter, pre-monsoon, monsoon, post-monsoon, and annual precipitation in the region. Annual precipitation is projected to increase by 18 per cent by the middle of the century, and by 13 to 34 per cent by the end of the century. Higher monsoon precipitation is also projected at higher altitudes (wet bias), and lower at lower altitudes (dry bias). However, uncertainties still exist in the analysis due to lack of data and comprehensiveness, as well as geographical complexities. Some of the key complexities that need to be taken into account in any attempt to understand climate change in the Eastern Himalayas are the modifying effects of the high Himalayan range, the complex physiographic environment, and the natural variations and cycles in the large-scale monsoonal circulation on weather and climate. Despite the challenges and uncertainties, certain conclusions appear to be justified. Overall the assessment indicates that the magnitude of change increases with elevation in relation to both temperature and precipitation, and further that climate change effects are likely to occur faster and be more pronounced than the global average.

Impacts of climate change: Observed and potential

Climate change will have a range of direct and indirect impacts on both the environment and the people of the Eastern Himalayan region. These impacts are closely interlinked, ranging from biodiversity impacts and related effects on ecosystem goods and services, through impacts on water balance and availability and hazards, to socioeconomic and health impacts on the population. The impacts are embedded in and affected by a range of other global and local drivers of change. The impact of climate change on biodiversity will occur in concert with well-established stressors such as habitat loss and fragmentation, invasive species, species exploitation, and environmental contamination, to name just a few (Chase et al. 1999). Problems associated with modernisation like greenhouse gas (GHG) emissions, air pollution, land use conversion, deforestation, and land degradation, are slowly creeping into mountain regions (Pandit et al. 2007). The out-migration of the rural workforce has decreased economic activities in rural areas. Thus, landscapes and communities in mountain regions are being simultaneously affected by rapid environmental and socioeconomic threats and perturbations. Climate change will have a significant effect on all natural ecosystems, but the impacts will be far greater on the already-stressed ecosystems of the Eastern Himalayas. Projections about climate change variability sound alarm bells for the fate of ecosystems and their long term sustainability. The region is particularly vulnerable to climate change due to its ecological fragility and economic marginality. The high level of poverty linked with pervasive livelihood challenges has already brought indicative changes in forest quality.

Land use and land cover changes contribute to local and regional climate change (Chase et al. 1999) and global climate warming (Houghton et al. 1999), as well as having a direct impact on biotic diversity (Chapin et al. 2000; Sala et al. 2000), influencing the reduction in species diversity (Franco et al. 2006). These changes also affect the ability of biological systems to support human needs (Vitousek et al. 1997). The impacts of climate change in the Eastern Himalayan region include changes in the hydrological regime, an increase in hazard frequency and intensity, and impacts on human health. There is evidence of noticeable

increases in the intensity and frequency of many extreme weather events in the region such as heat waves, tropical cyclones, prolonged dry spells, intense rainfall, snow avalanches, thunderstorms, and severe dust storms (Cruz et al. 2007).

Human wellbeing

The impact on hydropower plants could affect human wellbeing through reduced quality of life, reduced productivity, and loss of revenue from power export for countries like Bhutan where economic success is premised on sustained hydropower generation. This problem could be more prominent in the lower parts of the river basins. Climate change affects human wellbeing directly through extreme weather events and indirectly through its effects on ecosystems – the foundation of human wellbeing. Specific knowledge and data on human wellbeing in the Eastern Himalayas is limited, but it is clear that the effects of climate change will be felt by people in their livelihoods, health, and security, among other things. Although the Eastern Himalayas is one of the richest areas in the world for biological diversity, it is also one of poorest regions in terms of economic development. The majority of people living in the Eastern Himalayas are dependent on the goods and services provided by the biologically rich ecosystems and landscapes. As natural resources and ecosystem services decline with increasing human interference through industrial and infrastructural development and over exploitation, the human conflict and competition for scarce resources could reach alarming proportions, which, in turn, will set the context for further desolation. The consequences of biodiversity loss from climate change are likely to be the greatest for the poor and marginalised people who depend almost exclusively on natural resources. Poverty, poor infrastructure (roads, electricity, water supply, education and health care services, communication, and irrigation), reliance on subsistence farming and forest products for livelihoods, substandard health indicators (mean mortality rate [MMR] and infant mortality rate [IMR] and life expectancy), and other indicators of underdevelopment make the Eastern Himalayas more vulnerable to climate change as the capacity to adapt is inadequate. A major area of serious impact is agricultural production – the direct or indirect source of livelihood for over 70 per cent of the population in the region, and a substantial contributor to national incomes. Agriculture is highly sensitive to climate change and is expected to be affected differently throughout the region, with some places projected to experience a decline in potentially good agricultural land, while others will benefit from substantial increases in suitable areas and production potentials (Fischer et al. 2002). The management of climate hazards and climate change impacts in the agricultural sector will be critical for the viability of local communities. The positive effects of climate change – such as longer growing seasons and faster growth rates at higher altitudes – may be offset by negative factors such as changes in established reproductive patterns, migration routes, and ecosystem relationships, and not least water availability. Indirect effects will include potentially detrimental changes in diseases, pests, and weeds, the effects of which have not yet been quantified. The livelihoods of subsistence farmers and pastoral people, who make up a large portion of the rural population, could be negatively affected by a decline in forage quality, heat stress, and diseases like foot and mouth in livestock. Grassland productivity is expected to decline by as much as 40 to 90 per cent with an increase in temperature of 2 to 3°C combined with reduced precipitation (Smith et al. 1996). Climatic changes are predicted to undermine regional food security. Several studies in the past showed that the production of rice, corn, and wheat has declined due to increasing water stress arising partly from increasing temperatures and a reduction in the number of rainy days (Fischer et al. 2002; Tao et al. 2004). The net cereal production in the region is projected to decline by at least 4 to 10 per cent by the end of this century, under the most conservative climate change scenario (Lal

2005). In Bhutan, only around 16 per cent of the land is cultivable, which severely constrains agricultural production and also exposes the nation to the risk of food insecurity (Alam and Tshering 2004). Although China has made significant progress in poverty reduction and eradicating hunger, it is projected that by 2050 China's grain output could fall by as much as 10 per cent unless crop varieties adapt to new temperature and water regimes, while by the latter half of the century production of wheat and rice could drop by as much as 37 per cent (Kishan 2007). This poses new threats to food security in China. Similarly, food security is a chronic problem in Nepal, particular among hill and mountain populations and indigenous groups. However, it is believed that long-term male migration and the lengthy political conflict have also contributed to reduced food production and disrupted the food distribution in Nepal (Gill 2003). Climate change will have a wide range of health impacts across the Eastern Himalayas through, for example, increases in malnutrition due to the failure of food security; disease and injury due to extreme weather events (Epstein et al. 1995); increased burden of diarrheal diseases from deteriorating water quality; increased infectious diseases; and increased frequency of cardio-respiratory diseases from the build-up of high concentrations of air pollutants such as nitrogen dioxide (NO2), lower tropospheric and ground-level ozone, and air-borne particles in large urban areas. A reduction in wintertime deaths is anticipated; however, human health is likely to suffer chronically from heat stress (Bouchama et al. 1991; Ando 1998). In particular, the combined exposure to higher temperatures and air pollutants appears to be a critical risk factor for health during the summer months (Piver et al. 1999). Mortality due to diseases primarily associated with floods and droughts is expected to rise. In the lowlands, hygrothermal stresses (warmer and wetter conditions) will also influence increased transmission of epidemic diseases and higher incidence of heat-related infectious diseases (Martens et al. 1999). Malaria, schistosomiasis, and dengue are very sensitive to climate and are likely to spread into new regions on the margins of the existing endemic areas because of climate change. Vectors require specific ecosystems for survival and reproduction; and epidemics of these diseases can occur when their natural ecology is disturbed by environmental changes, including changes in climate (Martens et al. 1999; McMichael et al. 2001). With a rise in surface temperature and changes in rainfall patterns, the distribution of vector mosquito species may change (Patz and Martens 1996; Reiter 1998). Temperature can directly influence the breeding of malaria protozoa and suitable climate conditions can intensify the invasiveness of mosquitoes (Tong et al. 2000). Another concern is that changes in climate may allow more virulent strains of disease or more efficient vectors to emerge or be introduced to new areas. Changes in temperature and precipitation could also expand vector-borne diseases into previously uninfected high altitude locations. Expanding the geographic range of vectors and pathogens into new areas, increasing suitable habitats and numbers of disease vectors in already endemic areas, and extending transmission seasons could potentially expose more people to vector-borne diseases. Studies carried out in Nepal indicate that the present subtropical and warm temperate regions are particularly vulnerable to malaria and kalaazar. Climate change-attributable water-borne diseases including cholera, diarrhoea, salmonellosis, and giardiasis, as well as malnutrition conditions are prevalent in Bhutan, India, Myanmar, and Nepal. The risk of contracting such diseases or suffering from malnutrition in 2030 is expected to increase as a result of elevated temperatures and increased flooding (Patz et al. 2005).

NORTH EAST INDIA AS A CASE STUDY OF CLIMATE INDUCED MIGRATIONT

he North Eastern Region (NER) comprises of the states of Arunachal Pradesh, Assam, Manipur, Nagaland, Mizoram, Sikkim and Tripura. The region stretches between 21^{o}50' and 29^{o}34' N latitude and 85^{o}34' and 97^{o}50' E longitude. The region has a population of 43.7 m

and geographical area of 26.2 million hectare, which is 3.85% and 8% of the population and area of the country, respectively. Assam is situated in the center and hill states (except Sikkim) are situated around it. Out of the total geographical area 28.3% has an elevation more than 1200 m, 17.9% between 600 and 1200 m and about 10.8% between 300 m and 600 m above mean sea level. The hilly areas of the region are sparsely populated (63 people/km2) compared to plains (369/km2). Assam has 68.2% of the total population against an area of 29.9% of the region. The region has about 72% area under hilly ecosystems. The region has inaccessible terrain, fragility, marginality, excessive sloping land with rolling topography, rich biodiversity, unique ethnicity and socio-ecological set up. The NE region received high rainfall and therefore clothed with diverse and dense vegetation. Beyond the transitional pre-glacial region with increasing altitude, there appears the greater Himalayan region devoid of significant vegetative cover. Rocky surface, alpine vegetation and snow capped high peaks dominate the physical landscape of this area. The altitudinal pattern of north east varies from place to place. The plains mainly comprises of Brahmaputra and Barak valleys. The adjoining areas of Barak rivers are active flood plains with marshy lands subjected to extreme annual inundation. The Manipur basin has an area of 1,853 km2. The Tripura plains have an area of 3500 m^2 and has land features of erosive nature. The region has about 60% area under forest with Arunachal Pradesh having about 80% of its area under different kinds of forest, while Assam has the minimum percentage of forest area (30%). The varied physiological features and altitudinal differences gives rise to varied types of climate ranging from near tropical to temperate and alpine. The annual rainfall in the region is received mainly from south-west monsoon from middle of May and continue till October. On an average, the NE region receives about 2450 mm of rainfall. The Cherrapunji-Mawsynram range receives rainfall as high as 11,500 mm, annually. The region shows great variation in temperature regime too. The temperature varies from 15oC to 32oC in summer and 0 to 26oC in winter. The NE region is very rich in biodiversity and harbours the largest number of endemics and species then anywhere in the country. Of the total 17000 flowering plants of the country, about 5000 species is found in NE region. The distribution of various species has been restricted due to topographical features, deep valleys, slopes and river system. The agricultural practices of the region are broadly of two types, viz., (i) settled cultivation practiced in plains, valleys, foot hills and terraced slopes and (ii) shifting cultivation in hilly areas of all the states with the exception of Sikkim, where settled cultivation is practiced on terraces. Agricultural operations are carried out up to 3600 m altitude and on slopes up to 60%. Cropping system in the region is predominantly rice based except Sikkim, where maize based systems are dominant. More than 80% of gross crop area is under food grains and rice occupies 89.8% of the total food grain area and 93.2% of the total food grain production. The agriculture in the region is mainly at subsistence level. The region as a whole is having a deficit of 1.6 mt of food grains. The cropping intensity in the region is 120%. The low cropping intensity is mainly due to lack of irrigation facilities and insufficient soil moisture during winter.

The natural resources of the North East are also subjected to degradation and loss due to deforestation, unsustainable shifting cultivation practices, fragmentation and degradation which ultimately impact the biodiversity as well as forest biomass production. Increase in human and livestock population, increased extraction of fuel wood, lack of land ownership rights, shortening of jhum cycle, conversion of natural forests into plantations for horticultural crops, mining, overgrazing, and forest fire are the major causes of deforestation in North East India.

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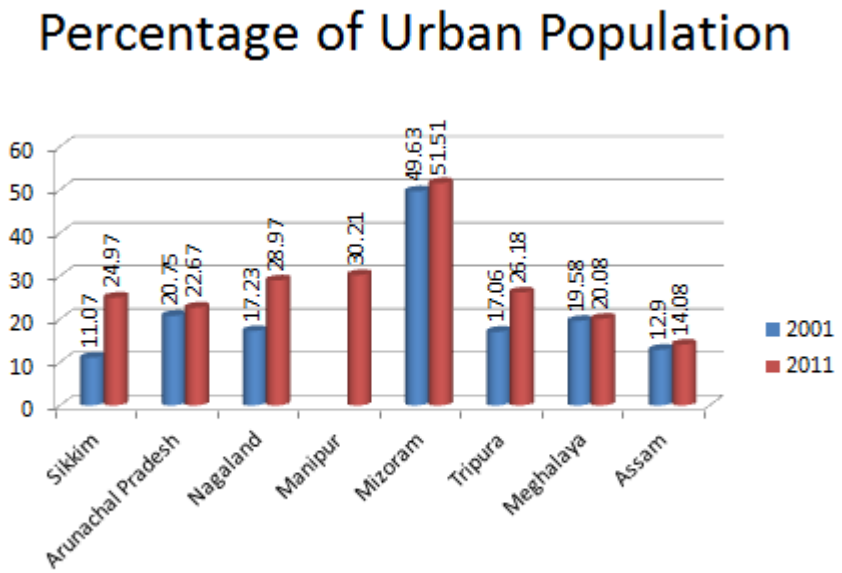
Table 1: Population Characteristics of North East India

	Population (in millions)		Decadal growth rate (in %)	
State	Rural	Urban	Rural	Urban
Arunachal Pradesh	1.06	0.31	22.88	37.55
Assam	26.78	4.38	15.35	27.61
Manipur	1.89	0.82	10.58	42.74
Meghalaya	2.36	0.59	27.04	31.03
Mizoram	0.52	0.56	18.20	27.43
Nagaland	1.40	0.57	-14.59	67.38
Sikkim	0.45	0.15	-5.20	153.43
Tripura	1.38	0.48	2.13	76.08



Deficits in urban centres

- Demand for housing is much greater than supply side
- There is a boom in construction activities, multi-storied building are constructed ignoring the ecological fragility of the town
- The source of drinking water is springs, a number of which are drying up while other are not protected
- Only about 40 percent of the households are supplied with tap water Inadequate attention to solid waste management

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Public Health & Nutrition

Title: Intra-household Bargaining and Investment in Child Health
Dr. Meherun Ahmed

I. Introduction

Women's empowerment is advocated by the World Bank and the United Nations as a prominent and important channel for improving child health, increasing school enrollment, reducing gender disparity and poverty and thus promoting growth and better governance[12]. Economists and sociologists have long been interested in the intra-household decision making process, specially how wife's preferences, if different from her husband, get reflected in the household decision making process and affect the outcome of interest, ranging from child health and education outcomes to expenditure on food and clothing etc.

Early research on intra-household resource allocation was founded on the "unitary" or the "common preference models", based on the notion that all the members of the household share the same preference or a single benevolent dictator acts for the good of the entire household. The second fundamental assumption of the unitary model is that individuals in the household pool their resources. In this type of model, inequitable allocations result from differing returns to investment in different family members. However, empirical evidence casts serious doubt on this type of characterization of the decision making process of the household in both developed and developing countries. An alternative to the unitary models are collective models that capture the idea that differing preferences across household members could create a conflict in allocation decisions and result in allocations different than indicated by the unitary case (Chiappori, 1992, 1997). One objective of this paper is to empirically test whether the decision making process in the household, particularly investment in children follows a unitary or collective models, that is whether the father and mother have varying preferences and abilities (bargaining power) in enforcing their tastes[13].

[12] Millennium Development Goals Report 2005.UN: http://unstats.un.org/unsd/mi/pdf/MDG%20Book.pdf
[13] Collective models (Chiappori 1992, 1997) assumes that intra-household allocations entail Pareto efficient outcomes but do not directly address the question of how individual preferences lead to collective choice. Two sub-classes of collective models put more structure on the decision making process, namely, cooperative and non-cooperative bargaining models. In cooperative approach, individuals choose between marriage and divorce depending on the utility associated with each state with marriage generating a surplus (Manser and Brown, 1980, McElroy and Horney, 1981). In this model the utility from divorce treated as a threat point which is external to the marriage. While in "separate spheres" or non-cooperative models (Lundberg and Pollak, 1993), the threat point is internal to the model. This approach is based on the assumption that an individuals actions are conditional on actions of others, they cannot enter into binding and enforceable contracts with each other. The allocation under these models may not always be Pareto efficient. Even though the exact nature of the

Controlling for household permanent assets status, human resources of the parents and other community variables, the relative bargaining power of the wife in the household should not have a differential impact on child health under the assumptions of unitary model. One of the goals of this paper is to test this prediction.

A critical problem facing the researchers is how to measure the bargaining power of wives. An accurate measure of bargaining power is difficult to obtain because of its multi-dimensionality. Also, one particular indicator may not represent underlying bargaining power across different cultures. Since it can be derived from various sources, like education, economic independence, socio-cultural norms, laws of the country, and family background, it is not easy to summarize the whole concept of bargaining power with one single measure. The impact of women's relative status, measured by various variables, e.g., female share of income and assets, assets brought into marriage, relative education and age etc. on various demographic and economic outcomes have been well researched for both developed and developing countries. These measures of bargaining power introduced in literature are different from each other and have substantial difference in the effects on the same outcome variable (Varadharajan, 2003). One particular indicator may not be applicable to all cultures, even within one country. Thus not all of these measures can be generalized as an indicator of female autonomy across different countries or societies. It is puzzling to see that the measures introduced in the literature are all proxies of the same underlying concept of "bargaining power".

In this paper, I construct new measures of empowerment which reflect a woman's relative status in the different decision making contexts. It is not necessary that a wife would have the same amount of control/power in all the decisions the household makes and these may have varying effect on the health of the children. This paper uses direct measures of bargaining power of women created from self reported status on various household decisions and activities. The measures were created using factor analysis of 19 variables that reflect a women's relative status in the household. Factor analysis revealed that three factors should be retained. These three factors capture various dimensions of her bargaining power: her mobility, her vulnerability and women's control over household's resource allocation. Usually in household surveys, the household head or the husband reports all the information

bargaining process and ultimate equilibrium may take different forms in these bargaining models, the underlying intuition is the same which suggests that household allocation decisions result from a bargaining process in which members allocate resources according to their individual preference. See, Thomas, Contreras and Frankenberg (2002) and Pollak (2005) for details about bargaining models.

about the family members. Thus the variables used to proxy women's bargaining power may suffer from systematic measurement errors. Since women themselves report about their status in various decision making contexts, the bargaining measures in this paper do not suffer from such problems. Female autonomy or empowerment in a developing country context is generally defined as ability to control her own life, ability to access resources and information to make informed and independent decisions to ensure her own wellbeing and the wellbeing of other family members. It also reflects freedom from any coercion, violence and constraints on physical mobility. It is interesting to find that data determined three factors need to be retained and these three factors captures the three most important aspect of bargaining power of women in the developing world.

I investigate the impact of these measures on the long run indicator of children's health, height for age. I also use other measures of children's health, e.g., weight for height, weight for age, the likelihood of getting vaccinated and receiving vitamin A drop etc. and see whether the bargaining measures have differential impact on different outcomes. I also investigate whether the these measures have any significant influence over the mother's own health seeking behavior and use likelihood of receiving prenatal care, having trained professional at the time of child birth, and delivering the baby in a proper medical facility as dependent variables. Since these three bargaining measures capture three distinct aspects of bargaining power, their impact may vary by outcome investigated, as some aspect may be more important in case of some outcome than others. If this is the case it will reinforce the fact that using one indicator may not adequately capture these separate dimensions of bargaining power of women in the developing world. A mother may have financial autonomy but if she has restricted mobility (due to various social taboo or customs) or has fear of domestic violence, she may have to compromise the health of her child by failing to avail proper health facilities which are most often free[14]. Focusing on one single aspect (mostly studies consider economic decision making power proxied by various income/wealth/asset variables) is likely to miss out on other important part of intra-household decision making process

Finally, finding appropriate instruments for these bargaining measures pose as the major hurdle as the usual measures of wife's bargaining power are most likely to be to endogenous to the outcome of interest. The commonly suggested measures in the literature

[14] Vaccination drive, Vitamin A drive in developing countries.

may reflect the same underlying processes that determine the outcome variables, e.g., investment in children's health and education, accessing health care services for herself and the child, expenditures toward food and clothing etc. In order to correct the potential bias from the endogeneity of the empowerment measures, instrumental variable approach is used. Religion and prevalence of polygyny in the neighborhood are used as instruments for the empowerment variables. The extent of polygynous unions in the neighborhood is correlated with a woman's status within the household via community values and norms regarding gender roles, but is unlikely to have an impact on the health of the child. Religion also plays an important role in determining women's status in the household, and thus can also act as instrument for mother's relative say in the child health matters. We control for mother's education which is endogenous due to the fact that mothers who acquire education are innately more able and motivated, given female school enrollment is very low in the developing countries. We use mother's birth cohort interacted with her childhood place of residence as instruments for endogenous mother's education with the assumption that these instruments would capture the relevant time school supply[15]. The results from the regression analysis indicate that mother's empowerment measures have positive and significant impact on long run health of her child. Households do not follow unitary model of decision making process. The impact of the bargaining measures varies by the outcomes, underscoring the multidimensionality of bargaining measures. Results also reveal that the impact of bargaining measures do not vary by the gender of the child.

The paper is organized as follows. Section II analyzes the possible mechanisms through which bargaining power of the mother affects the investment in child health. Section III outlines the various bargaining measures used in the literatures and discusses the direct indicators used in this paper that are constructed through factor analysis. Section IV presents description of the data and the variables used in the regression analysis. The estimation procedure is discussed in section V. The results from the multivariate analysis are presented in section VI. Section VII deals with the robustness of the results and paper concludes in section VIII.

[15] See Ahmed and Iqbal (2006) for a detailed discussion about instruments used for mother's education.

II. Why a Mother's Empowerment Matter?

Extensive research has been done investigating the possible effect of female autonomy on fertility; however, a growing body of research has also begun to examine how women's bargaining power within the household affect the health and well being of women and the children. Following Thomas, Contreras, Frankenberg (2002) and Rubalcava and Thomas (2000), the derived demand function for child health resulting from a household optimization program, depends on the distribution of power within the household; household provided health and nutritional inputs, local health environment and genetic endowments of the child, the prices, and an unobservable component reflecting heterogeneity in tastes and health production technology. Holding household income constant, child health will be invariant to changes in distribution of bargaining strengths of household members under the unitary model. Rejection of the unitary model would indicate that bargaining power of the mother has differential impact on child health.

It is important to understand the processes through which mother's empowerment influence the health of her child. In many societies, socio-cultural norms dictate that men and women have separate and distinct roles within the household; with women being primarily responsible for food production and child care (Caldwell and Caldwell 1993). In a resource-constrained household, men and women may have conflicting priorities over resource use. There are some evidence suggesting that women put more priority on food, clothing and health needs of the household members where as earnings of men are siphoned to meet their individual demand for alcohol, tobacco, recreational and consumer goods (Abadian, Sousan 1996; Jacobson 1992). The connection between malnutrition of children and diversion of income by males to personal consumption has been evident in Belize, Guatemala, Mexico, Indian Subcontinent, and some African countries (Carr, 1985. Blumber, 1990; Ascadi and Ascadi, 1987). Since mothers are primary caregiver, they are also more likely than their husbands to be aware of the health status of their children and to avail medical treatment in need (Caldwell 1986). A mother with more bargaining power is thus assumed to have greater control in household resources to invest in the health of the children.

Empowerment has several aspects, namely, control over resources, mobilization of interpersonal networks and basic attitudinal attributes (Quisumbing and Mallucio, 1999). An empowered mother as indicated by her relative status in the household compared to her

husband, exercises more control over the family budgets and can direct resources towards investment in human capital of children, are more confident and capable of taking timely informed decisions regarding vaccination and food and nutrition intake. She is more likely have control over fertility and birth spacing, and enjoy greater mobility and less likely to suffer from domestic violence. She has more control over her own health choices enabling her to access prenatal and post natal care leading to better health for herself and thus ensure a safe, secured and quality environment for her child. Mobility is an important aspect of female empowerment in the developing world and is positively associated child health outcome (Basu, 1992). This is because freedom from constraints on physical mobility enables a woman to acquire proper information, goods and services (e.g. participation in vaccination and Vitamin A drive, availing professional medical care in need). Domestic violence has been identified as an important indicator of child health status in the household. Violence impedes women's economic and social development and capacity of self-determination. A woman who is subject to frequent physical abuse is vulnerable and unable to influence household decisions and may have to compromise own and child health because of fear of violence and abuse. It is clear that bargaining power has different dimensions and each aspect may have a different impact on child health. Consideration of the multidimensionality of bargaining measures is very important in terms of policy interventions for child wellbeing.

III. Measure of Bargaining Power:

The intra-household bargaining literature has suggested several measures of bargaining power of women and investigated their impact on educational attainment, health status of the next generation. Traditionally in economic literature, "bargaining power" of a member of the household is determined by the share of resources contributed by that member. Various economic resources have been used as proxies of bargaining power, e.g. public transfer and welfare receipts (Lundberg, Pollak and Wales, 1997; Rubalcava and Thomas 1997); income shares of women (Hoddinott and Haddad 1995); unearned income (Thomas 1990; Schultz 1990); inheritance (Quisumbing 1994); assets brought into marriage (Thomas et al. 1997; Quisumbing and Maluccio, 2003), and current assets (Doss 1996).

Most of these mentioned measures are not perfect representation of women's bargaining power. In many developing countries female participation in the formal labor market is low. Since women do not work for wage, it is difficult construct a measure of income share of female. Even if they work in family owned agricultural farms, it is very difficult to disentangle their marginal contribution to total produce. It is also very important

to recognize the endogeneity of labor income as it reflects time allocation and is jointly determined with household production of children's health. Some studies used unearned income as a proxy for bargaining power. But this may be of some concern if unearned income is interest payments from assets accumulated during working life, pensions and unemployment and/or other benefits as they are associated inter-temporal labor supply decisions. Moreover, unearned income may systematically change consumption and labor suppy behavior and tastes, making it endogenous in the child health production function.

Again assets brought into marriage may be good proxies of bargaining power as these are exogenous to decision making process within marriage in some cultures, e.g., Indonesia.[16] But in other cultures, particularly in South Asia, asset brought into the marriage are often dowries and are not controlled by the wives. Social norms, marriage and divorce laws are very important when using this measure of bargaining power. Moreover, this measure may be influenced by assortative mating and selection in the marriage market making it endogenous to out come of interest (Foster 1996, Quisumbing and Maluccio, 1999). The validity of current assets as proxies of bargaining measure is questionable as it is correlated with asset accumulation decision and preference within the marriage. It may be difficult to separate out the relative shares of spouses depending on the marriage laws of the country, as they may be jointly controlled by spouses. Some researchers also used relative education and age difference of spouses as indicator of bargaining power (Handa 1996, Thomas 1994) but these may result in biased estimates due to endogeneity arising out of assortative mating.

Thus the validity of any measure of bargaining power crucially depends on the exogeneity of the measure and also how relevant the measure is in a particular culture. A woman may be empowered in some spheres but not in others. It is very complex to define and construct a quantitative index of such a multi-dimensional concept. A highly educated woman may not necessary possess a larger share of household assets or bring a significant amount of assets or property into the marriage. In developing countries dowry payments are usually associated with the idea of compensation for poor marriage market qualities, like beauty and education. A woman bringing in a larger share of assets into the marriage may not necessarily have more bargaining power in the household. The meaning of empowerment changes from one setting to another and also varies by region, and culture. It is multi-

[16] Women in Indonesia control the assets and preserve the right to them in case the marriage dissolves.

dimensional; some aspect exerts more significant impact than others on the outcome of interest.

Varadharajan (2003) used several measures of bargaining measures, namely, female share of income, female share of assets accumulated during marriage, female share of assets brought into marriage, relative family background, relative education and relative age and investigated their individual impact on three outcomes: child enrollment rates, child health status and budget shares on food. It was evident from her paper that there is substantial inconsistency in the effect of different bargaining power measure on the outcome variable. In some cases the relation between the three outcome variables and the bargaining measures had desired signs while in others they were insignificant, indicating that one variable cannot sufficiently proxy the latent bargaining power which has multiple dimensions. Moreover, she found the measures of bargaining power to be weakly correlated with each other. She used factor analysis to create two indicator of bargaining power, capturing economic and social dimensions, from all the above proxies. Her paper sheds light on the fact that women's empowerment cannot be adequately summarized by a single measure because of its multidimensionality.

In this paper I construct direct measures of women's bargaining power from self reported status on various household activities and decisions using factor analysis. A total of 19 such variables were used in the factor analysis. There are seven variables in Nigerian Demographic and Health Survey (NDHS 2003) which reflect women's relative bargaining power in a household's economics decision making process. They solely or jointly make decisions in the following cases: about their own health, large and daily household purchases, child health care and education, visiting friends and family and food to be cooked each day. Respondents were asked who had final say in these decisions. Women who claimed that they independently or with consultation with their husband or other family members decided on these issues, assumed to have some bargaining power in the household decision making process. Others, who reported that the decisions were taken solely by the husband or other family members, were assumed to have little or no autonomy in these economic decisions of the households.

There are six other variables in DHS Nigeria that reflect the degree of difficulty in getting medical help for herself. The questions were whether she knew where to go, whether it was a problem for her to get permission, to get money for treatment, to travel alone, and

whether distance was a problem for her. The categories of responses were "big problem", "small problem" and "no problem". Women who reported "small" or "no problem" were assumed to enjoy greater autonomy and freedom of movement.

The data set also contains six questions about women's opinion about domestic violence. Respondents were asked whether they believe wife beating is justified if she goes out without telling the husband; neglects the children; argues with husband; refuses to have sex; burns food or food is not cooked. The more she reports "yes", the less is her relative autonomy in the household. She is more vulnerable and may compromise her own and child health in fear of violence and abuse.

We create the autonomy measure using factor analysis from these 19 variables[17].

III.1 Factor Analysis (FA)

Factor analysis is a statistical technique which explains a set of observed variables in terms of a smaller number of latent variables called factors. These latent factors are assumed to account for the correlations among observed variables. Thus the common covariate of all these economic decision making, opinion about violence and permission variables would capture the latent bargaining power of women. I do not assume at the outset that one factor would overwhelmingly explain the entire common covariance matrix of these 19 variables. On the contrary, I let the data determine the number of factors to be retained and try to interpret them according to the factor loadings of the variables[18].

One important assumption regarding FA in this paper is that the latent concept/concepts of intra-household bargaining power can be derived from the self reported claims of the respondents in regard to various household decisions. Since the respondent herself is reporting about her status in these decisions, the assumption is not unreasonable.

[17] There are several papers use similar variables (say in various activities, mobility variables etc) either individually or as a summation of these variables to create an index to study influence of religion and region in determining female autonomy in India and Pakistan (Jejeebhoy and Sather, 2001); to investigate impact of women's autonomy on child survival in Muslim and non-Muslim countries in Asia (Ghuman, 2003); to understand the determinants of empowerment in five Asian countries (Mason and Smith, 2003); to study the investment in child human capital in Egypt (Roushdy, 2004); to investigate women's autonomy and health care utilization in Northern India and to analyze the women's status and domestic violence in Bangladesh (Koening et al., 2003). These papers did not capture the underlying latent bargaining power from these variables through factor analysis (except for Jejeebhoy and Sather, 2001). Most importantly, none of these papers corrected the biases arising from the endogeneity of the autonomy indices.

[18] We use factor analysis instead of principle component analysis as the latter imposes the restriction that all the components completely explain the correlation structure among the variables. Factor analysis, accounts for the covariance of these variables in terms of a much smaller number of common covariates (factors). Factor analysis does not force the common factors to explain the entire covariance matrix. That is it allows the individual-variable specific influences to explain the remaining variances.

Moreover, in household surveys, usually the household head reports about other members of the household. Thus other indicators like wages of the woman, assets brought into marriage, education and age might also suffer from systematic measurement error problem. The direct measures of female empowerment indices in this paper were created using a woman's own account of her relative status in various household decisions making process, her freedom of movement and her opinion about domestic violence, thus unlikely to suffer from mentioned measurement problem.

Table 1 shows the results of the factor analysis. The first panel is the table of factors. It lists the eigenvalues of the correlation matrix in ascending order. The third column shows the difference between the adjacent eigenvalues. A sudden drop in this number suggests that subsequent eigenvalues are just sampling noise. The second panel displays the factor loading matrix which only reports three factors as the eigenvalues of the other factors are negative or less than one[19]. Looking at the proportion column in the first panel we see that the first factor captures 46 percent, the second factor 30 percent and the third factor 23 percent of the common variance in the 19 variables. Both the Kaiser-Guttman (only the eigenvalues that are greater than one) and Scree plot[20] (the curve levels off after the eigenvalue) suggest that we keep only three factors.

The first factor relies mostly on the variables indicating respondent's relative say in large and daily household purchases and final say in child's health and education. This factor can be termed as economic measure of bargaining power. The permission and violence variables have little weight in this factor. This factor score is called empowerment.

The second factor loads the "opinion about violence" variables highly and positively and it explains most of the variance among these variables. It uses almost equal amount of all of the measures used. The factor score is called violence.

The third factor captures mostly the permission variables and the other variables have very little weights in this factor. This factor loads highly on per4 and per5 indicating that distance and traveling alone in getting medical help is a concern for the respondent. This factor thus reflects mobility aspect of empowerment. The generated factor score is called permission.

[19] See Kaiser-Guttman rule and Scree plot in the appendix for retaining the number of factors.
[20] See appendix for the Scree plots for factor analysis.

The factor analysis of these 19 variables results in three retained factor that captures basically three dimensions of women's status in a household. This paper studies the separate impact of each of these dimensions of bargaining measure on children's long run health outcome. Also alternative indicators of children's health are used as dependent variables. The impact of the bargaining measures on the health seeking behavior of the mother in terms of availing prenatal care, assistance at birth and appropriate delivery place are also investigated. The effect of these measures as they capture different dimensions of bargaining power may vary by the outcome and thus reinforce the fact that one proxy of bargaining power like assets or education may not be sufficient to capture all of the different dimensions.

IV. Nigeria: Data and Descriptive Statistics

Recently Demographic and Health Surveys for some countries have collected some variables that reflect women's relative position in the household decision making process. Nigerian DHS (2003) is an ideal choice to analyze the relation between human capital investments in children and mother's bargain power within the household, as it contains several dimensions of women's relative status within the household. Moreover, most research investigating this relationship in the developing world mostly focused on South Asia. Not much is known about female autonomy in Africa and its impacts on child health outcomes. The choice of using Nigerian data is also motivated by the choice of instruments. Since mother's bargaining index and education are endogenous in the child health production functions, paucity of suitable instruments handicap the literature in investigating the effect of mother's empowerment on child health. In this paper, I use prevalence of polygyny in the neighborhood and religion of the mother as an instrument for her bargaining power measures. I construct instruments for mother's education using the fact that there was a large variation in the education policy and the public investment in education in Nigeria (See Ahmed and Iqbal, 2006). The DHS data sets not only have a wide array of child anthropometrics measurements enabling to investigate short term versus long term child health outcomes but also contains a plethora of health seeking behavior variables for women themselves.

Nigerian DHS (2003) is a nationally-representative household survey containing the relevant health variables for our analysis. A total of 7985 women in the age range of 15-49 were interviewed from 7225 households in Nigeria. Height and weight measurements of all children (4189) born in five years preceding the survey were collected. We dropped some observations which have height, weight, age of the children and information on parental education, age and bargaining variables missing. This leaves us a sample of total 3602

children. NDHS also collects information on household characteristics, region of residence, parent and child characteristics, educational attainment, religion, and different health measures of the children.

In our study we use height for age Z score (HAZ) as our indicator of child's health as HAZ reflects long run health capital of the child[21]. Summary statistics of the variables used in the estimation are presented in table 2.

About 49 percent of the mothers do not have any formal education, and 24 percent have primary level education. Fathers on an average have 6 years of education. 37 percent of our sample population lives in an urban area. 57% of the mother's grew up in villages. About 58% women in the sample are Muslims and 41% are Christians respectively.

Lifetime permanent income of the household is an important determinant of the long run health status of the child and should be included in the health regression to control for the income effect. As the data on permanent income is rarely available to the researchers, current income or current expenditure is often used as proxy. But there is an obvious measurement error when current income is used[22]. Again, total income of the household is likely to be endogenous to the household health decisions (participation and hours are jointly determined with health inputs). To avoid this bias often non labor income and wealth information of the household is used as a proxy of permanent income. Unfortunately, NDHS 2003 did not collect any income or expenditure data We used father's education as a proxy for household permanent income. NDHS also collected a host of household asset information ranging from ownership of television, radio, to a bicycle, scooter as well as dwelling characteristics such as source of drinking water, type of sanitation facilities and type of material for house's floor and roof. A wealth index is also constructed by NDHS using these asset information and principle component analysis[23]. But due to the endogeneity of the wealth index it is not used

[21] Z score is the difference between the value for an individual and the median value of the reference population for the same age or height divided by the standard deviation of the reference population. The reference standard is one that is recommended by WHO. Z Score=(hi –hmed, g)\Stdmed

[22] People sometimes conceal their income. Also income from agriculture, self employment has accounting issues. Moreover, in household surveys, sometimes one person responds about income earned by all the household members, leading to measurement problems.

[23] Each asset is assigned a weight (factor score) generated through principle component analysis and the resulting asset scores were standardized in relation to a standard normal distribution with a mean of zero and standard deviation of one. Each household was then assigned a score for each asset, and the scores were summed for each household. This index has been consistent with expenditure and income measure and tested for

as a control. However, alternative specifications were run using the wealth index as a proxy for permanent income/measure of living standards of the household and the results are very similar adding to the robustness of the results[24].

Access to health facilities and neighborhood living conditions are important determinants of child health in developing countries. Unfortunately NDHS 2003 did not collect any information about availability of health personnel, health facilities or any indicators of community living conditions. But the survey included questions such as whether the mother received prenatal care, whether she was visited by family planning worker in the last 12 months, and whether the household have piped water inside the household etc. These are all binary variables. Information from these variables was used to construct variables that are reasonable proxies for access and availability of the health services and the standard of living conditions in the neighborhood. Higher percentage of mothers receiving prenatal care, frequent visit by family planning worker in each neighborhood would indicate the availability of health facilities in the locality. Again, higher percentage of households receiving treated piped water is assumed to be a good proxy of better living standard in the neighborhood. The NDHS 2003 had about 365 clusters covering all the administrative units of Nigeria. A cluster level measure of accessibility and availability of health services for each household i in cluster j was generated by averaging these variables over all the households in the cluster j excluding the household i within each cluster. These variables were calculated using the whole NDHS sample of all women ages 15-49.

V. Estimation

Following Thomas, Contreras and Frankenberg (1999) and Quisumbing and Maluccio (1999) I estimate the child health demand as a function of child's characteristics, parental characteristics including mother's bargaining power measures and the household and the neighborhood controls.

The reduced form child health demand function takes the following form:

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several countries. *Nigeria Demographic and Health Survey 2003.*National Population commission and ORC Macro, 2004

[24] Filmer and Pritchett (2001) showed that the wealth index consistently has less measurement error for 4 Asian countries than consumption expenditure as a proxy for long run wealth in analyzing the relationship household's wealth and children's school enrolment. Sahn and Stifel (2003) also found the wealth index to a much better proxy for long run economic welfare of the household compared to the household expenditure data as the latter has measurement issues because of the reliance on recall data, the large share of goods consumed from home production and suspect price deflators..

$$H_{ij} = \beta_o + \beta_1 C_{ij} + \beta_2 F_j + \beta_3 M_j + \beta_4 N_j + \beta_5 E_j + \varepsilon_{ij}$$

where, H_{ij} is the height for age of the ith child in household j; C_{ij} is the vector of child characteristics such as age in months, gender, age squared; M and F are vectors of mother's and father's human and physical capital respectively such as education, age, and E is the mother's empowerment measures; N is a vector of household and community characteristics that includes proxies for health service accessibility, community living conditions and region and location dummies and e_{ij} is the error term.

To identify the causal effect of empowerment measures on child health outcomes, we need to correct for the endogeneity of these indices arising through mother's unobservable attributes such as ability and motivation and self determination etc. Prevalence of polygyny and religion is used as instruments for empowerment[25]. According NDHS final report (2003), 36 percent of the married women are in polygynous unions (27 percent reporting the presence of only one co-wife, while 9 percent reported to have two or more co-wives)[26]. Again it is observed that in Northern part of Nigeria, both culture and Muslim traditions encourage polygyny, while in the Christian dominated South, monogamous unions are more acceptable. But polygyny is not uncommon among Christians. It is reasonable to argue that women is monogamous unions are more empowered and enjoy more bargaining power in the household compared to women in polygynous unions.

The extent of polygyny in the neighborhood of the women is correlated with her relative status in the household via the neighborhood externalities (role models), community values and norms about gender roles etc., but is unlikely to be associated with child's health. Anthropological evidence indicates that community level cultural and contextual factors are important in determining individual woman's relative status within marriage, particularly in cases of intimate partner violence across cultures (Counts, Brown and Campbell, 1992), Levinson 1989). Societal and cultural norms govern gender roles; impose segregated and asymmetric restrictions on all aspect of women's lives and behavior. Extent of polygynous unions in the neighborhood captures gender relations and norms and rules governing

[25] Extent of polygyny in the neighborhood is measured as percent of polygynous unions in the neighborhood over all the household in cluster j excluding the respondent's household i. The respondents were asked the respondents were asked whether there are co-wives residing in the household or not". This variable was used to calculate the percentage of polygynous unions in the neighborhood.

[26] Traditionally women in Nigeria are married to the husband's lineage. The senior wife enjoys a more privileged position and enjoys authority over junior wives. Seniority is determined by marriage rank, not by age. (See Oni, 1996).

women's behavior and thus identifies a woman's bargaining power in the household production of child health[27]. Religion also plays an important role in determining women's role in the household. The social institution of *Purdah* in muslim countries, i.e., the social, economic and physical seclusion of women are the tragic realities of woman in the developing world (Amin 1997, Mandelbaum 1988, Ghuman 2003). Muslim and Christian dummies were used as instruments with traditional and animist and other religion as the omitted category with the assumption that Christian women enjoy more bargaining power relative to Muslim women.

The interaction between mother's childhood place of residence and mother's birth cohort generates the instruments for endogenous mother's education. The education policy in Nigeria went through major changes in the last 50 years. Construction of schools accelerated at different rate in different time periods in different regions. Thus the interaction between mother's birth cohorts and childhood place of residences (urbanicity) are likely to explain the school supply in the relevant time when the mother was attending school[28].

To account for possible endogeneity of mother's education, we use instrumental variable estimation technique. Following the spirit of Duflo (2001) we introduce a set of instruments--the interaction terms between mother's childhood place of residence and mother's birth cohort. The regions where the mother went to school are not available in the NDHS. Therefore we used the variable where she lived when she was 12 years of age in constructing our instruments. Duflo (2001) exploited the massive school construction program undertaken by the Indonesian Government between 1973-78 and used the interaction between an individual's birth cohort and the number of schools built in the region of birth as instruments for individual's level of schooling. Nigeria's National Policy on Education was formulated in 1969 and revised in 1981. The 6-3-3-4 system of education is the result of this policy. The government started universal free primary education in 1976. Construction of schools accelerated at different rates in different time periods and regions. It would have been ideal if the breakdown of public investment in school construction were available by types, across regions and over time as Duflo (2001) had. But this data is not publicly available for Nigeria. Table 3 shows the construction of educational institutions in Nigeria in different decades.
[Insert table 3 here]

[27] It is possible that polygynous households would migrate to neighborhoods with high polygyny and this selection would undermine the usefulness of the instruments. In developing world, people are tied to their ancestral homes and mostly rural to urban migration is observed.
[28] See Ahmed and Iqbal (2006) for a detail discussion on the motivation behind the use of these instruments.

We see that there is a wide variation in the numbers of newly established schools in different decades and this reflect differential accessibility of schools for mothers born in different decades. Also the public education investment varied by urbanicity, i.e. whether it is a city, small town or village. Moja (2000) and World Bank assessment study (The World Bank, 2003) report that there are stark differences in rural and urban areas in terms of public investment in school infrastructure, provision of support materials etc. Thus mother's birth cohort captures the variation of public education investment over time and childhood place of residence captures regional variation. Thus the interaction between mother's birth cohorts and childhood place of residences (urbanicity) captures differential access to school for the mothers[4]. This is evident in table 4.

[Insert Table 4 here]

We classified all the mothers in the sample into four birth cohorts, 1953-59, 1960-69, 1970-79 and 1980-88 in light of table 3. This will enable us to examine the effects of differential rates of construction of educational institutions on the average level of mother's schooling for each cohort. Table 4 shows the average level of education of the mothers for different cohorts and place of their residence in their school going age and the t-statistics between regional differences. Mothers were asked where they lived when they were 12 years of age. The categories were a village, a small town or a big city. We see that the average level of education varies significantly across regions for each cohort. The average level of education is different for different cohorts with younger mothers having more education compared to older mothers irrespective of their childhood place of residence. This can be attributed to increase in school building in the period of 1950-60 and 1970-80. Note that the average level of education dropped for the youngest cohort across all three places due to less educational investment in the decades of 1980s and early 90s (see table 2). Table 6 shows the variation in average level of education between mothers born in different cohorts for each place of residence in childhood. We find that there is significant difference in the mean level of education between cohorts and this reflects that mothers belonging to different cohorts had differential access as indicated in table 3. Thus the variation of public education investment across regions and over time is reflected in differential average years of schooling of mothers. This motivates us to use the interaction between mother's childhood place of residence and her birth cohort as instrument for mother's education.

We also use mother's religion dummies as instruments (Kovsted, Pörtner and Tarp, 2003). We used two dummies for Christian and Muslim and treat animist and other religion as the omitted category. About 58% women in the sample are Muslims and 41% are Christians. Differential religious beliefs are argued to have influence on the choice of school type (i.e., traditional public schools, religious, English medium) enrollment and drop out decision of female. Thus mother's religion serves as a good instrument for her education.

Table 3: Numbers of Newly Established Schools

Year	<1949	1950-59	1960-69	1970-79	1980-89	1990-99
Number of Education Institution	2,986	6,100	1,555	16,000	3,592	9,431

Source: School Education in Nigeria, The World Bank, 2003.

Table 4: Average Years of Education, by Mother' Cohort and Childhood Place of Residence

	Average Education (Standard errors)			t Statistics Indicating the Difference in Average Education Between These Places		
Cohort	Village	Town	City	(Village-Town)	(Town-City)	(Village-City)
1953-59	0.99 (2.52)	1.84 (4.34)	1.33 (2.12)	1.58	0.39	0.45
1960-69	3.25 (4.34)	4.07 (4.82)	6.89 (5.70)	2.97	5.76	9.06
1970-79	3.03 (4.17)	5.16 (5.03)	8.61 (4.93)	11.88	11.48	22.84
1980-88	2.32 (3.69)	3.99 (4.34)	5.98 (5.21)	6.96	4.33	9.78

Source: Author's calculation from Demographic and Health Survey (DHS) 2003 data for Nigeria.

Table 5: Quality of Education, by Mother' Cohort and Childhood Place of Residence

	Education Quality (Standard Error)			t statistics Indicating the Difference in Education Quality Between the Places		
Cohort	Village	Town	City	(Village-Town)	(Town-City)	(Village-City)
1953-59	14.18 (35.01)	13.16 (34.22)	13.65 (49.35)	0.16	1.59	1.08

1960-69	12.83 (33.46)	10.68 (30.93)	12.76 (33.47)	1.06	0.68	0.02
1970-79	12.74 (33.36)	11.73 (32.20)	6.25 (24.24)	0.77	3.01	3.59
1980-88	13.38 (34.07)	13.71 (34.44)	10.79 (31.15)	0.15	0.85	0.80

Note: Quality of education is captured by percentage of mothers who are illiterate but claimed to have some formal schooling.

Table 6: Variation in Average Level of Education Across Cohorts for Each Place of Residence in Childhood

	t-Statistic Indicating the Difference in Average Education Between Different Cohorts		
Difference in Cohorts	Village	Town	City
[(1953-59) – (1960-69)]	6.02	2.83	3.34
[(1953-59) – (1970-79)]	5.71	4.15	5.08
[(1953-59) – (1980-88)]	4.11	3.01	3.05
[(1960-69) – (1970-79)]	1.26	3.62	3.47
[(1960-69) – (1980-88)]	4.62	0.26	1.37
[(1970-79) – (1980-88)]	4.02	4.13	5.15

Source: Author's calculation from Demographic and Health Survey (DHS) 2003 data for Nigeria.

Before discussing the results, it is important to test the validity of the instruments. To assess the explanatory power of the identifying instruments from the first stage regression, F tests are conducted for their joint significance and the results are shown in the lower panel of table 3-5 and table 7 for other dependent variables. The null hypothesis of no explanatory power is resoundingly rejected at 1 percent or better with p values of 0.000 in case of all specifications. Bound, Baker and Jaeger (1995) expressed concern about weak instruments bias if the F stat is not close to 10. Staiger and Stock (1997) further suggested that the value of F stat should be close to 10 as rule of thumb to signal strong explanatory power. The F

statistics for identifying instruments for education are all greater than 10 in all specification but that for bargaining measures drop below 10 for some of the models for some of the indices. The F statistics that are below 10 are close to 5 indicating that the instruments fare well compared to the criteria generated by Bound, Baker and Jaeger (max relative bias is between 1-9%). All of the F statistics indicate that the instruments are jointly significant at 1 percent or better. Results from the Hansen-Sargen J statistics for over-identification[29] and Wu-Hausman F test and Durbin-Wu-Hausman chi-sq test for endogeneity[30] are presented in the lower panel of table 3-5 and in table 7. It is evident that the instruments pass the over-identification test for all specification for the empowerment indices and last specification reported in column 7 of permission and violence indices in tables 4 and 5 respectively.. Since the estimated reported in these columns are specification of interest, the instruments can be considered as valid instruments and are appropriately excluded from the second stage regressions. The reported estimates are robust from the heteroskedasticity of the error term.

VI. Results:

Table 3 to table 5 present ordinary least square (OLS) and instrumental variables (IV) estimates of the determinants of the child health production functions. In table 3, the effect of empowerment index on children's long run health indicator height for age is presented. Table 4 shows the impact of permission index and table 5 depicts the relationship between the violence index and a children's long term health. In column 2, 3 and 4 of these tables only child's characteristics and parent's characteristics are included, i.e., the estimates from basic specifications. In column 5, 6 and 7, the household asset index, community and region dummies are included. Since Wu-Hausman specification test favors IV estimates over OLS for all the regressions, I will focus mostly on the IV results.

Table 3 shows that the indices of mother's empowerment have positive and significant impact on child health in all the specifications. It is interesting note that in table 3, when mother's education is included in the regression, the impact of empowerment index is reduced implying that education is an important determinant of mother's bargaining power. Again comparing column 4 and 7, it is observed that inclusion of proxies for health services and regional dummies reduces the impact of empowerment.

[29] Hansen-Sargen J stat for over identification: Ho:the instruments are uncorrelated with the error term and are correctly excluded from the stage two regression; Ha:the instruments are correlated with the error term and are incorrectly excluded from the main(stage two) regression.

[30] Wu-Hausman F test and Durbin-Wu-Hausman chi-sq test: Ho: Regressors are exogenous, i.e. OLS should be employed and Ha: Regressors are endogenus, i.e. Instrumental variables (2SLS) regression should be employed

The notion of relative bargaining power has no significance in the decision making process of the household under the unitary model. Since mother's empowerment measures have significant impact on child health outcomes, it implies that bargaining position of a woman relative to a man has a different impact on the investment in child health. Thus it can be concluded that "unitary" model is rejected by the Nigerian data.

The other control variables in table 3 show expected signs. The common pattern of initial decline, followed by a rise of health with age is observed in the results (Glewwe, 1999). There is no evidence of discrimination against girls. On the contrary there is a girl premium which not uncommon for a girl child below 5 years of age in Nigeria. This result is attributed to better endowment of health at the initial stages of life for girl children (Lavy et al. 1996).

Table 4 shows the impact of permission indices on child health. The permission indices capture the mobility aspect of female autonomy. The less a mother reports that getting medical help, knowing where to go, traveling alone, and distance to the medical center is not a problem for her, the less constrained she is in terms of physical mobility, the more she is able to make decisions on her own about getting treatment and other medical services. The results indicate that the permission index have positive and significant impact on child health. That is mothers who do not require permission to get help, do not consider the distance and traveling alone is a problem, are not physically constrained. They can ensure timely and proper treatment and vaccination for children which ensures better health. The signs of the other control are similar to table 3. Percentage of mothers receiving prenatal care and percentage of households having access to piped water in the neighborhood capture the impact of accessibility of health services and better living standard respectively. These have positive and significant impact on child health in all the three tables.

Table 5 shows the impact of mother's opinion about domestic violence on child health. The more a mother agrees that it is justified for a husband to physically abuse the wife for reasons as burning food, arguing, going out without his consent, refusing to have sex, not caring for children and the cooked food is not tasty etc., the less empowered she is. This index reflects her vulnerability and insecurity. The index has a negative impact on child health. When a mother herself is vulnerable and unsecured, she is not capable to secure the environment for her children. The impact of education in column 7 positive and significant.

Wealth index has positive impact on health. Access to health services and piped water has positive influence on child health.

The results in this paper are consistent with the existing literature. Dyson and Moore (1983) found lower female status is associated with higher rates of fertility, greater infant and child mortality, and higher female to male infant mortality in Northern part of India. Caldwell (1986), Varadharajan (2003), Durrant and Sather (2000) and Roushdy (2004) also found similar results. Durrant and Sather (2000) found that the fear of violence and access to financial resources are more important than 'decision making authority regarding children' in affecting child health.

I re-estimated table 3 to table 5 using weight for age and weight for height of the child, the likelihood of being vaccinated, receiving vitamin A doses, as the dependent variables. Only the last specification from table 3 (or 4 or 5) for each of the four outcomes are reported in columns 2, 3, 4 and 5 respectively in the top panel of table 6.

Even though, all most all the bargaining measures have expected signs for all the child health outcomes, it is observed that not all bargaining measures have similar impact on all the outcome variables. Empowerment index capturing economic decision making role of the mother has positive and significant impact on weight for age of the child but no such impact is found on the likelihood of getting vaccinated and receiving vitamin A capsules. The United Nations, and The World Bank are working with developing countries to provide universal coverage for vaccination to children again six diseases and also for providing vitamin A to prevent night blindness free of monetary cost[31]. Thus the empowerment index having no impact on the probability of receiving vaccination and vitamin A is not unexpected. The most interesting result is that the permission indices, reflecting the mobility of the mother, affect the likelihood of receiving vaccination and Vitamin A positively and significantly. A mother's freedom from physical constraints is the major determinant for the child to receive any vaccination for the six killer diseases and to participate in the vitamin A drive. Vulnerability of the mother is negatively associated with the all the health outcomes but has significantly affect only child height for age. These results underscore the multidimensionality of bargaining power. It has different aspects and each have distinct

[31] In Nigeria, like many developing countries, the federal government along with international development agencies and local NGOs provide primary health care services free of cost. These immunization teams are either permanently stationed in a community or had mobile vaccination operation in each community or had a national immunization campaign in a particular day in the whole country. See http://www.unicef.org/immunization/index_polio.html

impact on different outcomes. The fact that not all the measures have similar effects on the different health variables, provides evidence that one measure like assets, or income cannot fully capture all the aspects of bargaining power of mothers in the household.

This fact is strengthen by the observation that inclusion of education in column 7 of table 4 reduces the impact of permission indices but unlike the cases of empowerment indices, the education variable itself has positive and significant impact on child health. The empowerment index captures the aspect of economic decision making, control of family budgets while permission indices captures mobility aspects of female autonomy. Mother's education in table 4 captures the economic aspect of bargaining power. These results indicate that different aspects of bargaining power have differential impact on various child health outcomes and underscore the importance of studying different dimensions of bargaining power.

VI.1 Health Seeking Behavior of the Mother

Since bargaining measures comprise various aspects of a woman and her relative status in relation to others in the household, the effect of a woman's status on the demographic variables might change with the outcome investigated. Another set of outcome variables, namely a woman availing post and prenatal care during pregnancy are often used in the literature to demonstrate the effect of a woman's bargaining power in intra-household resource allocation. In this paper, I investigate three outcome variables indicating a woman's own health seeking behavior. They are likelihood of receiving prenatal care, receiving trained assistance at child birth and choosing an appropriate and safe delivery place during child birth. Instrumental variable technique is used to correct for the endogeneity of bargaining measures, where the first stage is run using ordinary least squares and the second stage is run as a linear probability model. The regression results are reported respectively in columns 6, 7 and 8 in the first panel of table 6. The empowerment and permission indices do not show any discernable impact on the likelihood of having trained personnel during child birth and on the choice of delivery place. But violence indices are negatively associated with the probability of delivering the baby in a medical center and having professional assistance at birth. That is it is less likely for vulnerable and unsecured mothers to have trained person at the time of delivery.

The effect of bargaining measures on the likelihood of receiving prenatal care is reported in column 6 of the top panel in table 6. The more a mothers reports "it is justifiable to be beaten by the husband" for various reasons, the less likely that she will receive any prenatal care. These vulnerable mothers can not direct household resources for investment in her health and the health of the unborn child. Empowerment measures do not have and significant impact on the likelihood of receiving prenatal care. Permission measures are positively and significantly associated with utilization of prenatal care. Control over resources, freedom of movement and violence all have expected relationship with utilization of prenatal care, but women's autonomy as measured by permission and violence measures reflecting freedom of movement and vulnerability of a woman respectively appears to be the major determinants of maternal health care utilization. Bloom et al. (2001) also witnessed similar results in Northern India.

The results again sheds light on the fact that "autonomy" is not a homogeneous construct and cannot be represented accurately by a single measure. This analysis of a mother's health seeking behavior during pregnancy and child birth suggests that certain dimensions of a woman's bargaining measures are important than others for the variable of interest. Women, who are most vulnerable and most probably suffer abuse by husbands and other family members, are less likely to receive any type of care during pregnancy and child birth. These mother do not have any say in household decisions, cannot direct any resources toward investment in her health and child health. In Nigeria six in ten mothers receive prenatal care from a trained professional, nurses and midwives and about one third of the mothers do not receive any antenatal care[32]. At least four antenatal visits are recommended during pregnancy. It is not surprising to find that permission indices reflecting mobility of the mother to have a very strong impact on the likelihood of receiving prenatal care.

VI.2 Gender Discrimination*:*

Traditionally for developing countries, a strong son preference has been documented in the literature. One of the hypotheses of this paper is that more empowered mothers would not discriminate against their daughters. Mothers are more egalitarian and if she has relatively more control over household decision making, she would invest equally in sons and daughters. If mothers have more bargaining power, and are more economically secured, she

[32] Table 9.1 in the Final Report of Demographic and Health Survey, Nigeria (2003)

does not need to differentially treat sons for old age security. Usually in the developing world mothers do not have much bargaining power and fathers treat sons differentially than daughters as the sons bear the family name and provide old age support.

I split the sample by the sex of the child and re-estimated the reduced form child health demand function involving all the three indices of bargaining power. The results are reported in column two in the second panel of table 6. The empowerment and permission indices are not statistically significant but have expected signs. The results show that a mother who is vulnerable and finds it is justifiable to beaten by husband for various reasons have a significant and negative impact on the health of the girl child. Her influence on the health of her sons is negative but is not statistically significant.

To sum up the gender specific results, it is observed that the impact of empowerment index do not vary by the gender of the child. But vulnerable mothers fail to provide a secure environment for the children, particularly for girl children. Mother's education has significant impact on health of daughters. Thomas (1994) also found mother's education have significant impact on daughter's height and attributed it to efficiency in child rearing technology, i.e., it might be more efficient for mothers to spend more time with daughters[33].

VII. Robustness Check:

In order to check the robustness of the results all the tables were reestimated with wife's rank number as an instrument for bargaining measures following Pitt et al. (2006) and the results show very similar pattern[34]. I also created three indices using factor analysis from each individual group (7 variables for empowerment, 6 variables for violence and 6 variables for permission). The results are reported in table 8 and are very similar but stronger both in terms of magnitude and statistical significance than the ones discussed earlier. These results add to the robustness of the findings of this paper.

VIII. Conclusion:

This paper reinforces the fact that because women's status has multiple facets, varies by context, not all aspect of women's bargaining power will play an identical role in the various household investment decisions. Several measures of women's relative bargaining power have been introduced in the literature to investigate their impact on different

[33] Not reported in this paper. These results can be found in www.students.washington.edu/meherun/research
[34] The detailed results can be found in www.students.washington.edu/meherun. These instruments do not fare well in terms of F stats from the first stage regressions and also in terms of over identification tests of exogeneity.

demographic outcomes, but none of them are perfect and cannot be generalized to capture bargaining power in different cultures. In this paper, I introduce new and direct measures of empowerment which reflect a wife's relative say in the different decision making context, her mobility and opinion of domestic violence. I investigate the impact of these bargaining measures constructed using factor analysis on the long term health status of her children. To correct for the potential bias from the endogeneity of the empowerment measures, instrumental variable approach is used. Religion and prevalence of polygyny in her neighborhood are used as instruments for the empowerment variables. The results indicate that mother's empowerment measures have positive and significant impact on the long run health of her child. The decision making process in the household does not follow a unitary model, the husbands and the wives have varying abilities in enforcing their tastes. The results also reveal that the impact of bargaining measures do not vary by the gender of the child except for the vulnerability index. Additional dependant variables were used to confirm the robustness of the results.

The results of the study would have important policy implications. If there is a differential impact mother's relative bargaining power on child health outcomes, policy reforms (laws regarding dowry, property, marriage etc.) and interventions (micro-credit, NGO activities, non-formal education food for education program etc.) can have differential influence the intra-household decision making process and thus the health outcome of the next generation. Since different dimensions of women's bargaining power have different impact on child health and use of professional care during pregnancy and birth, different policy interventions or empowerment programs can reap desired results. The success of some micro credit program in changing the dynamics of women's position in the household have been documented (Schuler and Hashemi, 1994, Pitt et al. 1990). But, a rise in the empowerment of women is likely to conflict with established social norms regarding gender roles and may give rise to domestic violence. Thus careful consideration is needed for policy formulation for greater empowerment of women.

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Sustainable Agriculture & Food Security

Title: Assessing the Impacts of Climate Change on Dry Season Crop Yields Using the Aqua Crop Model

Debanjali Saha and M. Shahjahan Mondal

Introduction

Bangladesh lies in the lower riparian portion of the Ganges-Brahmaputra-Meghna basins with significant geo-physical characteristics such as dynamic tidal actions, lower elevation and proximity to the Bay of Bengal. The coastal region of Bangladesh, marked with a 700 km long coastal belt, covers 32% area of the country (Islam, 2004). Despite vast resources and opportunities, this area is very much prone to frequent natural disasters like cyclone, storm surge, tidal flood, water logging, river erosion, salinity intrusion, etc. The impacts of natural disasters have been so widespread in this country that, since 1970 to 2009, almost 39 million people were displaced by major natural events (Akter, 2009). Cyclone and associated storm surge events have caused prolonged salinity problem in the coastal region. Especially the super cyclones Sidr in 2007 and Aila in 2009 have changed the settings of the region. For the coastal communities, agriculture is one of the dominant livelihoods and a major driver of their socio-economic condition. Natural disasters and associated difficulties have restricted the agricultural activities and income generation thus rendering them poor and vulnerable. High soil and water salinity is the major restriction for agricultural activities in the area. Though there is favorable condition for crop cultivation (aman rice) during the monsoon season, dry season crop cultivation is very much difficult due to high salinity and scarcity of suitable freshwater for irrigation purposes. Also, long term shrimp cultivation has intensified the salinity problem and hampered the agricultural practices. Moreover, global climate change phenomenon is also a threat to coastal agricultural activities as it may increase salinity and decrease availability of suitable irrigation water.

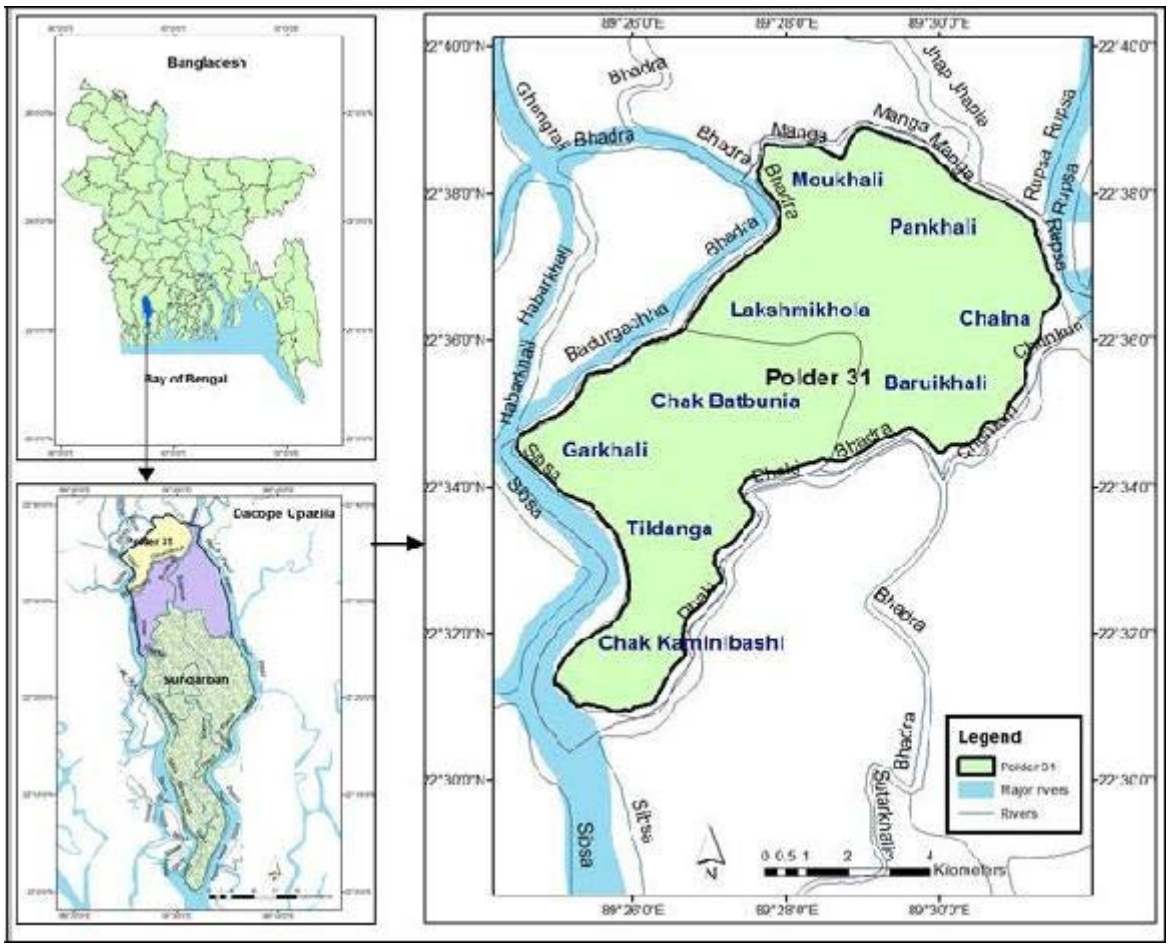
Presently, boro rice and some non-rice crops including sunflower, sesame and watermelon are being cultivated in the coastal areas which bear the risks of being affected by future changed climate. Cultivation of these crops is linked to the food security and standard of living of the coastal communities. So, it is necessary to evaluate the impacts of climate change on the yields of these dry season crops. FAO AquaCrop, which is a crop growth and yield simulation model, can be helpful in this process. This study has been performed to assess the impacts of changed climate on the common dry season crops of the coastal areas of Bangladesh, with this vision that the knowledge may assist in bringing the cultivation of these crops on a larger scale to improve the standard of living of the coastal inhabitants and to adapt with the global climate change regime.

2. Literature Review

Agriculture has been the dominant livelihood sector of Bangladesh for a long period. About 84% people in Bangladesh are directly or indirectly engaged in a wide range of agricultural activities (Rahman, 2004). The coastal economy is also predominantly agriculture based. In most of the areas, one or two seasons' crop cultivation is the general practice. Since long, coastal people have been cultivating aman rice during the monsoon season and boro rice during the dry season. Some vegetables and pulses have also been cultivated in a smaller scale. During the 1980s, saline water shrimp cultivation had become a great attraction for the coastal people, specially the socially privileged class, due to its high profit margin (Khan et al., 2006). But in spite of being a significant earner of foreign exchange in Bangladesh, shrimp farming faced much criticism

due to the damages it caused to local ecology (Haque, 2004). So, most of the people have abandoned shrimp farming to avoid further salinization of water and soil and degradation of the environment before cyclone Aila in 2009. During that time, dry season crop cultivation was very much difficult due to high salinity. So, crop agriculture was only limited to monsoon season rice cultivation and very small scale vegetable cultivation during the dry season. Damages caused by Aila coupled with the long term salinity problem disrupted the food cycle of the local people and hampered local food security (Kibria et al., 2015). But recently, soil and water salinity of the coastal areas have been decreased by natural and man-made activities. So, local people are now interested to cultivate non-rice cash crops along with boro rice to improve their standard of living and to ensure sufficient food production during the dry season. Some of them have taken initiative of cultivating some non-rice cash crops along with boro rice in small land areas with the help of some local non-governmental oragnizations.

Rice is the staple food crop in Bangladesh and boro rice is the dominant crop of the coastal region in the dry season crop agriculture in terms of both food supply and income generation. High yielding variety (HYV) boro rice is the biggest contributor of rice supply in Bangladesh (Shahid, 2011). Though its cultivation requires irrigation water supply throughout the growth season, but it is the major crop that farmers are interested to cultivate during the dry season to ensure sufficient food production. Among the other dry season cash crops, sunflower is an emerging one. It was first introduced on an experimental basis by Bangladesh Rural Advancement Committee (BRAC), which is an international non-governmentalorganization. Sunflower cultivation has started for the last two-three years in the area. It is a less labor intensive and less water requiring cash crop with good profit margin and health benefits. Farmers now cultivate these crops though in a small scale, instead of keeping their lands fallow. However, global climate change is expected to increase the frequency of common natural disasters in the coastal areas which will also hamper cultivation of these dry season crops. To determine the impacts of future climate on dry season crop yields, FAO AquaCrop model can be a beneficial tool. AquaCrop model, developed by the Land and Water Division of the Food and Agriculture Organization (FAO), is a simple and robust model (Steduto et al., 2009; Steduto et al., 2011). It has been used by many users around the world on different crops under different field conditions and future climatic scenarios (Heng et al., 2009; Hsiao et al., 2009; Araya et al., 2010; Geerts et al., 2010; Andarzian et al., 2011; Hussein et al., 2011; Salemi et al., 2011; Stricevic et al., 2011; Abedinpour et al., 2012; Masanganise et al., 2012; Mkhabela & Bullock, 2012; Bhattacharya and Panda, 2013; Sam- Amoah et al., 2013). After the release of its salinity module in 2012, very few studies have been accomplished using the salinity component. Also, other crop productivity simulation model like DSSAT does not have the salinity module. Salinity is the common feature in the coastal regions of the whole world and its present and future climate induced impacts on the agriculture sector need to be evaluated. But very few studies have been performed to assess these impacts on dry season crop yields under future climatic scenarios in the adverse conditions of the coastal Bangladesh using AquaCrop (Mondal et al., 2015; Saha & Mondal, 2015; Zaman et al., 2015). This study has been conducted to fulfill the above mentioned purpose, i.e., to determine future yields of dry season crops under future climate using the AquaCrop model which is



Mondal expected to help in farmers' decision making process on selection of crop types and management strategies

during the dry season, so that they can earn their living, ensure sufficient food supply and improve their socio-economic condition.

Study Area

For this study, Dacope upazila of Khulna district in the south-west coastal region of Bangladesh has been selected (Figure 1). Dacope upazila is located at 22.5722°N latitude and 89.5111°E longitude in Khulna where there are three polders, named polder 31, 32, and 33. Among the three, polder 31 is in the northern side which is enclosed by the Rupsa river to the east, the Dhaki river to the south Sibsa river to the west and Bhadra (locally known as Badurgacha and Manga in some parts) to the northern side. The region is in the Ganges River Floodplain where sub-tropical monsoon climate is the common feature. In the polder 31, local people have started to cultivate some dry season cash crops during the last 1-2 years after the reduction of soil salinity. Also, they are practicing different water storage techniques like on farm reservoir construction and re-excavation of nearby canals for irrigation water supply to the rice and non-rice crop fields. For the assessment of climate change impacts on the dry season crops, a field experiment was conducted during the dry season of 2014 with Binadhan-8, a high yielding variety of boro rice and Hysun-33, a local variety of sunflower.

Fig 1: Location of the study area

Data Collection and Methodology

For the study, necessary primary and secondary data were collected both from the fields and from relevant organizations. Climate data of present and future years were required for simulation and prediction of dry season crop yields. Required climatic parameters included daily maximum and minimum temperatures, relative humidity, wind speed, sunshine hour and rainfall. Present climate data were collected from the Khulna station of Bangladesh Meteorological Department (BMD). Future climate data were obtained from the output of the PRECIS model run from the Met Office, Hadley Centre, UK. Among the 17 ensemble members of the IPCC-SRES scenario A1B, three were used for the future crop yield prediction, which were QUMP (Quantifying Uncertainty in Model Predictions)-00 (wet condition), QUMP-08 (average condition) and QUMP-16 (dry condition). Future crop yields were simulated for the year 2015-2050 using these three future climatic scenarios. For bias conrrection of future climate data, observed historical data from Khulna BMD station were used.

From the field experiments of rice and sunflower in the study area, necessary primary data for AquaCrop model calibration and validation were collected and incorporated in the model. The growth period of Binadhan-8 ranged from December 25 to April 11 (106 days) and growth period of sunflower ranged from January 1 to May 11 (129 days). From seeding/transplanting to harvesting phase of both the crops, different growth stages of the crops were monitored. Data were collected from two nearby plots for each crop for the calibration and validation purposes. Relative conservative data were collected from the crop library of AquaCrop model and it's Reference Manual (Raes et al., 2012). Soil parameters were measured in the laboratory of Soil Resource Development Institute (SRDI) from the testing of several soil samples collected at different growth stages of the crops. Irrigation water salinity was also measured at the field in different crop growth stages. Amount of irrigation to both rice and sunflower fields was determined based on farmers' perception and on field measurements.

All the collected primary and secondary data were incorporated in the AquaCrop model to simulate present yields of rice and sunflower and predict future yields under climate change scenarios. AquaCrop model has a set of components namely, the climate, crop, soil and management where all the data were added. Climate data of both present and future times were used to calculate reference crop evapotranspiration (ET0) using the ET0 calculator (Allen et al., 1998), which was recorded in the climate component. Also, daily rainfall data for the growth periods of both the dry season crops were incorporated along with the maximum and minimum temperatures. In the crop component, initial and maximum canopy covers were added from which canopy expansion has been calculated. These canopy covers were calculated from photographs taken in the field at a vertical distance of 1 meter at initial and maximum growth stages of each crop. Each photograph was divided in a number of grids from which the percentage of canopy cover was calculated. Crop response to salinity stress was obtained by calibrating the model for stressed condition using the maximum canopy cover and biomass production at a stressed condition. Soil parameters including the texture and salinity of the soil were added in the soil component. Groundwater level and salinity condition were recorded in the groundwater file under the soil component to determine the capillary rise and related salinity situation. In the management component of the model, information of soil bunds, irrigation method and scheduling, amount and frequency of irrigation were incorporated. Initial soil and water salinity data were added in the simulation portion, to record the initial field condition. After the incorporation of necessary primary and secondary data, the model was calibrated for one experimental field and validated for another one. This process was followed for both the crop types.

The parameterized model was afterwards used for prediction of future yields of the crops. Future yield simulation was performed depending on the climate data of each climate change scenario for 36 future years (2015-2050). ET0 calculated from future climate data and future maximum

and minimum temperatures were incorporated in the model to obtain rice and sunflower yields from 2015 to 2050. Bias correction of the future climate data were performed using the 'Delta' method which is also referred to as 'Delta Change' method (Arnell, 1998; Lettenmaier et al., 1999; Graham, 2004; Eisner et al., 2012; Teutschbein and Seibert, 2013; Paul, 2014). In this approach, mean monthly change factors between climate model generated data of control (past) and scenario (future) periods were superimposed on the observed historical data (BMD station data) to obtain future climatic data. In this method, using a historical 30 year time series data from 1976 to 2005, bias corrected future climatic data of 2015 to 2044 were calculated. Applying relative change variable for precipitation data and absolute change variables for temperature, humidity, wind speed and sunshine hour data, bias correction process was completed (Rasmussen et al., 2012).

$$\underset{d,m}{T}^{scen} = \underset{d,m}{T}^{obs} + \left(\overline{\underset{m}{T}^{GCMscen}} - \overline{\underset{m}{T}^{GCMcon}} \right)$$

The scenario daily temperature ($\underset{d,m}{T}^{scen}$) was derived from adding the absolute monthly change signals to the observed time series. The notations d and m means daily data. Here.

$\overline{\underset{m}{T}^{GCMscen}}$ = Mean monthly temperature obtained from PRECIS model simulation for each ensemble member for a 30 year future time period (2015-2044)

$\overline{\underset{m}{T}^{GCMcon}}$ = Mean monthly temperature obtained from PRECIS model simulation for each ensemble member for a 30 year observed time period (1976-2005)

$\underset{d,m}{T}^{obs}$ = Observed daily temperature obtained from BMD data of the local station for a 30 year observed time period (1976-2005)

$\underset{d,m}{T}^{scen}$ = Bias corrected daily temperature for a 30 year future time period (2015-2044)

The difference between model results of past and future years (daily data) was added to the observed climate station data, to obtain bias corrected data of the future years. Thus, the changes in climate from observed to future years, which is called the delta change, were perturbed in historical data, assuming that using this average change, future bias corrected climate is obtained. Using this very concept of Delta method, correction of other climatic parameters was performed except the precipitation. The formula used for correction of precipitation data is provided in the following:

$$P^{scen}_{d,m} = P^{obs}_{d,m} * \left(\frac{\overline{P^{GCMscen}_{m}}}{\overline{P^{GCMcon}_{m}}} \right)$$

The only difference between the formula of other parameters' correction and precipitation correction is that, the difference between model results of an observed and future time series data is calculated by dividing future model data with observed model data, and the monthly changes are multiplied with the observed climatic data to derive bias corrected future precipitation. The notations in the formula mean the same as in the formula for other parameters, except 'P' denotes precipitation here and 'T' denoted temperature in the previous formula. As the model prediction duration is up to 2050, so the correction of 2045-2050 has been performed using the

monthly change signals of the above stated 30 years period on observed data of 2006- 2011, using the same two formulae metioned earlier. In this way, bias corrected data of 36 future years were obtained and used in the AquaCrop model for prediction of future crop yields.

Results and Discussion

From the starting of the growth period of Biandhan-8 (25 December, 2013) to the ending of the growth period of Hysun 33 sunflower (3 May, 2014), the reference crop evapotranspiration (ET0) values have been calculated and added in the AquaCrop model. The values ranged from 1.1 mm/day to 6.7 mm/day throughout the growth periods of rice and sunflower. Also there were five rainfall events during this time. The initial and maximum canopy covers of rice and sunflower were calculated from the percentages of canopy coverage from the photographs taken at different growth stages of the crops as mentioned earlier. The canopy growth coefficient (CGC) value was 0.62% in GDD and canopy decline coefficient (CDC) value was 0.5% in GDD for rice. While CGC value was 1.5% in GDD and CDC value was 0.6% in GDD for sunflower. All these values lied in the range of suggested values in the crop library. Duration for emergence or recovery, days to reach maximum canopy, days to senescense, days to maturity, etc., have also been calculated. All the phenological chanracteristics of both the crops along with other parameters are provided in Table 1.

Tab. 1: Input values of parameters used in the AquaCrop model

Parameters	**Unit**	**Value for the rice field**	**Value for the sunflower field**
Initial canopy cover, CC0	%	3.43	0.39
Maximum canopy cover, CCx (optimum condition)	%	95	99
Canopy growth coefficient (CGC)	%	8.1	24.4
Canopy decline days	days	35	21
Canopy decline coefficient (CDC)	%	9.5	14.4
Days to emerge/recover (DAT/DAS)	days	8	8
Days to maximum canopy (DAT/DAS)	days	80	40
Days to senescence (DAT/DAS)	days	90	115
Days to maturity (DAT/DAS)	days	106	129
Days to flowering (DAT/DAS)	days	82	60
Duration of flowering	days	9	9

Length building up HI					days	21	18
Determinacy linked with flowering						yes	yes
Maximum effective rooting depth					m	0.30	0.33
Time to reach maximum rooting depth (DAT/DAS)					days	45	50
Minimum effective rooting depth					m	0.30	0.3
Shape factor describing root zone expansion						2	1.3
Base temperature					°C	8	4
Upper temperature					°C	30	30
Crop coefficient for transpiration						1.10	1.1
Decline of crop coefficient with age					%/day	0.15	0.3
Effect of canopy cover on reducing evaporation in late season stage					%	50	60
Water productivity, WP					gm/ m2	19	18
Reference harvest index, HI0					%	50	35
Threshold for canopy expansion (pexp, upper)						0.00	0.15
Threshold for canopy expansion (pexp, lower)						0.40	0.65
Shape factor for water stress coefficient for canopy expansion						3	2.5
Threshold for stomatal control (psto)						0.50	0.6
Shape factor for water stress coefficient for stomatal control						3	2.5
Threshold for canopy senescence (psen)						0.55	0.7

Shape	factor	for	water	stress	coefficient	for	cano-py			
senescence									3	2.5
Soil water depletion threshold					for failure of	pollination				
									0.75	0.85
(ppol)										
Possible increase in HI due to water stress before flowering								%	0	4
Excess of potential fruits (%)									200	200
Maximum possible increase of HI								%	15	10
Cold stress temperature for pollination								°C	8	10
Heat stress temperature for pollination								°C	35	40
Maximum canopy cover under soil stress condition								%	70	65
Relative biomass production								%	66	60

The irrigation supply to the rice field was provided from an on-farm reservoir in the field while for sunflower, irrigation was provided by collecting water by low lift pump from a nearby canal. Irrigation amount and irrigation water salinity of calibration and validation fields for both the crops were also determined. Salinity of the irrigation water ranged up to 3 dS/m which is in the acceptable limit. Irrigation water was applied to these crop fields in surface irrigation method. Irrigation amount to the rice fields was about 140-150 mm while irrigation amount to the sunflower fields was about 40 mm which was applied just to adequately wet the field with no standing water. In total, 9 irrigations were provided to the calibration field of rice and 6 irrigations were provided to the rice validation field. Also, irrigation events to the calibration and validation fields of sunflower were found to be 3 and 2 respectively. This is because irrigation requirement of rice is much higher that that of sunflower and rice also requires standing water in the field.

Soil texture of the fields of both crops was found to be silty clay loam from testing of samples in the laboratory and there were soil bunds present in the field. Initial soil salinity of the rice field was 3.81 dS/m and it was 7.7 dS/m for the sunflower field. The minimum and maximum thresholds for salinity were 3 dS/m and 11 dS/m respectively for rice and 2 dS/m and 12 dS/m respectively for sunflower. The salinity response curves were found to be convex in shape for both the crops and the shape factor of EC (Ks) were 3 for rice and 2 for sunflower. The observed yields of rice and sunflower were measured in the field for both the calibration and validation fields. The yield and biomass value are provided in Table 2 in the following:

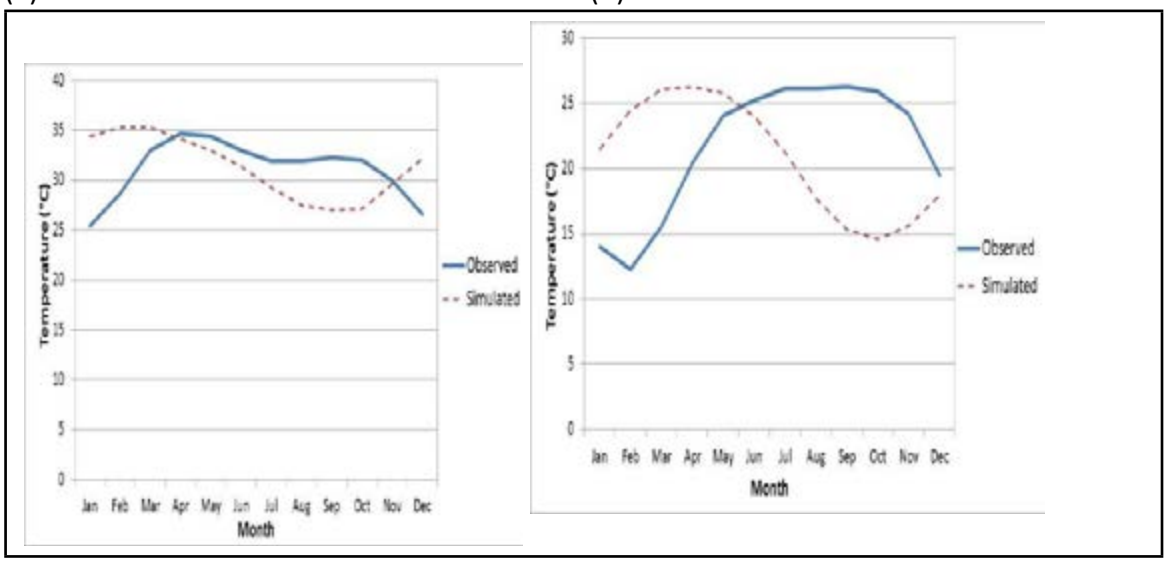
Tab. 2: Crop yield and biomass of calibration and validation fields

	Rice				Sunflower			
	Calibration field		**Validation field**		**Calibration field**		**Validation field**	
	Yield	Biomass	Yield	Biomass	Yield	Biomass	Yield	Biomass
	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)
Observed	5.30	10.00	5.20	9.75	1.20	5.00	1.10	4.50
Simulated	5.33	10.65	5.32	10.64	1.25	3.58	1.14	3.25

From the results shown in Table 2 it is observed that, the model simulated yields of both the crops closely match with the observed yields. For calibration and validation, the yields are close enough to state that the model was calibrated and validated well. Also, it is observed that the model can capture the crop yields reasonable well with acceptable accuracy. If calibrated and validated properly, the model can simulate yields of other dry season crops in the saline condition of other coastal areas like Bangladesh with variable soil, climatic and hydrologic conditions.

Using the parameterized model, the future yields of rice and sunflower were predicted for the years 2015 to 2050 with the bias corrected data of three climate change scenarios. Bias correction of the climate data was performed as the data were found to be highly biased. Figure 2 represents bias of climate data. Here the comparison of monthly historical data from 1976-2005 between observed and model simulated climate data (maximum and minimum temperatures and rainfall) has been shown.

(a) (b)



(c)

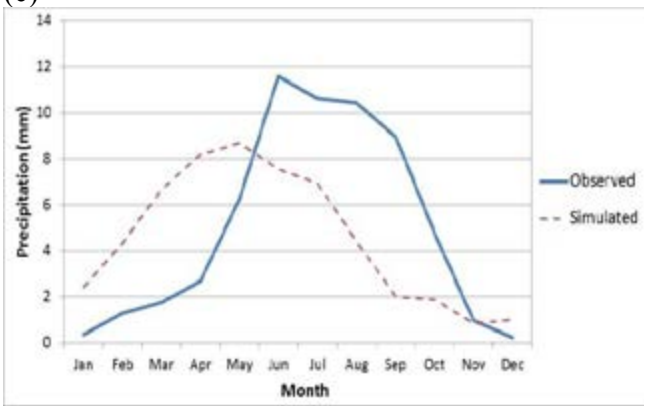


Fig 2: Comparison between observed and model simulated data of (a) maximum temperature (b) Minimum temperature and (c) Precipitation

From the above figure it is observed that, the observed (BMD station) and model generated data (PRECIS generated) of previous 30 years period show significant discrepancies. The temperature and rainfall values of the observed and the model generated data are very much different and also not representative. The pattern of monthly variation is also not similar for the observed and model data. This is the same case with other climatic parameters. This fact proves that there is a need to perform bias correction of these data. The prediction of future rice and sunflower yields with the biased climate data also did not provide acceptable yield values for rice and sunflower (Figure 3).

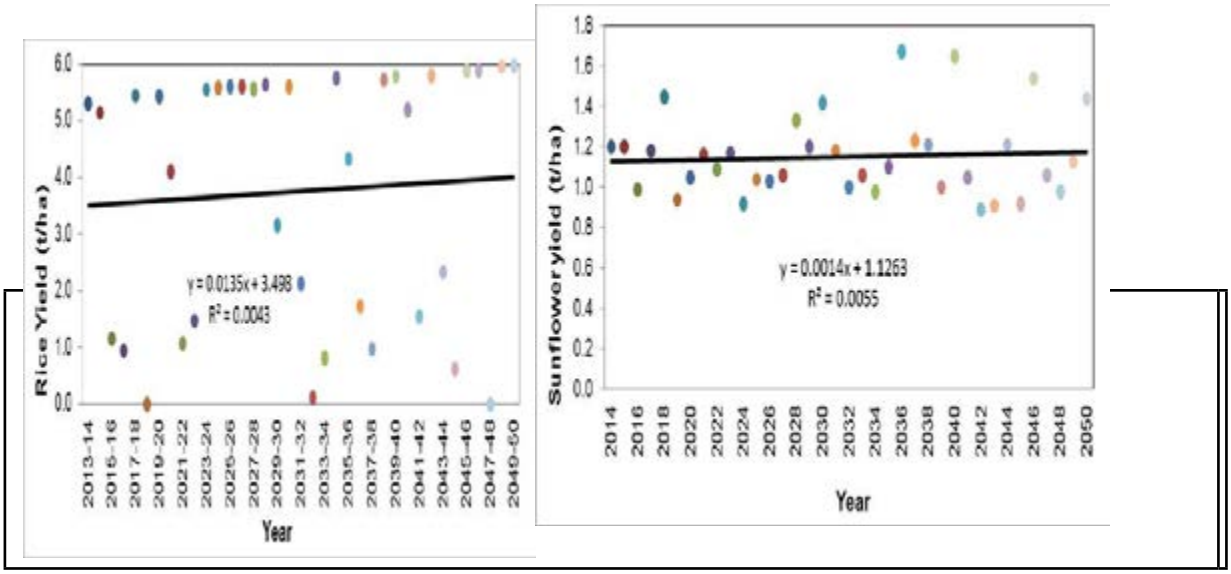


Fig 3: Future (a) rice yield and (b) sunflower yield from 2015-2050 for biased data of ensemble QUMP-00

From the above figure it can be observed that, biased climate data of the future years provided prediction that is not acceptable, especially for rice, where zero yields can be observed for some years. Though they showed slightly increasing trend, the difference in monthly data is very high. This fact required bias corrected climate data for using in the prediction of future yields. With the Delta method bias correction has been performed as mention in the methodology. Then with the corrected data, the future yields of rice and sunflower have been calculated and represented in a graphical manner to observe the trend of the yields of these crops.

Figure 4, 5 and 6 represent the future predicted yields:

(a) (b)

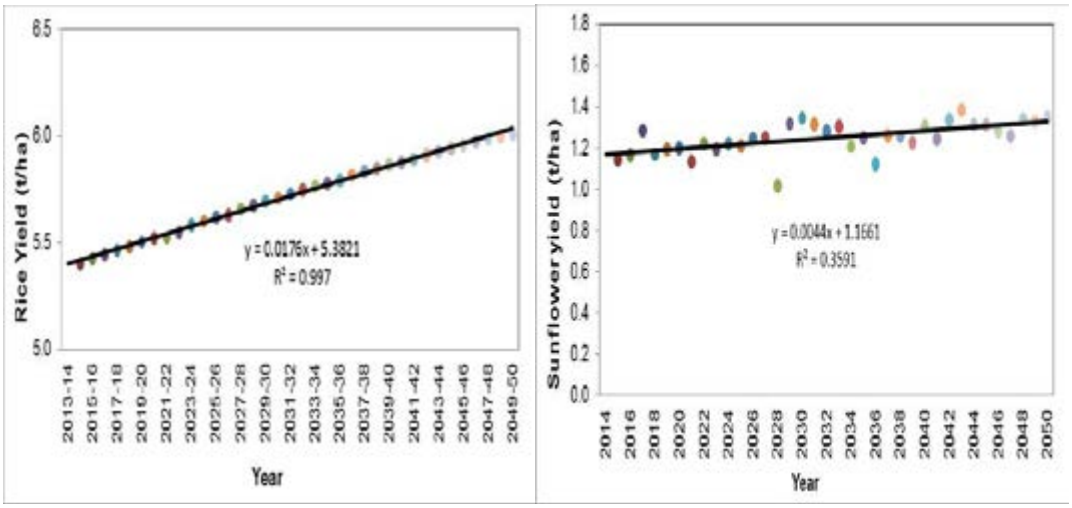


Fig 4: Future (a) rice yield and (b) sunflower yield from 2015-2050 for bias corrected data of ensemble QUMP-00

(a) (b)

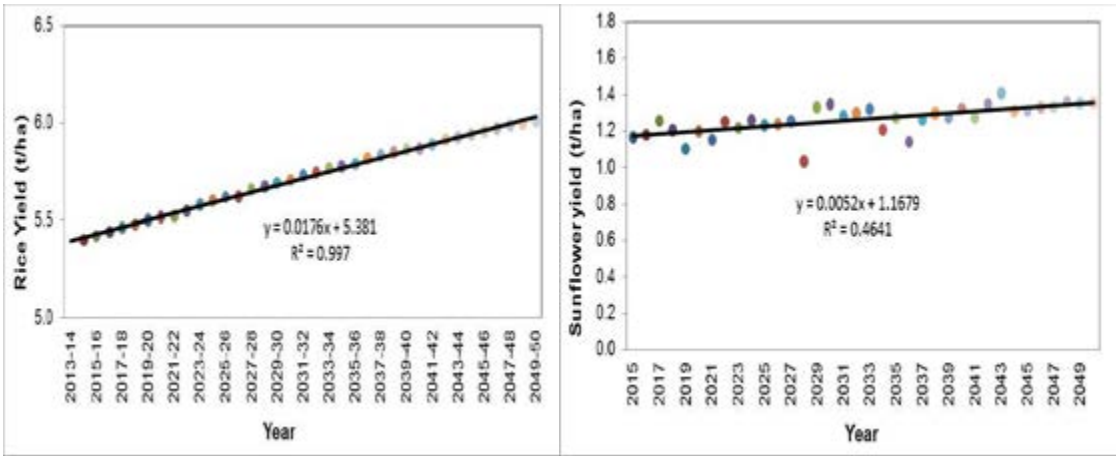


Fig 5: Future (a) rice yield and (b) sunflower yield from 2015-2050 for bias corrected data of ensemble QUMP-08

(a) (b)

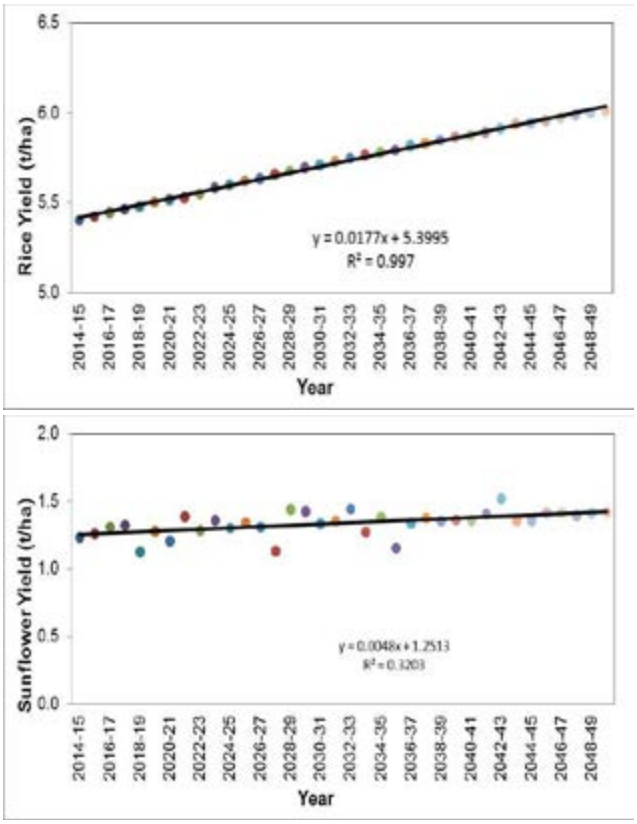


Fig 6: Future (a) rice yield and (b) sunflower yield from 2015-2050 for bias corrected data of ensemble QUMP-16

From the above three figures it is observed that the future yields of rice and sunflower show statistically significant increasing trends with significant R2 values for each of the three climate change scenarios. Rice yield is expected to reach up to 6 t/ha while sunflower yield may reach up to 1.5 t/ha in the future years under projected climatic conditions if present soil and water conditions are maintained. The most sensitive growth stage of any crop is the flowering or reproductive stage and if temperature reaches beyond acceptable limit in this stage, crop yield gets affected. Though it is expected that, in future maximum temperature may increase, but the future climate data used in this study showed that maximum temperature during the reproductive stages of rice and sunflower will remain within the range of acceptable temperature (35°C for rice and 40°C for sunflower). Thus, the temperature is not expected to hamper the crop yields and with increasing CO2 concentrations in the future years, the yields of rice and sunflower

may increase compared to the present yields. Moreover, the soil and water salinity in the study area is decreasing with time which will provide better soil condition and suitable irrigation water supply in future. This field condition and favorable future climate show better prospect of dry season crop cultivation in the study area. A similar study by Zaman et al (2015) found that, under future climatic condition dry season crop mustard can have similar or increased yield in saline coastal areas. Local respondents from the study area informed that, the expected profit from cultivation of dry season crops are high and this can very well support their lifestyle. Local farmers who are presently cultivating dry season crops in their lands are getting a profit of 50000 tk/ha for rice, 45000 tk/ha for sunflower and 20000 tk/ha for sesame. So, instead of keeping their lands fallow or doing very small scale vegetable cultivation, if the farmers can cultivate the cash crops along with the staple food crop rice, they are expected to get additional food supply, income generation and better standard of living. This will ensure the food security and improvement of socio-economic condition of the local people. If they are provided with some support from the local government or NGOs working in the area such as, provision of seeds and fertilizers, monetary incentives for initial costs or training and capacity building activities about the new improved high yielding varieties of the dry season crops, they can bring the cultivation in to a larger scale. Also, availability of irrigation water can be increased in the area with re-excavation of existing silted up canals. A similar study found that, re-excavated canals can provide additional storage of monsoon water which may increase the area under irrigation during the dry season. Local farmers are also practicing construction of on-farm reservoirs inside their lands which serve as the source of irrigation along with an opportunity for white fish cultivation. Combined dry season crop production and white fish cultivation can provide more profit than any other cropping practice or combination has ever done. So, from every perspective it can be firmly stated that, agricultural crop production during the dry season with additional income generation from relevant sources is the best practice for the people in the study area, and also for the coastal people, given the present and future climatic conditions.

Under these circumstances, this knowledge of increased future yield of these crops may reassure the local farmers so that the ones who are still not cultivating any crops may come out of their unemployed condition and others can scale up their cropping practices themselves or with the help of the local government, NGOs or community people. In this way, the agricultural practices can be sustainable in the long run with a solvent and resilient community.

6. Conclusion

In the coastal areas of Bangladesh, salinity is one of the major problems which greatly hampers the agriculture sector. Moreover, crop agriculture is under the threat of global climate change phenomenon the most which is expected to affect the poor coastal farmers. This study was performed to evaluate the impacts of climate change on dry season crop cultivation in a coastal region of Bangladesh using the AquaCrop model. The performance of the model in simulating crop yield in the saline condition of the area was found to be well as the yields closely matched with the observed values. Also, the prediction of rice and sunflower yields showed positive impacts of future climate indicating good potentials of these crops in the area. Cultivation of dry season crops has been found profitable for the local farmers and with proper incentives and the knowledge of increased future yields, farmers may be encouraged to cultivate staple food crop and cash crops in a larger scale during the dry season to ensure their food security and better standard of living in future. This can maintain sustainable agriculture in the coastal region thus providing majority of the people better livelihood opportunities.

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Title: Productivity improvement opportunities in the coastal polders to address food security challenges of Bangladesh

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Introduction

The coastal zone of Bangladesh comprises low lying lands within a dense network of rivers and canals. The rivers are tidal and this effect extends about 150 km inland, with diurnal fluctuations of 2 to 3 m, and salinity of the rivers increases during the dry season, more so closer to the coast line and in the south west (Khan et al. 2015). The water resources in the coastal zone are vital for crop production, ecosystem sustenance and livelihood. More than 30% of the cultivable land of the country is in the coastal zone (SRDI 2010). Of the 2.85 Mha of the coastal and offshore lands, about 1.2 Mha are protected from flooding and saline water intrusion as a result of the construction of polders. Despite this, cropping intensity and productivity in this region is much lower than in other parts of the country. The cropping intensity in the coastal zone is 173%, which is lower than the national average of 199% (BBS 2011).

There is a general perception that, during the dry season, the river water is saline throughout the coastal zone. In reality, most of the rivers in the south central coastal zone (Barisal Division) remain non-salinethroughout the year (Khan et al 2015). It is predicted that this will continue to be the case, even in the climate change scenario with a 22 cm mean sea level rise and a moderate precipitation change (Khan et al. 2015). On the other hand, the river water in medium salinity areas such as Khulna District only remains suitable for irrigation from July to until early to mid February i.e., for the first couple of months of the *rabi*season (Mondal et al. 2006, Khan et al 2015). River water in high salinity areas such as Satkhira District remains above 3 dS/m throughout the year and is considered unsuitable for crop irrigation. But it is a valuable resource for shrimp cultivation (Khan et al. 2015).

Although Bangladesh as a whole is currently self-sufficient in rice production, this is not the case for the coastal zone (MoA-FAO 2013; Tuong et al. 2014). The country faces enormous challenges to maintain food self-sufficiency for its growing population, as there is little scope to further increase cropping system intensity, except in the underutilized coastal zone lands. Unlike the rest of Bangladesh, the farmers in the coastal zone have not widely adopted modern high yielding rice varieties (HYV) because their shorter stature makes them unsuitable for the high water depths (20-70 cm) which often prevail during the rainy season. In the coastal zone the traditional low yielding *aman* crop (2.0-3.5 t/ha) is sometimes followed by a low input, low yielding relay-sown grasspea (0.5-1.0 t/ha) crop and/or preceded by a nearly rainy season *aus*rice (2.5-3.5 t/ha) crop (common in parts of Barisal Division) or late sown sown (mid February to early March) sesame and mungbean (0.5-1.0 t/ha)(common in parts of Khulna Division). The sesame and mungbean crops are often damaged by the early *kharif* rains, and by cyclones which tend to occur every 3 to 4 years in May. Moreover, many fields remain flooded until December, delaying harvest of *aman* and establishment of *rabi* crops. The late harvest of the local *aman* varieties and water logged soil prevent the cultivation of high yielding *rabi* crops such as maize, sunflower and wheat which need to be established in early December for maximum yield. Thus large areas of the coastal land (approximately 810.000 ha) lie fallow during the dry season (Hasan et al. 2013) due to late aman harvest, lack of ready access to fresh

water, and increasing soil salinity as the dry season progresses.

The feasibility of increasing productivity in the coastal zone by intensifying to an HYV *aman-rabi* system was shown by Mondal (1997). The feasibility of a high yielding *aus-aman* system using a short duration HYV *aus* variety and a non-photoperiod sensitive HYV *aman* variety has also been shown in medium salinity areas of the coastal zone (Ritu et al. 2015). Furthermore, Sharifullah et al. (2009) and Mondal et al. (2010) showed the feasibility of an HYV *aman-boro* system in the moderately saline coastal zone. This involved 'early' (timely) sowing of the *boro* crop (mid November), irrigation directly from the river until salinity increased to about 4 dS/m, and finishing the crop on river water stored in the polder canal system prior to the river becoming too saline. The earlier maturity HYV aman rice creates the possibility of drainage in early November and earlier rabi crops establishment. This in turn allows diversification to higher yielding and/or higher value rabi crops in the coastal zone. The present study was therefore conducted to take the next step in cropping system intensification - to demonstrate the potential for more productive double (*aman- boro/rabi*) and triple (*aus-aman-boro/rabi*) cropping systems in medium and low salinity areas, respectively, of the coastal zone of Bangladesh.

Methodology

2.1 Study site

Cropping system intensification strategies were evaluated in non-replicated demonstrations in the farmers' fields. Of the trails, two replicated experiments were conducted in boro season. The demonstrations were implemented at two locations: (i) a medium salinity location at Kismatfultola (220 41' 00''N and 890 30' 00''E) at Batiaghata upazila in Khulna Division, and (ii) a low salinity site at Bazarkahli (22o11'33"N and 90o15'41"E) at Amtali upazila in Barisal Division. Replicated boro season experiments were conducted also at two locations: (i) at KismatFultola, Batiaghata and (ii) in a low salinity site (22o27'51"N and 90o22'56"E) at Patuakhali Science and Technology University (PSTU) field in Dumki upazila (Barisal Division). All sites were located adjacent to a *khal* connected to the surrounding river via a sluice gate in the polder embankment, to facilitate drainage during the rainy season, and to provide a source of water for irrigation during the dry season.

2.2 Cropping systems

At Amtali and Dumki, fresh water is available year round. Here, triple cropping systems (*aus-aman-boro* and *aus-aman-rabi*) were tested. At Batiaghata, fresh water becomes very scarce in the second half of the dry season, and double systems of *aman-boro* and *aman-rabi* were evaluated.

2.3 Variety selection

Modern, high yielding varieties of rice were used in all systems. To fit three crops per year, short duration varieties of *aus*, medium duration non-photoperiod sensitive varieties of *aman*, and a medium duration *boro*variety were used. Some of the *aman* varieties were also known to have some tolerance to water stagnation. Local grain type preference for the *aman* varieties was also considered – bold in Amtali and slender in Batiaghata.

Hybrid and high yielding varieties of chilli, maize, mungbean, sesame, sunflower and watermelon crops were evaluated in *aus-aman-rabi* and sesame and mungbean in *aman-rabi* cropping systems.

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2.4 Rice crop management

2.4.1 Sowing date

The sowing date of *aman* was chosen to ensure that the rice would be ready for harvest by mid-November,so that the field could be drained in early November. This would enable the soil to start to dry for ease of harvesting and to enable soil preparation for *rabi* crops to be advanced. At Amtali, sowing dates were late July/early August. At Batiaghata, where longer duration *aman* varieties were grown, the rice sowing date was earlier (first week of July). All *aus* crops were sown in mid April at Amtali.

The sowing date for *boro* in Bangladesh varies widely, from November to January, depending on farmer practice and location. As our objectives were to fit three crops per year at Amtali and Dumki, and to minimize the stored water requirement to finish off the *boro* crop at Batiaghata, it was important to establish the *boro* rice as early as possible. However, planting too early can lead to cold damage during the reproductive stage and greatly reduce yield (Mondal et al. 2010). Therefore, *boro* sowing dates from late October to end of December were evaluated in this study. Replicated experiments were conducted at Kismat Fultola village in Batiaghata upazila (medium salinity) in Khulna Division during 2005-06 and 2006-07dry seasons, and at Patuakhali Science and Technology University (PSTU) farm (low salinity) in Barisal Division during 2012-13 and 2013-14. The non-replicated demonstrations were at Batiaghata and Amtali during 2011-12, 2012-13 and 2013-14. Details of the replicated experiments are provided in Mondal et al (2010) and Saha et al (2015), and details of the demonstrations in Mondal et al (2015a).

2.4.2 Cultural management

All rice crops were managed according to BRRI recommendations (BRRI 2010). The lands were ploughed three to four times (wet tillage) using a power tiller powered by a two-wheel tractor. All fertilizers other than urea were broadcast just prior to the final land leveling. Urea was broadcast in equal splits at various times after transplanting. Excess water from the *aus* and *aman* fields was drained before topdressing of urea. The *aus* and *aman* crops were primarily grown on rainfall, with gravity irrigation by letting in river water at high tide during dry spells. The *boro* crops were fully irrigated by pumping water from the *khal* to maintain a shallow depth of water (2 to 5 cm). Weeding was done synchronizing with topdressing of urea. Preventive measures were taken to control pest and diseases of rice. Basudin was applied with urea to prevent pest and disease. Besides, Diazinon, Synothrene and Virtoka were applied to control stem borer and leaf roller.

2.4.3 Crop monitoring

The duration of each rice crop was determined as the number of days from the day of sowing on the seed bed to physiological maturity. Physiological maturity was taken as the stage when 80%

of the grains had turned golden. Grain yield was determined by harvesting a 5 m2 area at five locations (four towards the corners and one in the middle) of each plot at Amtali. At Batiaghata and Dumki, rice was harvested from a 2 m x 5 m and 2 m x 3 m area, respectively in the middle of each plot to determine the yield. Grain moisture content was determined and the yield was calculated at 14% moisture content.

2.5 *Rabi crop management*

2.5.1 Sowing date

Sowing date (Table 1) of the *rabi* crops varied among crops, seasons and sites depending on soil moisture after *aman* harvest and the optimum sowing time for each crop, but all were sown within the recommended period (BARI 2006). Harvest dates were influenced by variety, sowing date, temperature and soil moisture.

Tab. 1: Sowing and harvesting dates of *rabi* crops at Amtali and Batiaghata during 2011-2014.

Crop			Amtali		Batiaghata	
		Sowing date		Harvest date	Sowing date	Harvest date
Chilli	10	Dec – 17 Jan		10 Apr – 10 May		
Maize	16 Dec – 9 Jan			27 Apr – 13 May		
Sunflower	16	Dec – 9 Jan		9- 25 Apr		
Watermelon	13	– 30 Dec		1 – 15 Apr		
Sesame	12	– 24 Jan		25 Apr – 3 May	08 Feb – 16 Mar	16 May – 12 Jun
Mungbean	11	-24 Jan		30 Mar-13 Apr	06 Feb – 06 Mar	30 Apr-29 May

2.5.2 Cultural management

The land was tilled by a power tiller powered by a 2-wheel tractor when the soil had dried to around field capacity, followed by one leveling using a wooden ladder pulled by the tractor. The exception was land preparation for watermelon for which 60 cm x 60 cm x 60 cm pits were dug at 2 m x 2 m spacing.

Rabi crops were grown under mulched and un-mulched practices and BARI recommended management was applied for all *rabi* crops (BARI 2006). Chilli was sown at 50 cm row spacing, and mungbean and sesame at 30 cm spacing, and thinning was done two weeks after emergence to give 5 cm spacing between plants. Planting geometry was 75 cm x 25 cm for maize, 60 cm x 45 cm for sunflower, and 2 m x 2 m for watermelon. One seed per hill was sown for maize and sunflower, and two seeds per pit for watermelon. Earthing up was done in maize and sunflower 50-60 d after sowing.

Since river water remains non-saline throughout the year at Amtali, one-third of the N (50% in mungbean) and all the P, K, S, Zn and B were broadcast just prior to the final tillage operation, 1 d before seeding, with the exception of watermelon for which the fertilizer was applied to the pits 5 d before sowing. The rest of the urea was topdressed thrice in chilli and watermelon, twice in maize, sesame and sunflower, and once in mungbean. At Batiaghata, river water is saline in the dry season. For that half of the N and the full dose of P, K, S, Zn and B were applied during final land preparation. The remaining N was topdressed once or twice depending on rainfall and salinity of water in the *khal*.

At Amtali, the *khal* was filled with river water by opening the sluice gate at high tide when needed, and then the gate was closed to store the water in the *khal* for irrigation. All *rabi* crops were irrigated by pumping water from the *khal*. Irrigation method varied depending on the crop and stage of growth, topdressing of N fertilizer, and soil moisture, and included watering of small seedlings with a watering can, spraying with a hose, and flood irrigation. Chilli and watermelon were irrigated five times using a hose and spray nozzle, and the other *rabi* crops were flood irrigated. At Batiaghata, the *rabi* crops were mainly grown using residual soil moisture and rainfall due to scarcity of good quality water. Irrigation was not applied in 2012 due to timely rainfall, and there was no irrigation in 2014 due to the high salinity of the water in the *khal*(Mondal et al. 2015a). Two irrigations were applied to mungbean in 2013 from *khal*.

In non mulched plots, weeding was done twice by hand at 20-25 d and 40-50 d after emergence, prior to urea topdressing and earthing up in maize and sunflower. In other crops weeding was done during thinning. In mulched plots, weeding was not generally required, but sporadic hand removal was done when weeds appeared.

Disease and insect pest infestations were controlled well by spraying pesticides and insecticides when necessary. At Amtali, Instar and Admire were sprayed once to control aphid in mungbean and Savin was applied 5-6 times to control red pumpkin beetle in watermelon. At Batiaghata, Bevistin and Nitro were sprayed to control yellow mosaic virus and Virtako to control semilooper in mungbean. No biocides were applied to other *rabi* crops.

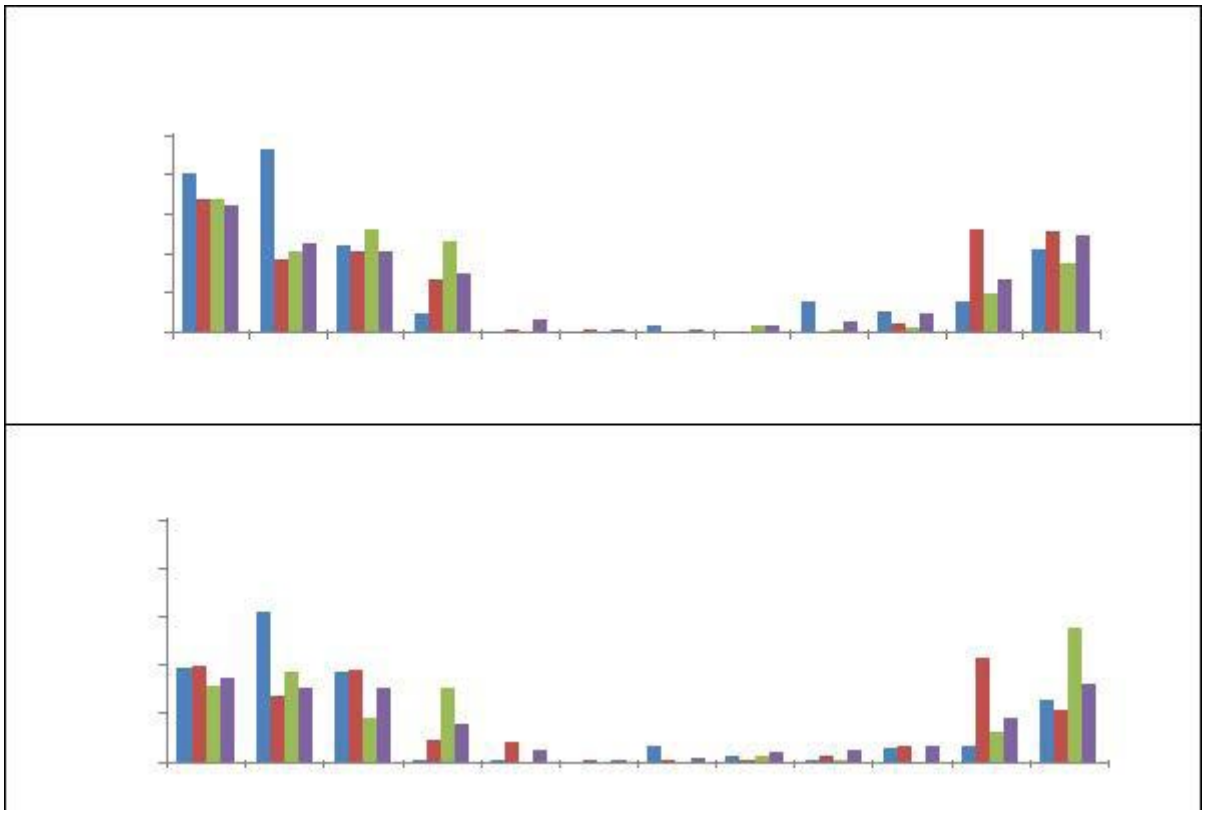
2.5.3 Crop monitoring

The growth duration of *rabi* crops was determined. Most *rabi* crops were harvested when the leaves turned dry, brown and/or yellow. Sesame and mungbean were harvested when the pods were black and chilli when the fruit had turned reddish. Several pickings were required for mungbean, chilli and watermelon. Grain or fruit yield of the *rabi* crops was determined in a 4 m x 5 m harvest area in the middle of each plot for all crops except watermelon at Amtali and all crops at Batiaghata, the yield was assessed on whole plot harvest. Yield of maize, sunflower and mungbean was converted to 14% moisture content. Yield of chilli and watermelon was determined immediately after harvest (green weight). Rice equivalent yield (REY) of the *rabi* crops was calculated taking farm gate price of rice and rabi crops using the formula:

REY (kg/ha) = rabi yield (kg/ha)*rabi price (Tk/kg)/rice price (Tk/kg)

2.6 Water resources

Water level, flow rate and salinity in the river systems in the study area were monitored during 2011-2014.Water level and flow rates in the peripheral rivers of the study sites were measured at half an hour intervals over a full tidal cycle during neap and spring tides in the dry (rabi/boro) and monsoon (aus and aman) seasons. River water salinity was measures on alternate days at high and low tide at 36 stations across the Ganges coastal zone. The current conditions of salinity intrusion and availability of fresh water were analyzed based on historical data (collected from the Bangladesh Water Development Board), the detailed field measurements and by applying numerical modeling techniques. Numerical models are effective tools to characterize and predict the quantity and quality of water. These models provide a means of generating a



continuous time series data of water level, flow and salinity at a large number of locations in the study area. The river model developed by the Institute of Water Modelling (IWM 2005) for the southern region (based on the MIKE modeling system) was used to establish hydrological conditions and variations of salinity over space and time across the study area. The model was calibrated using measured data for 2012 and validated against measured data for 2011, for water flow, water level and salinity in the different rivers. The agreement between model generated results and measured data was good for both water flow (R2 from 0.87 to 0.95) and salinity (R2 from 0.73 to 0.97) in different rivers.

The depth of water in the paddy fields was also measured daily using vertical scales installed in the plots at several locations. Salinity of the polder canal water was also measured daily using a portable EC meter.

2.7 Weather

Daily rainfall, maximum and minimum temperature, and sun shine hours at Khepupara (in Patuakhali District, Barisal Division) and Khulna were collected from the Bangladesh

Meteorological Department for the period 2011-2014. The weather station at Khulna is about 8 km north of the experimental site at Batiaghata, while the station at Khepupara is about 24 km and 56 km south of the experimental site at Amtali and Dumki, respectively.

Results

3.1 Weather

3.1.1 Rainfall

Monthly rainfall totals at Khepupara and Khulna meteorological stations were generally similar to the long- term averages, with a few exceptions (Fig. 1). At both locations, rainfall was extremely high in August 2011, with totals in excess of 600 mm at Khulna, and 900 mm at Khepupara. The monsoon season ended late in 2013, with unusually high rainfall at both sites in October (301 mm at Khulna, 457 mm at Khepupara). Pre- *kharif r*ainfall was also unusually high in May 2013 at both locations due to cyclone Mohasen (430 mm at Khulna, 518 mm at Khepupara), and in June 2014 at Khulna only (555 mm).

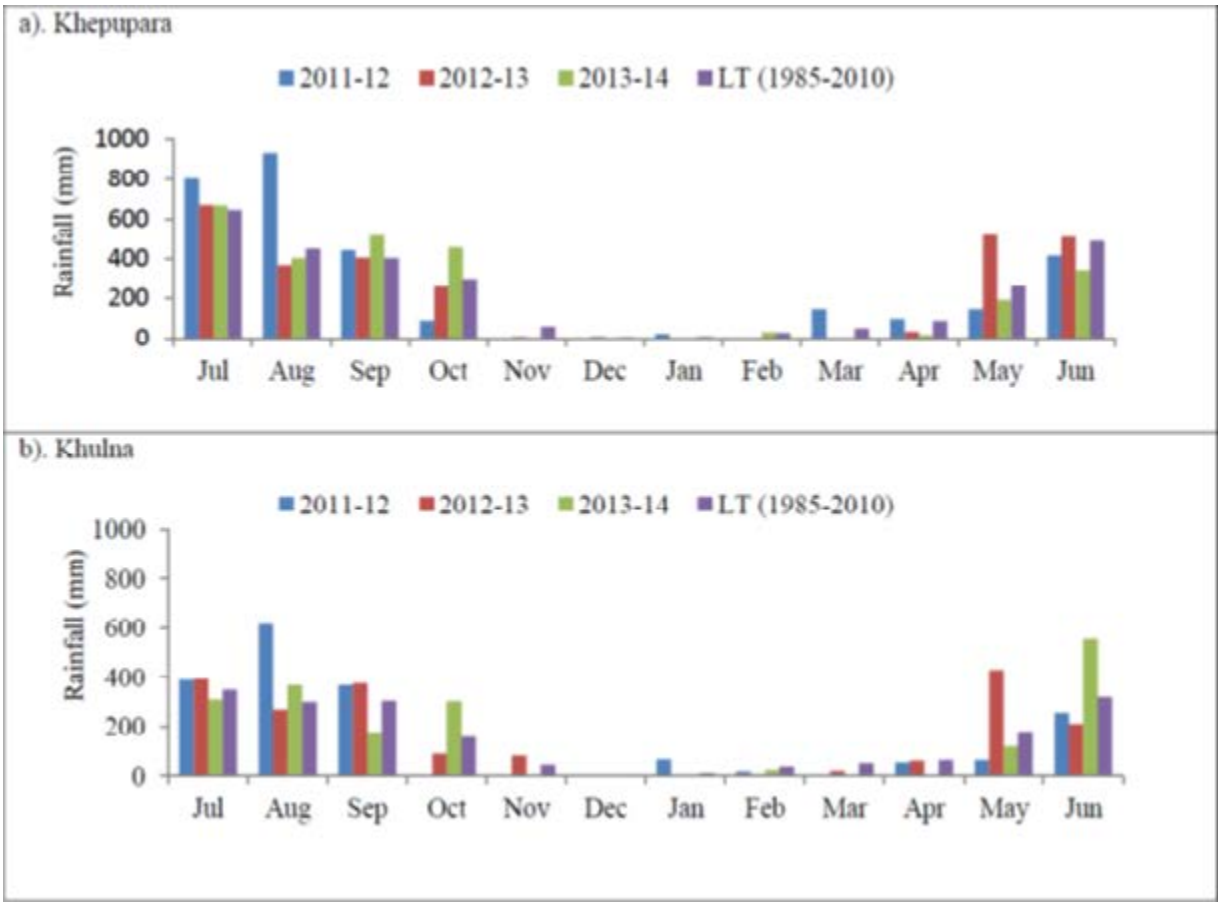


Fig. 1: Monthly rainfall at Khepupara and Khulna from July 2011 to June 2014 compared with long-term average (1985-2010).

3.1.2 Temperature

Trends in temperature across the years were similar within and across sites (Fig. 2). Temperatures were generally favourable for growing rice throughout the year, apart from low minimum

temperatures (around 10oC) in late December/early January each year, and high temperatures (approaching 40oC in May). The mean monthly temperatures at Khepupara and Khulna during the study period were generally similar to the long-term average temperatures, except for higher than average temperature in April 2014, in May 2012 and 2014, and in Jun 2012 (Mondal et al. 2015a). Based on the long-term data, the temperature regime is slightly more extreme at Khulna than at Khepupara. Maximum temperature is higher at Khulna during summer and the rainy season, while minimum temperature is lower at Khulna in winter.

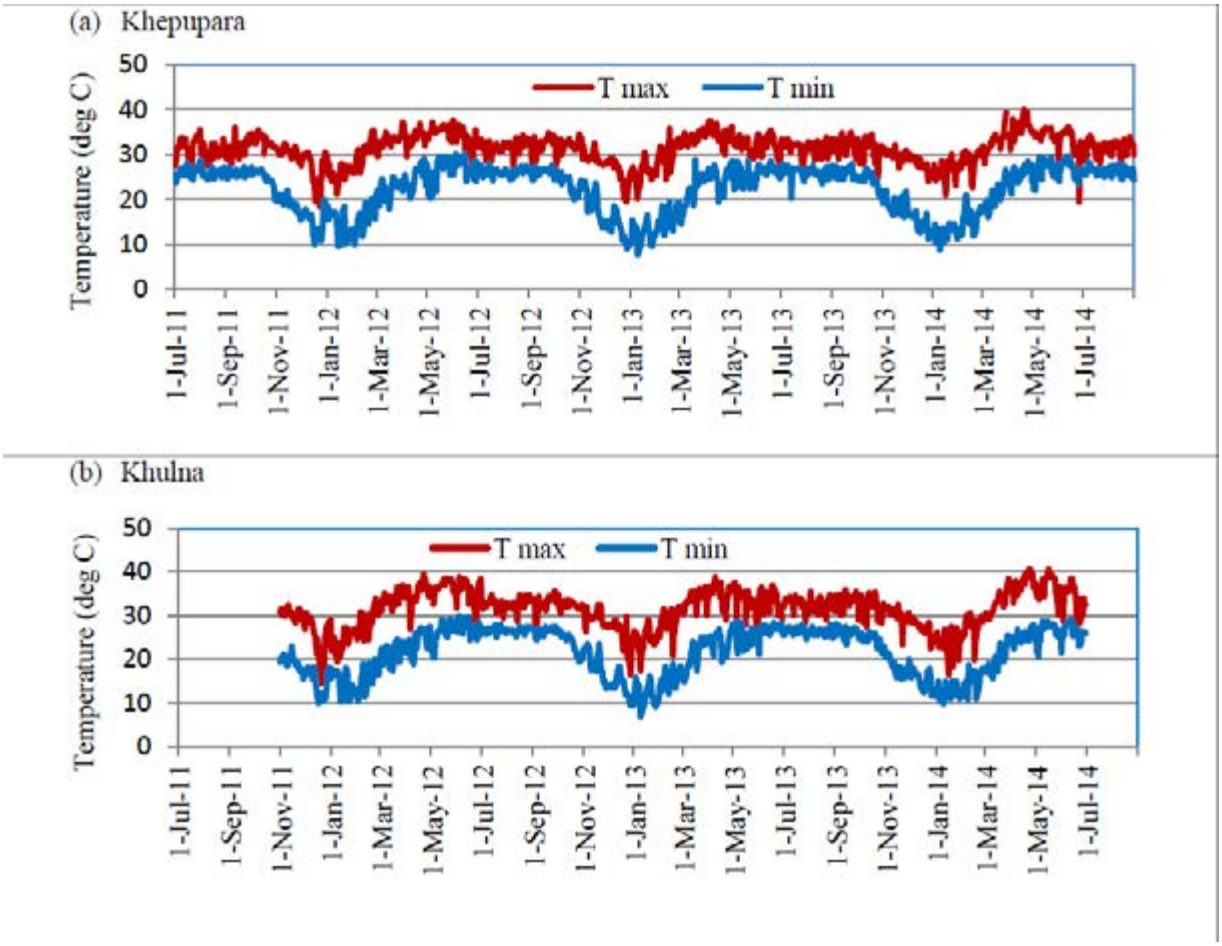


Fig. 2: Daily maximum and minimum temperatures at Khepupara and Khulna from July 2011 to June 2014.

3.1.3 Sunshine hours

During the monsoon season (June to September), the amount of bright sunshine (3 to 5 h per day) was lower than at other times of the year (Fig. 3). Daily sunshine hours were highest in November and February to May. The long-term data suggest that the amount of bright sunshine at Khulna is higher than at Khepupara throughout the year (Fig. 3b).

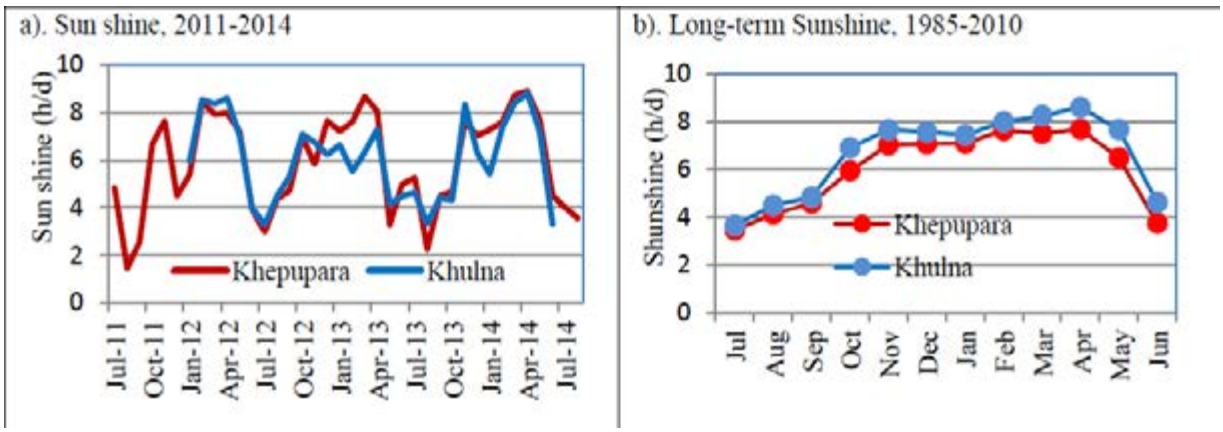


Fig. 3: Monthly average sunshine hour of Khepupara and Khulna during 2011-2014 (a) and long-term means (b).

3.2 River water resources

The main source of fresh water in Khulna Division is the Ganges river. The flow during November to April is vital in pushing the salinity front downstream and enhancing the fresh water areas in the river for dry season irrigation, domestic and industrial uses. The average daily flow rate in the Gorai river during 01 November 2011 to 30 April 2012 was 261 m3/s, while the maximum instantaneous rate was about 693 m3/s (Khan et al 2015). The south-central region (Barisal Division) is connected with the lower Meghna river through the Swarupkati-Kocha-Baleswar, Buriswar and Bishkhali rivers. The area also receives flow from the Padma river through Arial Kha river. Salinity in the lower Meghna remains within 3 dS/m during the dry season (Khan et al. 2015). The flow in the lower Meghna during the dry season is enormous since it carries the combined flow of the Ganges, Brahmaputra, and upper Mehgna rivers. The average daily flow from February to March is about 24,000 m3/s.

Field observations showed that the river water salinity remained below 1 dS/m throughout the year in much of the Barisal Division and the same was true of simulated salinity (Khan et al. 2015). Simulated monthly mean daily flow in the Buriswar (Payra) river varied from 5,400 to 6,300 m3/s. It is thus evident that much of the Barisal Division has abundant fresh water available for irrigation, aquaculture, industrial and domestic uses throughout the year. In contrast, simulation and monitoring data showed a limited area with available fresh water in March in Khulna Division. Salinity in the peripheral rivers of Batiaghata upazila (Khulna District) started to increase from December and reached the peak (20-15 dS/m) in April, decreased rapidly in June and remained below 4 dS/m until mid-February (Mondal et al 2006, Mondal et al 2010 and Khan et al 2015). The simulated monthly mean daily water flow rate in the Kazibacha-Passur river ranges from 3,700 to 5,300 m3/s. The river water can thus be used for irrigation from June to mid-February directly from the river during high tide. Non-saline river water can be stored in the internal drainage canal networks inside the polder to irrigate crops in the later part of dry season. Mondal et al. (2010) and Khan et al. (2015) reported that 25% to 30% of the cultivable area in polder 30 in Batiaghata upazila could be brought under rice cultivation in the dry season (boro rice) using internal storage to finish off the crop. The cropped area would be much higher if low water requiring rabi crops or salt-tolerant HYV rice are grown in the dry

season. It is therefore, evident that the water resources of the coastal Ganges basin are largely underutilized and there is huge potential for enhancing land and water productivity in the coastal zone, if water is judiciously utilized. Khan et al. (2015) and Mondal et al. (2015b) reported the feasibility of both gravity irrigation and drainage opportunities in and from the coastal polders, meaning its cost effective utilization in agriculture.

3.3 Water depth in rice field

Water depth in the paddy fields varied widely within and across sites, seasons and years, mainly depending on rainfall and management of the sluice gates during the rainy season.

Water depth in the *aman* crops was generally fluctuated between 5 and 25 cm (Fig. 4), except at Amtali in early September 2012 (second or third week after transplanting) when it increased to 50 cm due to high rainfall (Fig. 1). The crops were thus submerged for about 5 d. At Batiaghata, in 2011, the crop was inundated for about a week starting two weeks after transplanting due to excessive rainfall coupled with the intake of water though the sluice gates by the community for land preparation and transplanting of the high lands. The 2011 crop at Batiaghata also experienced water stagnation throughout the grain filling period, from mid-October to maturity (Fig. 4b), as a result of further intake of water by the community to flood higher lands in the landscape.

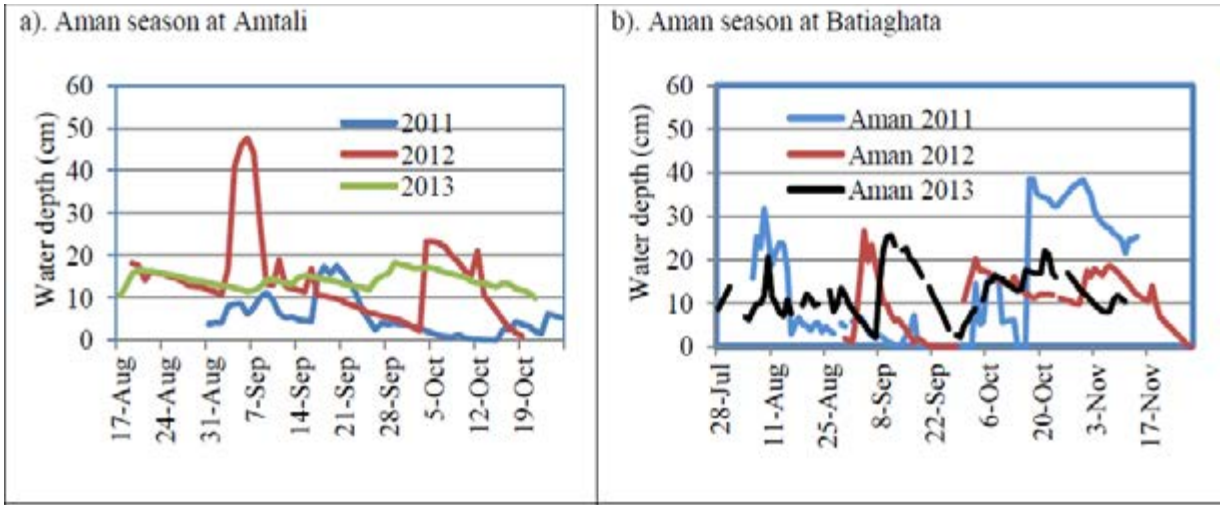


Fig. 4: Water depth in the rice field in aus and aman seasons at Amtali and Batiaghata.

Water depth in the *boro* crops fluctuated between 1 and 5 cm throughout the season in all the study sites as a result of careful irrigation management, while that in the *aus* season fluctuated between 0 and 10 cm (data not presented) because the high tide river water level during May-July was only slightly higher than the land level. However, in mid-May 2013, water depth increased rapidly to about 60 cm due to excessive rainfall (Fig. 1) from cyclone Mohasen. As a result, the crop was submerged for about a week after transplanting.

3.4 Khal water salinity

Salinity of the water in the *khal* at Amtali reached a maximum of about 0.6 dS/m towards the end of each dry season, and declined to about 0.1 dS/m during the rainy season (Fig. 5a). Thus the water in the *khal* was always suitable for irrigation. Salinity of the water in the *khal* at Batiaghata was much higher than that at Amtali, and increased as the dry season progressed (Fig. 5b). Maximum salinity ranged from 15 dS/m in 2012 to 21 dS/m in 2013. Salinity level declined to about 0.2 dS/m during the rainy season. At Batiaghata, in the 2012 dry season, the *khal* was filled with river water by opening the sluice gate at high tide until first week of February, and the water was stored for irrigation by closing the sluice gate. The water remained suitable for irrigation (<4 dS/m) until early May 2012. But in 2013 and 2014, the Water Management Organization kept the sluice gate partly open during the dry season to try and prevent siltation in the gate intake canal. Thus the *khal* water became unsuitable for irrigation by late February in 2013 and 2014.

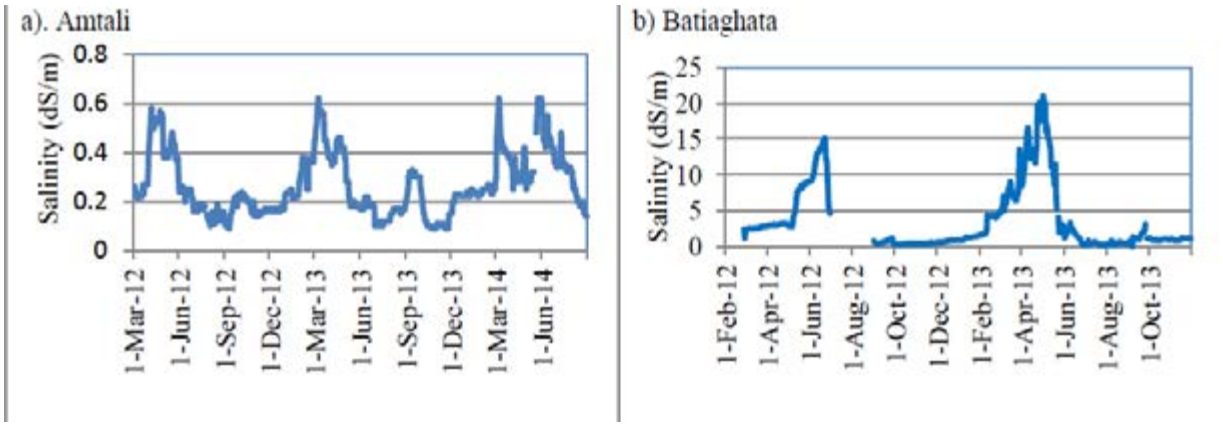


Fig. 5: Khal water salinity in the polders at Amtali and Batiaghata.

3.5 Performance of rice

3.5.1 Aman

Among the tested HYVs, BRRI dhan33 had the shortest duration each year (105-115 d), while BRRI dhan54 had the longest duration (Fig. 6b). Duration of BRRI dhan54 was longer at Batiaghata than at Amtali, where the crop was sown 24 d later, reflecting the fact that this variety is sensitive to photoperiod. Duration of all varieties at Amtali other than BRRI dhan54 was 6 to 20 d longer in 2012 than in the other two years (data not presented), probably due to inundation for about one week shortly after transplanting (Fig. 4a). BRRI dhan54 was transplanted 10 d earlier than the other varieties and is taller and thus more tolerant to water stagnation. Yield was always in excess of 4.1 t/ha except for BRRI dhan33 in 2011. Over the three years, average yield of BRRI dhan49, BRRI dhan53 and BRRI dhan54 and BINA dhan-7 was similar (4.6-4.9t/ha), while BRRI dhan33 averaged 4.2 t/ha (Fig. 6a). The inundation in 2012 did not appear to affect yield.

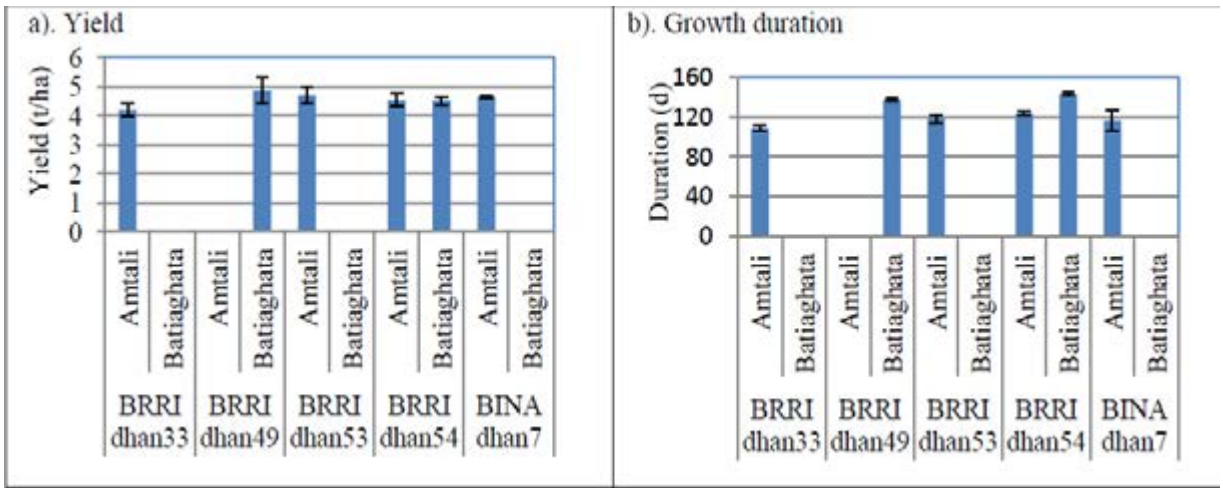


Fig. 6: Yield and growth duration of HYV aman rice in Amtali and Batiaghata. Vertical bars are standard error

3.5.2 Boro

Grain yield of *boro* rice in Barisal Division ranged from 4.4 to 7.9 t/ha and in Khulna Division it varied from zero to 6.3 t/ha across sowing dates and years (Mondal et a.l 2015c). Similarly the growth duration of *boro* crop varied widely (123-152 d in Barisal and 135-166 in Khulna) across locations, sowing dates and years. There was a consistent trend for declining crop duration as sowing date was delayed (Fig. 7), due to the warmer weather experienced by later sown crops (Fig. 2). But the results from two locations (Amtali and Dumki) in Barisal Division (low salinity) showed little effect on sowing date on yield from mid-Novemberto mid-December (Fig. 8a). During this period, rice yields were always above 6 t/ha, except for the first sowing at PSTU, Dumki, which was affected by stem borer and brown spot. Yields at Batiaghata (Khulna Division) were always much lower than yields at both sites in Barisal for similar sowing dates (Figs. 8 a,b). Maximum average yield at Batiaghata (medium salinity) occurred when sowing was done during 7-15November. The minimum temperature in Khulna and Barisal (Khepupara) was similar during each *boro*season from 2011-12 to 2013-14 (Fig. 2). However maximum temperature during the coldest part of the year was a couple of degrees lower in Khulna in 2011-12 and 2013-14, but not in 2012-13, the coldest of the three years. So the low temperature only partly explains for the low yields of *boro* rice in Khulna. A more likely explanation of such low yield is the higher salinity in Khulna than the Barisal region. The threshold for salinity injury in rice is about 3 dS/m for Indicas and 1.9 dS/m for Japnicas. BRRI dhan28 is an Indica variety. Since temperatures in both the regions were similar during the *boro* season, therefore we suspect that the cause of the generally much lower yields in Khulna was the combination of salinity and low temperature. We observed some of the seedlings of the 10 November 2011 sowing in Khulna died after transplanting, presumably due to the combined stresses of low temperature and mild salinity. In 2012-13,the 30 November and 20 December sowings died after transplanting, and likewise the 20 December sowing in 2013-14. Whether the combination of marginally high salinity and marginally low temperature for rice would have an antagonistic effect on plants is not known. The long term data show that both minimum and maximum temperature are lower at Khulna than Barisal from late December to mid-February (critical growth period for *boro* rice, when panicle initiation occurred), suggesting that Khulna is more risky environment for early planted *boro* rice than Barisal. Therefore, this study provides strong

evidence of the feasibility of HYV *boro* rice cultivation in the south-central (Barisal Division) coastal zone of Bangladesh, where temperature and river water salinity remain within the permissible limits for HYV rice throughout the year. Yields of 6.0-7.5 t/ha could be achieved with sowing from mid-November to mid-December in this region. Whereas, in the medium salinity areas in the southwest (Khulna Division) region, maximum yields of around 5.0 t/ha could be achieved with sowing in the second week of November.

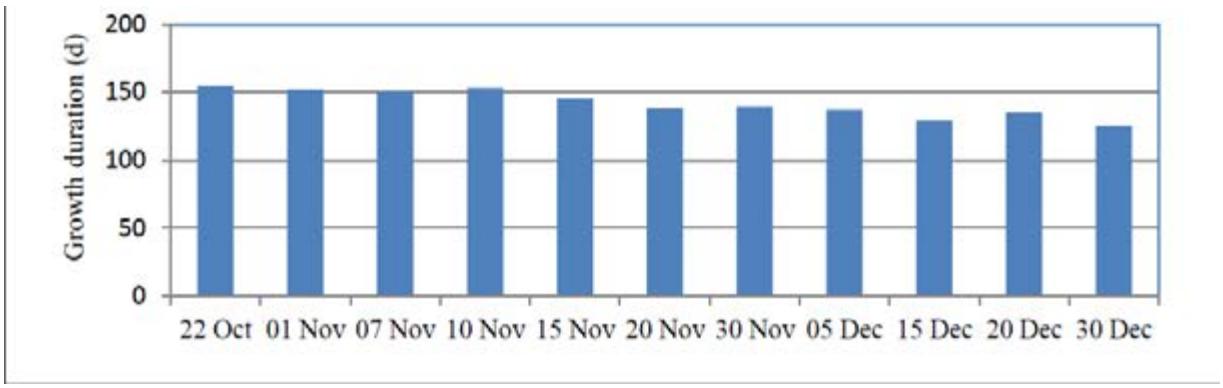


Fig. 7: Effect of sowing date on the growth duration of BRRI dhan28 in the coastal zone

a). Amtali and Dumki (PSTU)

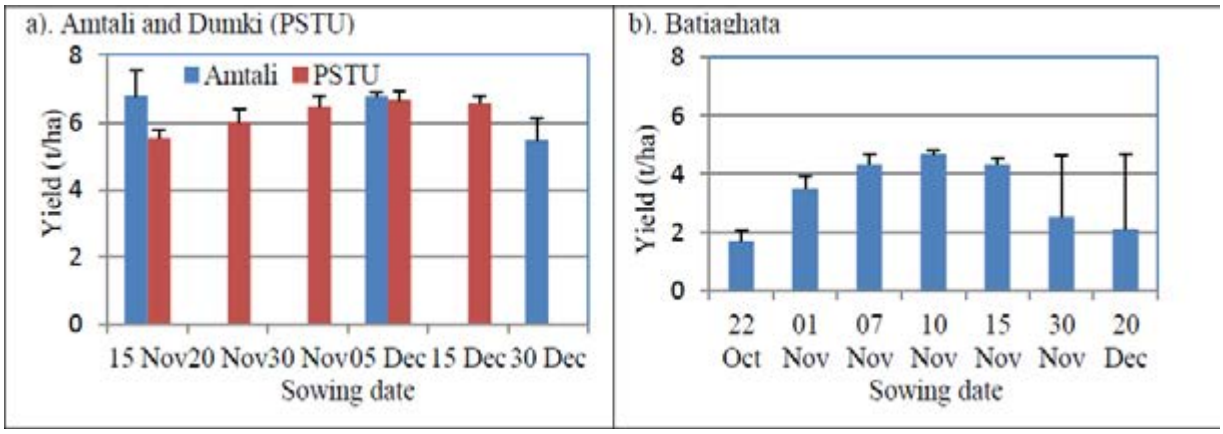


Fig. 8: Effect of sowing date of BRRI dhan28 on grain yield in (a) Amatli and Dumki, and (b) Batiaghata in *boro*season. Vertical bars are standard error.

3.5.3 Aus

Duration of all *aus* varieties was about 100 d except in 2013 when duration was longer (Table 2), probably because the crops were submerged for about a week shortly after transplanting due to excessive rainfall from cyclone Mohasen. Yield ranged from 3.6 to 5.2 t/ha across the years and tested varieties. The lower yield in 2014 may be due to lower solar radiation at flowering (data not presented) than in other years, as the temperature was similar each *aus* season. Tidal

river water and rainfall was sufficient to meet up the crop water requirement and pumping was not required to cultivate aus rice. Therefore, the south-central (Barisal Division) coastal zone has the great potential to grow HYV rice in aus season with minimum cost of its production.

Tab. 2: Duration and yield (mean ± SE) of *aus* crops at Amtali

Year	Aus-aman-boro	Aus-aman-rabi		
	BRRI dhan 48	BRRI dhan 42	BRRI dhan 43	BRRI dhan65
Duration (d)				
2012	102	103	103	-
2013	117	108	108	108
2014	100	100	100	103
Mean	106	104	104	106
Grain yield (t/ha)				
2012	4.6±0.0	5.1±0.2	5.2±0.2	-
2013	4.3±0.1	4.2±0.2	4.0±0.2	3.8±0.1
2014	4.1±0.1	3.6±0.0	3.6±0.1	3.6±0.1
Mean	4.3±0.2	4.3±0.4	4.3±0.4	3.7±0.1

3.6 Performance of rabi crops

3.6.1 Amtali

The maize and sunflower performed well each year, with maize yields ranging from 8.7 to 9.5 t/ha, and sunflower from 3.6 to 3.8 t/ha (Table 3). Yields of the mulched watermelon (42 and 63 t/ha) and chilli (2.3 and 3.6 t/ha) were also good. The effects of mulch on maize and sunflower yield were inconsistent across crops and years. The high yields and lack of effect of mulch on maize and sunflower suggests that soil moisture was adequate both with and without mulch as a result of timely flood irrigation. In contrast, at a nearby site (PSTU), Bhattacharya et al. (2015) found a small (~0.5 t/ha) but significant increase yield of maize with mulching, but a significant decline (~0.5 t/ha) in yield of sunflower with mulching. There was a consistent trend for slightly higher yield of sesame and mungbean with mulch, and for much higher yield of watermelon with mulch. This may have been due to lower soil water availability in the non-mulched plots, as all these crops were only lightly irrigated by watering can or sprinkler. Yield of mungbean was disappointing, especially in the first and third years, due to poor germination for unknown reasons (possibly poor quality seed), and the chilli crop stand was poor in the third year (many plants died after emergence).

Tab. 3: Yield (t/ha) of rabi crops at Amtali and Batiaghata

Crop	Mulching	2011-12[1]		2012-13[2]	2013-14		Mean yield ± SE
		Amtali	Batiaghata	Amtali	Amtali	Batiaghata	
Maize	Mulch	8.7		9.3	9.2		9.07±0.2
	No-Mulch	9.5		8.7	9.1		9.10±0.2
Sunflower	Mulch	3.6		3.6	3.8		3.67±0.1
	No-Mulch	3.7		3.8	3.7		3.73±0.1
Mungbean	Mulch	0.40		0.85	0.46		0.57±0.1
	No-Mulch	0.35	0.65	0.63	0.25	0.77	0.53±0.1
Sesame	Mulch			0.80	0.57		0.69±0.1
	No-Mulch		0.57	0.56	0.49	0.38	0.50±0.1
Watermelon	Mulch			63.0	42.0		52.5±11
	No-Mulch			33.0	12.0		22.5±9
Chilli	Mulch			3.62	2.3		3.0±0.5
	No-Mulch				2.0		2.0

[1]At Amtali sesame crop damaged by 112 mm rainfall prior to harvest, yield of watermelon were not recorded
[2]All crops at Batiaghata damaged by about 500 mm rainfall in May 2013 due to cyclone Mohasen; chilli at Amtali after the first harvest (yield of chilli combined for both mulched and non-mulched plots).

.The growth duration of the *rabi* crops varied from 68 to 140 d, and there was no effect of mulch on crop duration (Mondal et al. 2015a).The crops matured one to two weeks earlier in 2011-12 than in later years, probably because of late sowing (second half of January, two to three weeks later than in 2012-13 and 2013- 14) and thus warmer growing conditions in 2011-12. All crops were harvested by the end of April, well before the beginning of the pre-monsoon and cyclone seasons.

3.6.2 Batiaghata

In 2011-12 and 2013-14, maximum mungbean yields of 0.9 to 1 t/ha were achieved, but yields of sesame were generally poor (usually <0.5 t/ha) (Mondal et al. 2015a). Average yield of mungbean was about 0.7 t/ha (Table 3), it tended to increase with improved management. The highest yields were achieved with line sowing plus fertilizer and irrigation. All *rabi* crops in 2013 were destroyed by waterlogging as a result of cyclone Mohasen in mid-May, which occurred shortly before maturity.

3.7 Total system productivity

3.7.1 Aus-aman-boro

Total system yield ranged from 13.2 to 16.6 t/ha over the three years and three *boro* sowing dates (Mondal et al. 2015a). The lowest system yield was due to severe stem borer attack of the earliest *boro* sowing at Dumki. Average yield of the *aus-aman-boro* system was more than 15 t/ha rice per year (Table 4), which is 2-3 times higher than the present farmers' production level.

3.7.2 Aus-aman-rabi

Total system yield (REY) ranged from 8.5 to 30.7 t/ha over the three years with six rabi crops grown under mulched and no-mulch practices (Mondal et a. 2015a). Inclusion of watermelon resulted in much higher REY than in the *aus-aman-boro* system (Table 4), due to the high green yield of watermelon. Inclusion of maize and sunflower gave comparable or slightly higher

REY (16-19 t/ha) than the triple rice system, due to the higher yield of maize and the higher value of sunflower seed. System yield with mungbean, sesame and chilli (10-13 t/ha/yr when planted on time) was always considerably lower than that of the triple rice system, but much higher than farmers' practice. Mulching greatly increased system yield of watermelon, but yield variability across years was high in both mulched and non-mulched treatments. System yield with maize and sunflower was more stable over the three years than with the other *rabi* crops.

3.7.3 Aman-boro

Total system yield ranged from 4.7 to 10.5 t/ha and was strongly affected by *boro* sowing date (Mondal et al. 2015c). Average system productivity was about 8 t/ha (Table 4) in medium salinity areas (Khulna Division). The most consistent *aman-boro* system was with *boro* sown during 7-15 November, with system yield ranging from 8.8 to 10.2 t/ha over the three years, which was at least double than farmers' practice.

3.7.4 Aman-rabi

Total system yield (REY) ranged from 5.2 to 8.9 t/ha and systems with mungbean (5.9-8.9 t/ha) had higher yield than with sesame (5.2-7.3 t/ha) (Mondal et al. 2015a). Although REY of the best *aman-rabi* systems was slightly lower than that of the best *aman-boro* systems, the mean REY was higher in aman-mungbeanthan *aman-boro* (Table 4). But REY of the improved systems was almost double than the farmers' practice.

Tab. 4: Annual system yield of different cropping patterns in the coastal zone

Location	Cropping Pattern			Total system rice equivalent yield (t/ha)	
	Aus	Aman	Boro/Rabi	Potential production	Farmers' practice
Barisal	Rice	Rice	Rice	15.2	
	Rice	Rice	Maize	17.8	
	Rice	Rice	Sunflower	16.4	
	Rice	Rice	Watermelon	21.7	
	Rice	Rice	Mungbean	11.2	
	Rice	Rice	Sesame	9.9	
	Rice	Rice	Chilli	11.2	
	Rice	Rice	Grasspea	-	6-9
	Fallow	Rice	Mungbean	-	5-7
Khulna	Fallow	Rice	Rice	8.0	
	Fallow	Rice	Mungbean	8.8	
	Fallow	Rice	Sesame	6.6	
	Fallow	Rice	Sesame	-	4-5

Discussion

Cropping system intensification in the coastal zone of Bangladesh has been limited by the misperception that the river water is too saline for irrigation throughout the coastal zone. In reality, most of the rivers in the south central coastal zone (Barisal Division) remain non-saline throughout the year, while the rivers in Khulna District are suitable for irrigation from July to until mid-February (Khan et. al 2015). Our findings on salinity in the *khals* in polder 43/2/F (Amtali) and polder 30 (Batiaghata) are consistent with this. There is also the misperception that HYV *aman* cannot be grown in the coastal zone, whereas there are significant areas of medium high lands on which flooding depth is not to high for HYV. Furthermore, in the polders, systematic operation of the sluice gates to enable drainage of excess water at low tide and separation of lands of different elevation could enable the production of HYV *aman* over large areas (Mondal et al. 2015b).

The results of the work presented above clearly demonstrate the feasibility of intensifying to high yielding *aus-aman-boro* and *aus-aman-rabi* cropping systems in the south central coastal zone of Bangladesh. Here, triple rice cropping can produce more than 15 t/ha/yr in comparison with current farmer production of 3-6t/ha of rice, and 0-1 t/ha of *rabi* crops (grass pea/mungbean). Alternatively, high yielding or high value *rabi*crops such as maize and sunflower can be grown instead of *boro*, with total rice equivalent yield similar to or slightly higher than that of the triple rice system. Intensification and diversification to a wide range of *rabi* crops provide further more productive and climate resilient cropping options than current farmers' practice.

The results also demonstrate the feasibility of adoption of high yielding *aman-boro* cropping systems in areas where fresh water is limited in the dry season (Khulna District). In such areas, river water can be brought in through the sluice gates at high tide for irrigation directly from the river from November to until early to mid February. The final intake of river water should take place in early February, after which the sluice gates should be closed to store the water in polder *khals* for irrigation by pumping from the *khals*. In the medium salinity areas, 'early' (7-15 Nov) sowing of *boro* was critical for consistently high *boro* and thus system yields of 9 to 10 t/ha, compared with current farmer production of 2- 3 t/ha of *aman* rice and 0-1 t/ha of sesame or mungbean. Salt-tolerant HYV in *boro* might increase the system productivity further. Use of improved production techniques increased the productivity of sesame and mungbean, but not beyond 1 t/ha.

Successful production of traditional *rabi* crops (sesame and mungbean) in medium salinity areas like Batiaghata (Khulna Division) currently depends very much on rainfall – too little, or too much at the wrong times, and thus production is highly risky and varies greatly from year to year. Better management to allow timely establishment and capitalize on stored soil moisture, and storage of fresh water in polder canal system for irrigation at the later part of the growing season, would be beneficial. A key requisite to enable the cultivation of high yielding and high value *rabi* crops is 'early' (mid-Nov) harvest of the *aman* crop, and drainage in early November (Mondal et al. 2015b). Early drainage is essential to allow suitable conditions for harvest of the *aman* crop, and to allow the soil to dry sufficiently for timely *rabi* crop establishment. Early *aman* harvest means growing modern non-photoperiod sensitive short to medium duration *aman* varieties instead of the current practice of late maturing, photoperiod sensitive traditional varieties. This in turn means the need for drainage of water at low tide when field water depth is too high for HYV rice, and prior to topdressing urea for high yield of rice. Late establishment results in damage or destruction of the *rabi* crops by pre-monsoon rainfall and

cyclones in May, as happened in 2013 (r*abi* crops usually damage at least once in 2-3 years, and in Batiaghata crops were destroyed in last three consecutive years: 2013-2015).

Conclusions

The results show that it is possible to greatly increase cropping system productivity in low and medium salinity regions of the coastal zone, using improved rice and *rabi* varieties and good water management – in particular, drainage after excessive rainfall during the monsoon season to enable the cultivation of high yielding, early maturity *aman* varieties. In the south central coastal zone (Barisal Division), where fresh water was available throughout the year, triple rice system productivity of 13 to 17 t/ha/yr (av 15 t/ha/yr) was achieved in a farmer's fields using short duration high yielding *aus* varieties, followed by short to medium duration HYV *aman* and a medium duration, mid November to mid December-sown *boro* variety. Similar or higher system rice equivalent yields were achieved by replacing the *boro* crop with early December-sown maize, sunflower and watermelon. In moderately saline areas in Khulna District (southwest coastal zone), freshwater is limited to the couple of months during the dry season. Here, 9 to 10 t/ha/yr (av 8 t/ha/yr) of rice were produced in an *aman-boro* system with sowing of the *boro* crop in the second week of November.

Since cropping intensity and productivity in other parts of Bangladesh are already high, the under-utilizedagricultural lands of the coastal zone may well be the only region where significant gains in food production can be made to address future challenges to the food security of Bangladesh.

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Sustainable Livelihoods

Title: An assessment on the perception alteration of the local people on the conventional land use pattern to achieve livelihood sustainability

Md. Ahsan Habib, Debanjali Saha and M. Shahjahan Mondal

Introduction

The coastal region of Bangladesh, which has vast resources and opportunities, is very much prone to frequent natural disasters, among which cyclone and associated storm surge events are the major ones. The sustainability of this region is often threatened due to the exposure and vulnerability of the coastal communities to these day to day challenges. About 84% people in Bangladesh are directly or indirectly engaged in a wide range of agricultural activities which is the major livelihood of this country (Rahman, 2004). The coastal areas of Bangladesh are also aligned with this pattern. In the past, coastal people basically depended on agriculture for livelihood activities and income generation. In 1980s, shrimp culture was introduced in the coastal areas considering its high economic value which became another important livelihood opportunity. Governments and the international donor community have promoted shrimp farming as a means of speeding development and alleviating poverty in developing countries (EJF, 2003). Though shrimp cultivation was highly profitable, but it was subjected to a lot of criticism that time. It eventually damaged the local ecology by rapidly increasing the salinity in the water and soil, altering the structure of the soil and initiating hasty changes in land use and land cover (Haque, 2004). This also caused disintegration of economic and social conditions of coastal rural communities. Large tracts of agricultural land were inundated with saline water to create shrimp ponds which caused changes in soil composition and pollution of water bodies. Shrimp culture has had direct impacts on crop productivity and on the health and livelihoods of rural farming communities (EJF, 2003).

A relevant study found that, instead of shrimp farming, prawn and rice cropping pattern could be an innovative system to mitigate the ongoing problem of shrimp and rice farming dilemma in the poldered areas of the coastal region. This pattern eventually enables the opportunity to grow more environment-friendly and diversified high value crops, vegetables, fruits along with livestock rearing. Thus, soil health of the poldered area could be improved and sustainable food and nutrition security of the people could be ensured for the greater interest of the present and future generation of Bangladesh (Fatema and Miah, 2011).

Because of environmental and social impacts associated with shrimp cultivation, farmers of the coastal areas have abandoned shrimp farming to avoid further degradation of local ecology. They are now incorporating vegetables and domestic animals into existing farming practices, integrating prawn and fish with rice and vegetables, etc. As a whole, the people of the coastal areas are trying different agricultural practices to cope with the changing environment. The changes in the traditional agricultural activities in the coastal areas have occurred due to some factors. This study has been conducted to analyze the changes in land use and traditional cropping practices and to represent the changes in a timely manner. So far, not much study has been conducted on the representation perspective of the variations of land use and livelihood activities in the coastal areas of Bangladesh. The findings of this study are expected to make people better understand about the conventional cropping activities and the reasons of the paradigm shift in their perception about agricultural and fisheries activities.

Study Area

This study was conducted in polder 31 of Dacope upazila, Khulna district which lies in the south-westcoastal region of Bangladesh (Figure 1). Like the whole coastal belt, this area experiences regular attack of several natural hazards including cyclone, storm surge, waterlogging, river erosion, salinity intrusion, etc. These disasters have affected the lives and livelihoods of the coastal people. Dacope upazila of Khulna district consists of three polders namely polders 31, 32 and 33, among which polder 31 is situated in the northern part. The major livelihoods of the area are crop agriculture and fishery. Some people are also associated in day labor, working in the Sundarbans, small business, etc. There are two unions and one pourashava in polder 31 which are: Pankhali and Tildanga unions and Chalna pourashava. The population of polder 31 is 46,764. The socio-economic conition of the area is not much satisfactory as most of the people live under poverty line and their standard of living is relatively low. The area has been selected for the study because compared to the other two polders of Dacope upazila, the impacts of natural disasters are less and livelihood diversification is also observed.

Methodology and Data Collection

As this study focused on the local people's perception and decision making and also it was a qualitative assessment rather than a quantitative one, so different tools and techniques of participatory approaches were used to gather primary data from local people. Participatory Rural Appraisal (PRA) techniques like Transect Walk, Focused Group Discussion (FGD) and Key Informant Interview (KII) were used to gather the community level information. Several FGDs were conducted within different livelihood and gender groups like farmers, fishermen, small businessmen, shrimp practitioners, day laborers and marginal women. Two KIIs were conducted featuring the UNO of Dacope upazila and upazila Agriculture officer.

Using the indigenous knowledge obtained by different PRA techniques and secondary statistical data, eventually a timeline was prepared which covered the different critical activities and decision making of local people about their land uses and livelihoods. A timeline is an expression of aggregation of landmark events in an area depending on the perception of the community. It provides the evidence of critical events in a chronological order. It involves the analysis of notable historical events, changes in natural, socio- economic and environmental aspects along with community responses to those occasions (Callens et al., 1999). The purpose of this tool is to learn about important events in the community's past, identify their trends, understand the impacts of these events from community perspective and define the transformation in their lives and livelihoods (SEPP, 2007).

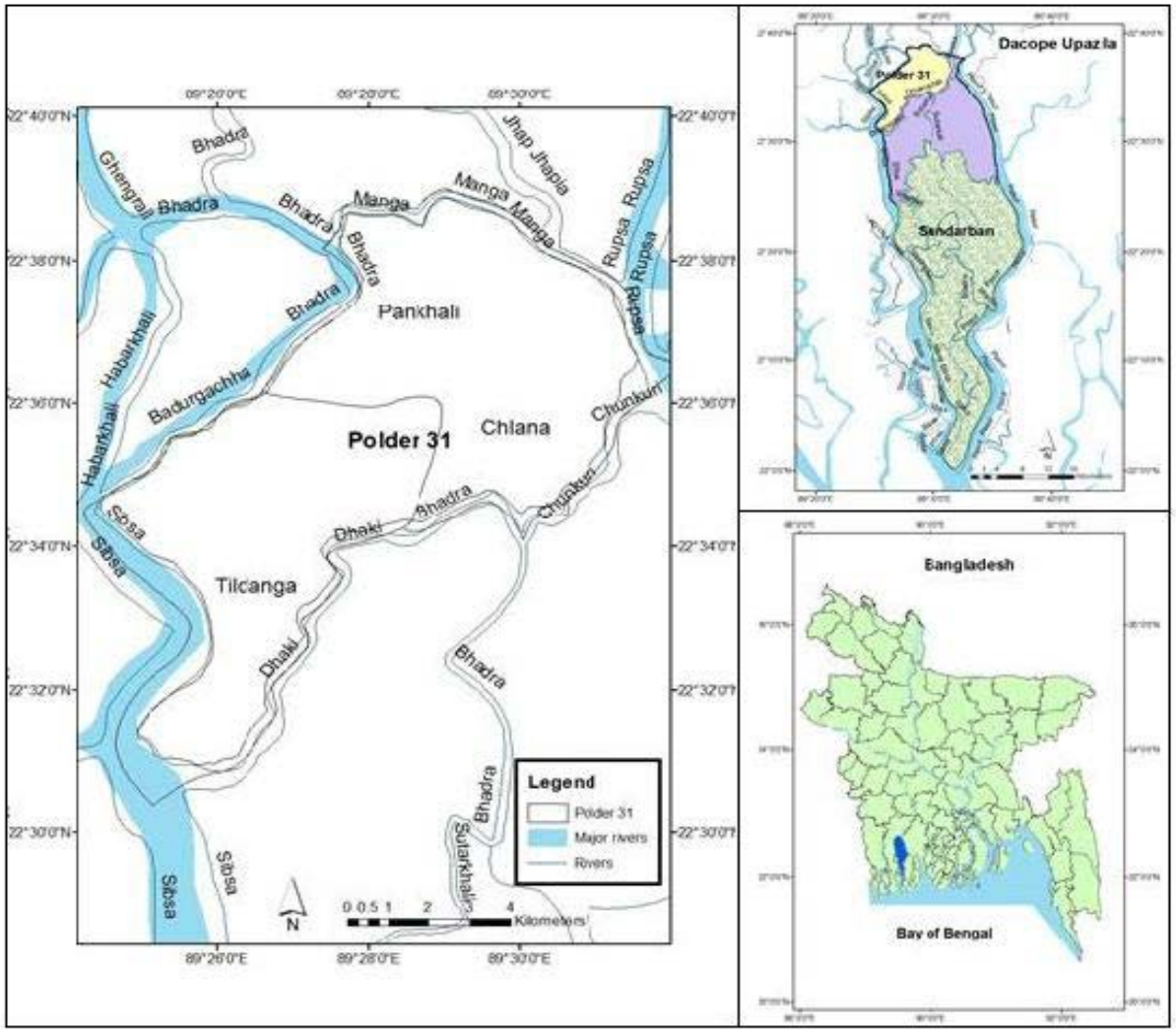

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Fig 1: Map of the Study Area

The process of analyzing information using timeline analysis is provided in the following (SEPP, 2007):

•Selection of community people from different livelihood groups and variable social status to perform the exercise and initiation of the discussion

•Letting the community people address their present situation, current livelihood practices, challenges and opportunities in the area, etc.

•Asking the community about earlier events in history and associated activities

•Enquiring about the key events and the years of occurrences which played crucial roles in perception alteration of the local community

•Adding of dates and time of the events in chronological order and confirming them with the local knowledge

•Facilitation of discussion among the community people about the impacts of any event in their lives to gather all relevant information for future analysis and decision making

Though there are some limitations of the timeline analysis tool, as sometimes people lose focus from the actual facts and start discussion in an indiscreet manner. Also, if the participants cannot recall the past events and reasoning, then the analysis remains incomplete. Despite that, the tool is advantageous for analyzing facts from socio-economic perspective as it involves community participation and it prioritizes the contribution of the local people. Also, to understand the trend of the livelihood practices in an area this tool is suitable.

For the specific analysis of this study, super cyclone Aila of 2009 was taken as the benchmark as local people considered it as a critical event. This was also the reason that triggered the paradigm shift in the lives of the local people and in their livelihood practices. Information about the present and historical livelihood practices, existing cropping pattern and crop agricultural activities, types of agricultural crops, notable natural and anthropogenic events, changes in their perception and associated factors, sustainability of the present livelihood practices, etc. were collected from the local people of the study area. Both statistical and historical secondary data were collected from the UNO office and Dacope Agriculture Office about the historical and present practices in the area.

Results

For the specific analysis, essential information was gathered from several visits to different wards of polder 31, as ward is considered as the lowest administrative unit. The PRA tools were used in a manner so that representative data can be collected from the whole area for further analysis. During the transect walk in the study area, the present resources and their uses have been observed. There were fallow lands, agricultural lands with existing dry season crops, on-farm reservoirs, shrimp farms, small and medium canals in the study area that have been observed during the transact walk along the polder boundary. Also, there were some

establishments including village markets and local gathering places, community shelters, governmental and non-governmental organizations' offices, etc. where most of the FGDs and KIIs took place. Discussions with the local farmers and fishermen were arranged nearby the agricultural lands or in the local village markets.

Though there were several discussions for the timeline analysis, but, there was a common pattern of the events. The impacts and sufferings of natural and man-made events have been almost identical for the community. So, the timeline was prepared from the joint analysis of the reported events and discussions from the local people. All the information gathered from primary and secondary sources have been arranged in a chronological order in the timeline spanning for the last 42 years. Such time span has been considered as the key events that changed the overall situation and livelihood practices in polder 31 started since then. Figure 2 represents the critical events in polder 31 along with their years of occurrences.

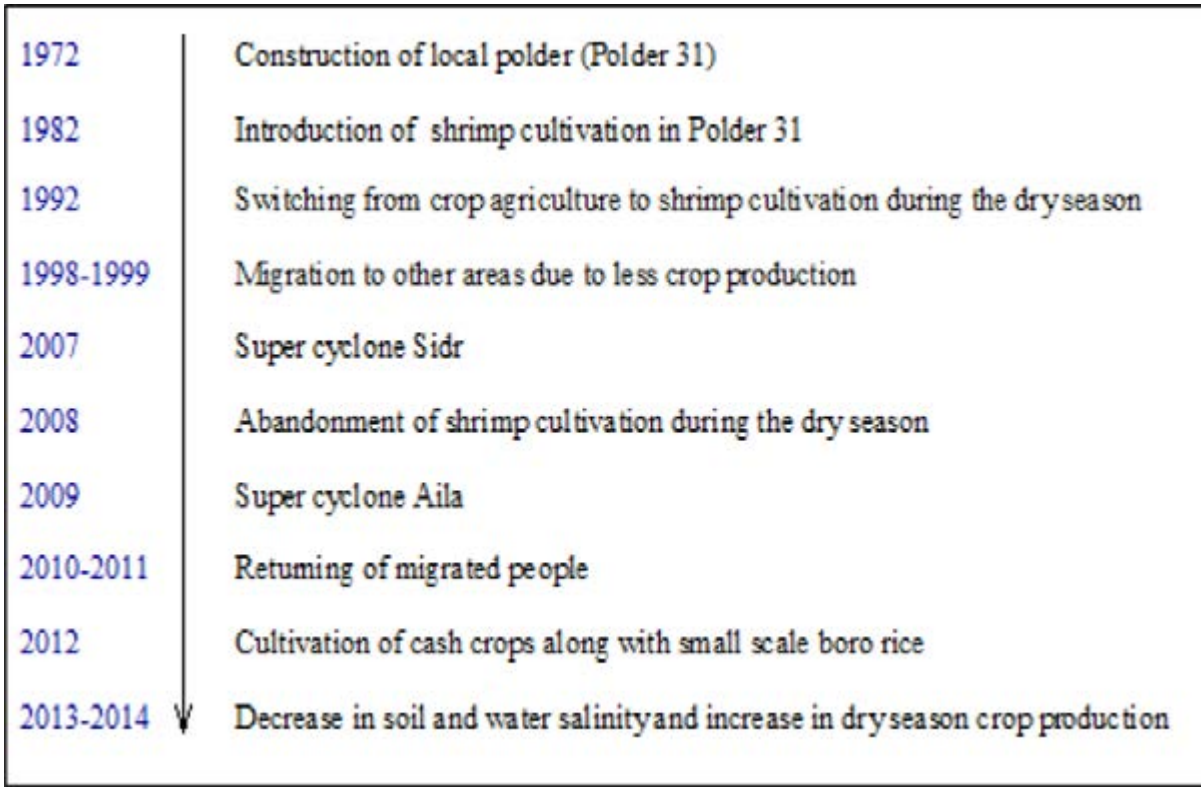

Fig 2: Critical historical events in the study area

From the above figure the major events in polder 31 can be observed. It can be seen that the changes in conventional livelihood practices have occurred due to construction of the polder in 1972. After that event, almost 40 years have passed and many changes in the perception and practice of the local communities have occurred in the area. These changes have been triggered by a number of factors and some natural and anthropogenic events. The critical events with their years of occurrences, the situation and factors behind the events and associated changes in the lives of the local people have been described briefly in the following:

1972: Construction of polder 31

There are total 139 polders in the coastal region of Bangladesh (Khan, 2014). A good number of them are in the south-west coastal region. These polders have been constructed in the coastal region during the 1960s. In the specific study area, polder 31 was constructed in 1972 to protect the lower areas from tidal flooding and salinity intrusion so that agricultural activities can be enhanced. The polder is 16.28 km in length and covers 6072 hectares (ha) of area. Before the construction of polder 31, there was only one season crop cultivation which was aman rice during the monsoon season. Only some vegetables were cultivated in the homestead gardens during the dry season at the higher lands, but there were no crops in comparatively lower areas. Agricultural activities were expected to increase in the area due to the protection from the embankment after its construction.

1982: Introduction of shrimp cultivation in polder 31

Shrimp farming was introduced in polder 31 as an outcome of extensive promotional activities of shrimp cultivation by different development agencies to reduce poverty, create employment, and generate revenues in Bangladesh. The idea was disseminated by local government agencies and some people from the beneficiary part of the locality started shrimp cultivation. Within a few years, a lot of people of polder 31 got interested about it as it generated relatively higher profit. Shrimp culture became very much attractive by 1985 and during early 90s most of the people switched to shrimp farming eventually.

1992: Switching from crop agriculture to shrimp farming

Almost 10 years after the introduction of shrimp cultivation in polder 31, local people of the area completely switched to shrimp farming practice. Due to frequent natural disasters like cyclonic storm surges and flooding, agricultural production was not satisfactory. Aman rice yield was very low and there occurred some losses in aman crop cultivation. Again some farmers who tried to produce dry season crops also failed. To mitigate this loss, some local rice farmers started saline water shrimp farming during the dry season taking the advantages of the enclosure provided by the polder as mentioned earlier. Being inspired from the shrimp farmers of other polders and to avail the so called high profit in shrimp business, some socially privileged people made this practice their major livelihood. This choice of livelihood provided them with significant income generation and increased their standard of living. Thus, there was a sudden switch from crop cultivation to shrimp farming to gain easy profit. Also, shrimp cultivation required lower labor activities than rice cultivation and generated more profit, which was another controlling factor for this change in local agricultural practice.

The area was enclosed by the polder and there was no way of saline water intrusion from the rivers during the dry season except opening of the sluice gates. These gates were operated by the local community people and were closed at the beginning of the dry season. So, to allow saline water inside the polder for the convenience of shrimp farming, some people inserted pipes through the polder after creating holes in them. This has made the polder vulnerable to natural disasters. Though it caused infrastructural and environmental damages, but high profit margin from shrimp cultivation and social stratification in the area have constrained the practice in the grasps of some elite classes of the society.

1998-1999: Migration to other areas

Despite the high profit and improved living standard of the local farmers from shrimp practice, the damaging aspect of this livelihood brought distress to other non-shrimp practicing farmers. Due to shrimp farming, the salinity of water and soil had risen up to an extent which affected the aman rice production during the monsoon. Before shrimp cultivation, local farmers used to get 4.5-4.8 ton/ha yield from aman rice. But after

shrimp cultivation became the dominant practice in the area, rice farmers in the polder started to get lower aman rice yield which even reached to 1.5-1.8 ton/ha. This decrease in rice yield occurred as shrimp farming required saline water in an area for the shrimp growth period. The salinity in the water was concentrated and leached to the soil thus increasing soil salinity. This had reduced the soil fertility which ultimately resulted in lower aman rice yield. The rice farmers who were not ready to switch to shrimp farming from crop production, migrated to other nearby districts like Jessore, Narail and other upazilas in Khulna in search of labor works like earth cutting, wage laboring in other farmers' lands, small business purposes, etc. These people had to earn money from different livelihood practices to bear the cost of their families living in polder 31. While the male members have migrated to other places, female members of the families used to rear some livestock and grow vegetables in homestead gardens to earn some money for living. In some cases, full families have also migrated to other places due to lack of job opportunities and livelihood options.

2007: Cyclone Sidr

Cyclone Sidr was a tropical cyclone that struck the coastal area of Bangladesh on November 15, 2007. It was classified as a 'Category-5' cyclone as it heavily affected the Sundarbans and caused damages in Patuakhali,

Barguna and Jhalokathi districts, but its impact on polder 31 was not much significant. Surge water entered inside the polder in a few places and drained out very soon. There was severe damage in polder 32 which is in the southern portion of polder 31, because of which impact of the cyclone was comparatively less in the study area. But this natural disaster made the people concerned about the salinity problem in the area that was day by day increasing due to shrimp farming.

2008: Abandonment of saline water shrimp cultivation

Prolonged salinity problem have resided in the area due to both natural and anthropogenic causes. Cyclonic storm surge and inundation of saline water in the area had already increased the soil and water salinity when long term saline water shrimp cultivation had amplified this salinity condition. Soil salinity had reached to such level that it hampered aman rice yield during the monsoon season as mentioned earlier. The environmental condition had degraded up to a significant level and soil became so saline that it was crusty and could not hold the plinth of the houses. No homestead vegetables or fruit trees could be grown in the area due to high salinity and livestock also suffered from lack of food. These facts made the shrimp farmers rethink about their livelihood practice. They realized that shrimp farming was bringing them enough profit for the time being, but it was leaving a permanent mark on the sustainability of agriculture and environmental condition. So, most of the shrimp farmers abandoned shrimp farming practice to avoid further environmental degradation and reduction of aman crop yield. Another reason for

abandoning this practice was death of shrimp fries and associated losses. Due to high salinity, certain virus used to attack the shrimp fries and caused death of most of them in a shrimp *gher*. Due to this, shrimp farmers faced heavy losses and their interest from shrimp cultivation was diverted. Almost all the shrimp farmers stopped dry season shrimp farming and started to keep the land fallow so that salinity could leach out and the lands could regain suitability for crop cultivation. Local governmental agencies also took some initiatives to discontinue this practice for the betterment of the society and environment.

2009: Cyclone Aila

Super cyclone Aila hit the coastal region on 25 February, 2009. Its impact on polder 31 was comparatively less than on polders 32 and 33, other two polders of Dacope upazila, Khulna. When the cyclone attacked most of the farmers have harvested their dry season crops, so crop damage was not so high. The polder was overtopped in some places through which saline water entered in the area. Water was stagnant for 18 days after the event and then started to drain out. But due to some ill practices of shrimp farmers including cutting of polders and creating holes in it, the polder was damaged and vulnerable which caused its failure during Aila. Local farmers blamed shrimp farmers for the damaging of polder and associated sufferings from Aila. Among the two unions and one pourashava, Tildanga union which is in the southern portion of the polder, is a bit lower in topography and suffered relatively more than the other parts of the polder. Salinity intrusion was higher in the area and high salinity condition resided for a longer period than the other areas.

2010-2011: Returning of migrated people

The people who have migrated to other upazilas and districts in search of livelihood activities due to lower aman crop yield and associated losses, have returned to the polder during 2010-11. As mentioned earlier, local shrimp farmers have abandoned dry season shrimp cultivation and started to keep the crop lands fallow as the salinity condition was not much suitable for crop cultivation. In some places where soil salinity was somewhat reduced since the last three years, farmers started some vegetables cultivation with boro rice cultivation in a very small scale. This new opportunity of agricultural activities has brought the migrated people back to the polder. Some farmers who had their own land started cultivating dry season crops while landless farmers worked in other people's lands during the crop season, both at the time of aman rice and dry season crops (boro rice or vegetables). Some farmers also cultivated sesame and mustard in the area along with vegetables. They started to earn some profit from these crops as they require less water supply and labor cost than rice cultivation. Also after shrimp cultivation was stopped, the environmental condition was improved. There was no such condition where houses and homestead trees were damaged due to high soil salinity. Lives of people were considerably better than before with some cropping activities and stable environmental condition. All these factors brought back the migrated people in the area so that they can also improve their standard of living.

2012: Cultivation of cash crops

After shrimp cultivation was stopped during the dry season, local salinity situation has been improved and lands have become suitable for cultivation of crops. As rice is sensitive to water and salinity stresses, and also it is labor intensive, so cultivation of boro rice was in a small scale.

But some new cash crops like sunflower, watermelon have been initiated in the area during 2012. Sunflower cultivation was first introduced by Bangladesh Rural Advancement Committee (BRAC), a well-known non-governmentalorganization, in the study area. BRAC provided seeds of sunflower and fertilizers for initial cultivation as a demonstration to other farmers so that they become interested in cultivating in their own will. Sunflower is a less water consuming and less labor intensive crop, and the health benefits of its oil consumption have drawn the attention of the local farmers. Watermelon is also another cash crop which was started being cultivated in the area after the success of watermelon farmers in polder 33. Due to less salinity the production of watermelon was high in polder 33, and profit was also high. The farmers of polder 31 tried watermelon cultivation and got high profit in less saline areas. But in the areas where salinity is comparatively high, sunflower cultivation is more suitable. It also generated some profit and inspired the farmers to cultivate crops who used to keep their lands fallow. Also, sesame and mustard cultivation was an old practice in the area which generated some profit and provided livelihood options to both the landless and marginal farmers.

2013-2014: Decrease in salinity and increase in crop cultivation

As shrimp cultivation has been stopped for a long period, and local people have taken some initiatives to reduce soil salinity including gypsum application in soil, soil salinity has deceased and soil became fully suitable for crop cultivation. Local people stated that, even for rice cultivation salinity of soil is acceptable in most of the places. Also, continuous cultivation of some cash crops and vegetables during 2012 has reduced salinity. In this way, the opportunities of crop agriculture have increased in the area up to a significant extent. So, local farmers have been inspired to cultivate both cash and staple food crops in the area. Along with sunflower, sesame, mustard, watermelon, etc., they also cultivated pulses and short duration vegetables. Rice cultivation also scaled up in the area. Farmers started to experiment with new salt tolerant rice varieties like Binadha-8, BRRI Dhan 47 and received significant yields. They also constructed some ponds and on-farm reservoirs to store rainwater and used this water during the dry season for rice irrigation. There was some consecutive white fish cultivation in these reservoirs which brought additional income to the farmers. The farmers realized that, for food consumption they need rice and for other living costs they can cultivate cash crops and earn profit. Overall, dry season crop cultivation is beneficial to them and suitable for the environment, rather than keeping fallow land or cultivating saline water shrimp in the area. Many of the farmers have earned profit from crop cultivation and improved their lifestyle. They are now economically solvent and socially peaceful. So, other farmers are now-a-days highly interested in crop agriculture and they require initiatives from the local governmental and non-governmental organizations for their livelihood enhancement. They stated that, if the local silted canals can be re-excavated, then they will be able to store rainwater for irrigation purpose during the dry season. In this way, rice and other crop cultivation will increase in the area. They also want some seed and fertilizers facilities along with proper training and capacity building activities to cultivate new improved variety of the crops for better yields and higher profit. In a nutshell, they seek for better standard of living and improved socio-economic condition.

Discussion

Analyzing the outcome of the above stated timeline, it is evident that, the local communities of polder 31 are more focused towards the sustainable environment rather than shrimp farming practice which provides only profit but is unsustainable in nature. The experiences of about 15

years of shrimp farming and associated environmental degradation have made them realize that this way of livelihood will not serve them in the long run. They have learned that, without rice cultivation, even with the high income generated from shrimp farming, they will not be able to buy food. And only fish cannot satisfy nutritional balance of the local people. In this way, food security cannot be ensured. Also, large scale shrimp farming is affecting small crop farmers as they are being forced to switch to shrimp culture. In a small part of the study area still some shrimp farming activities are being performed. Shrimp farmers are the powerful classes of the locality and they are forcing the crop farmers to switch to shrimp cultivation. Though being large in number, they are being controlled by the elite class people. So, there remains a conflict between livelihood practices and use of land and water. This conflict is harmful for local agricultural and environmental sustainability. There remains another problem which is insecurity of the minority class due to the power practice of the socially privileged groups. There is a tendency of illegal land encroachment of the minority class for forced shrimp farming. This is also a driving factor for permanent migration. But, crop agriculture instead of shrimp farming can provide a gateway to the vulnerable and disadvantaged groups from this despair.

Most of the previous shrimp farmers have realized that with this risky practice, the existence of the locality will be threatened and permanent migration can also be triggered. As monsoon season aman production is hampered by saline water shrimp, the crop production and income generation will be the lowest if this practice is brought back. So, at present, irrespective of the high profit margin, people do not want to go back to shrimp cultivation. Also, another factor drove the local people to change their age old shrimp practice, which is an increased job opportunity in crop agriculture compared to shrimp farming. Shrimp cultivation requires relatively less labor activities than crop agriculture. Thus, for increased income from wage labor, people became more interested in dry season crop cultivation. Another study found that, combined profit from previous practice (aman cultivation followed by saline water shrimp farming) was less than that of the present practice (aman cultivation followed by dry season crop cultivation). So, at present, income of the poor community in the area is much more than any other historical time. Their perception has changed towards sustainable and environment friendly livelihood practices through which they can achieve food security and ecological stability in the area. They believe that, in future, if they receive proper assistance from the governmental and non-governmental organizations in terms of agricultural activities, they can thrive for a stable and balanced condition utilizing their indigenous knowledge.

Conclusion

This study has been performed using some PRA tools to determine the changes in livelihood practices in the area. Through this assessment it is observed that the community of polder 31 thrives for sustainable livelihood rather than high economical profit. The adverse effects associated with shrimp cultivation hindered the livelihood and ecological sustainability and the local community now-a-days are cautious about it. They are now focused on an agriculture based livelihood practice where they believe they have good prospect of stability and development. Outcomes of some institutional researches also support the prospect of future agricultural development. It appears that the alteration of community perception of livelihood to agriculture possesses a good potential to be sustainable. So, proper land zoning should be ensured in the whole coastal area similar to polder 31, where both crop agriculture and shrimp farming exist, so that the agricultural lands can be protected from any sort of encroachment activities. This will maintain the food availability and security as well as economic solvency of the local community.

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Title: Organic Farming Prospects and Constraints in Bangladesh: a case study of Daynna Union of TangailSadarUpazila

Md. Sariful Islam, Md. Nasir Uddin, Mizanur Rahman and Tazwar Muttaqi

Introduction

Bangladesh is one of the most densely populated countries in the world with more than 160 million people. Due to its very small territory (147,570 square kilometers), the amount of additional land available to be brought into cultivation is very limited (BBS, 2006). The country has 8.20 million hectare arable land against the huge population (Hassan, 2011). The land area is steadily decreasing due to its population growth, rapid industrialization and infrastructural development. As a result, the amount of per capita land declined from 0.13 hectare in 1960 to 0.06 hectare in 2000. However, agriculture plays a pivotal role in overall economic development of the country. More than 70% of the population depends on agriculture (Jensen, 2000). Thus, the agriculture sector in Bangladesh is the most important sector in terms of sustaining growth and reducing poverty. However, a lack of adequate nutrient supply, the depletion of organic matter in soils, and soil erosion are major obstacles to sustainable improvements in agricultural production (MoA, 2008). The total amount of fertilizer used in Bangladesh has increased by about 1.55 million tons from 1994–95 to 2006–07, although the use of urea fertilizer has only increased by about 0.95 million tons over this period (BER, 2008). The use of pesticides increased from 7,350 metric tons in 1991 to 16,200 metric tons in 2001 (MoA, 2005), more than doubling over the course of a decade. Among this huge amount of pesticides, insecticides accounted for about 90%, and are generally used for vegetables and Boro rice (UNDP, 2006). This huge consumption of chemical fertilizers and pesticides applied to 7.32 million hectares of cultivated land (BBS, 2008) represents an over-use of agro-chemicals and a waste of foreign currency reserves, as the country imports most of the applied agro-chemicals, except for urea fertilizers. Given the challenges that arise from the over-use of agro-chemicals, a key policy intervention for sustainable agriculture is to encourage the adoption of agricultural technologies that rely to a greater extent on local or renewable resources. Organic farming (OF) is one such technology that can reduce the harmful impacts of agro-chemicals, and is considered by many scientists to be the best form of agriculture in terms of maximizing cost-effectiveness and minimizing pollution (Christian et al. 2005).

1.1 *Statement of the problem*

Before the introduction of chemicals, Bangladesh agriculture was fully dependent on the organic sources of fertilizers (animal manure, crop residues and domestic wastes) to fertile the land. In 1960s, with the introduction of green revolution, to follow former agricultural policy - to meet the demand of food for increasing population, some farmers started to use chemical fertilizers. Some of them used both chemical and organic fertilizers and some of them didn't adopt chemicals fertilizers due to conservativeness or lack of infrastructural facility (Hossain, 2001). The objectives of the organic farming are mainly to protect natural and agricultural resource bases from further degradation and to ensure long term sustainability in agricultural system. Therefore, the understanding of organic farming status in Daynna union of Tangail Sadar Upazila, Bangladesh is necessary and also necessary to identify Constraints of organic farming in Daynna Union for visualize the overall status of organic farming in our country.

1.2 *Objectives*

The objectives of this research are mainly to protect natural and agricultural resource bases from further degradation and to ensure long term sustainability in agricultural system. Based on the

above mentioned situation, the specific objectives of the study are:

1. To identify the present status of organic farming in Daynna Union of Tangail Sadar Upazila.
2. To look for the constraints of organic farming in Daynna Union of Tangail Sadar Upazila.
3. To know about the awareness status of organic farming in Daynna Union of Tangail Sadar Upazila.

Material and Methods

1.1 *Study area*

The studies were carried out in Daynna Union of Tangail Sadar Upazila under Tangail district of Bangladesh. Daynna Union is located within 24° 16' N latitude to 24° 14' N latitude and 89° 53' E longitude to 89° 51' E longitude.

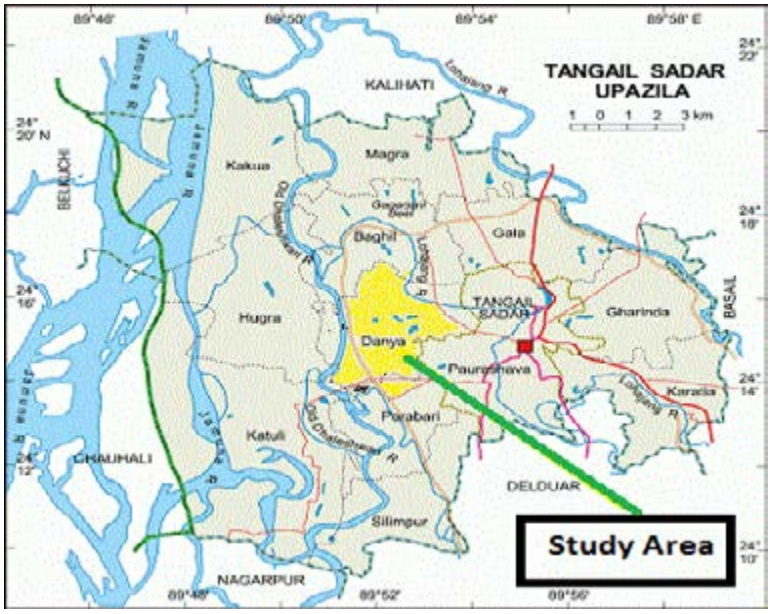

Fig. 2.1 Map showing Daynna Union at Tangail Sadar Upazila (Source: Banglapedia, 2008)

2.2 Study materials

The research carried out on the bases of primary and secondary information's. In this research, for collecting primary data, different methodologies were used including key informant interview, semi structured questionnaire survey, Focus Group Discussion (FGD) and other participatory rural appraisal (PRA) tools for the data collection. Secondary data were collected from different books, journals, different reports and websites. The key informants were Government officials, NGO officials and influential farmers.


Photo 1: Cow dung uses in organic farming **Photo 2: Pest Management system**

1.2 *Sample collection*

The following data were collected by making a farmer questionnaire on independent variables for the individual (age, sex, education) and family (size and land holding) with dependent variables (awareness, available technology, opportunities and constraints). In contrast, a consumer questionnaire was created based on independent variables for individuals (age, sex, education, social status) with dependent variables (awareness and intention to buy production of organic farming). For collecting primary data, two types of questionnaire were created and used.

2.2.1 Questionnaire for farmer

Through a purposive random sampling technique, 20 farmers were selected. In addition, farm size and existing resources, number and area of interventions, awareness of the farmers, resource base and management capability of the farmers and other aspects were considered in selecting the participating farm households. The results of this questionnaire produced a view of each farmer's awareness and understanding regarding organic farming.

2.2.2 Questionnaire for consumer

Our objectives were to discover the awareness-level of consumers about organic production. We collected data from 20 consumers in the Tangail Sadar Upazila, Tangail. Consumers were randomly selected (interviewed the consumers in the open places as random basis) for this study.

Results and Discussions

3.1 Farmer's data analysis

3.1.1 Local concepts of organic farming in Daynna Union

The meaning of organic farming to farmers of Daynna Union is a practice in which farmers manage their farm based on natural resources and avoiding synthetic compounds.

3.1.1.1 Practice as Fertilizers

In the organic management system to supply essential plant nutrients, farmers of Daynna Union usually use, cow dung, different composts, green manure, crop residues, ash Rice barn, poultry litter etc.

3.1.1.2 Practice as Pesticides

For controlling insects and diseases, they use different non-chemical measures such as: Integrated Pest Management (IPM), Mechanical measures (e.g. Hand net, light trap etc.), Biological control (e.g. rearing of beneficial insects and pathogens).

3.1.1.3 Practice as Preservatives

Organic farmers and consumers in Daynna Union rely on different natural inputs rather than toxic hormones and preservatives for ripening fruits and storing their seeds and other harvested crops.

3.1.2 Present cultivation pattern in Daynna Union:

According to field survey the Figure 4.1.2 shows that 50% farmers are practicing inorganic farming, 20% farmers are practicing organic farming and 30% farmers are practicing mixed (organic farming and inorganic farming)

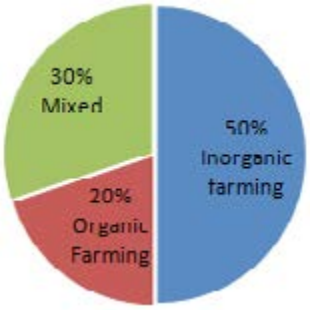

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Fig. 3.1: Present cultivation pattern in Daynna Union.

3.1.3 Level of awareness of farmers about the harmful effects of pesticides

The Figure 2 shows that 77% of the farmers, agreed with the proposition that Chemical fertilizers and pesticides have harmful effect on soil, human and environment and 23% farmers have no idea about the proposition that Chemical fertilizers and pesticides have harmful effect on soil, human and environment` due to the lack of knowledge.

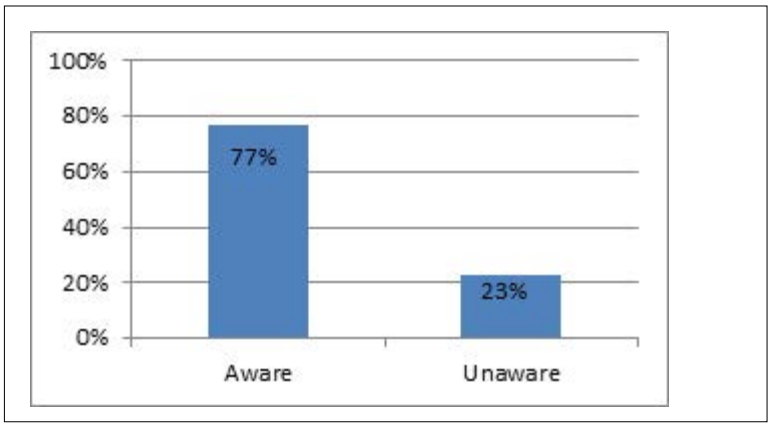

Fig. 3.2: Level of awareness among farmers about the harmful effects of pesticides in Daynna Union.

3.1.4 Interest in conversion from inorganic to organic farming among farmers

The Findings show that 20% of the farmers are interesting in conversion from inorganic to organic farming and rest are uninterested in conversion from inorganic to organic farming.

3.2 Consumers data analysis

3.2.1 Level of awareness of consumers about the harmful effects of fertilizers and pesticides

It is observed that 75% of the consumers are aware of the `harmful effects of pesticides or chemical fertilizer on human body and environment. Due to the lack of knowledge about organic farming only 25% of the consumers have no idea about the harmful effects of pesticides or chemical fertilizer on human body and environment.

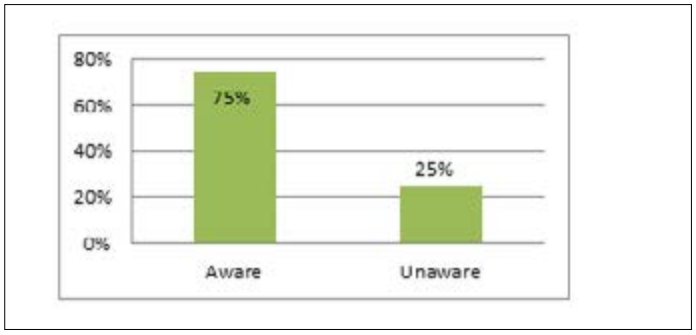

Fig. 3.3: Level of awareness about the harmful effects of pesticides or chemical fertilizer on human body and environment.

3.2.2 Interest in buying production of organic farming

It is observed that 80% of the consumers are interest in buying production of organic farming due to the purity, tasty and aesthetic value of these products. On the other hand 20% consumers have no interest in buying production of organic farming due to the lack of knowledge and the high rate of organic product.

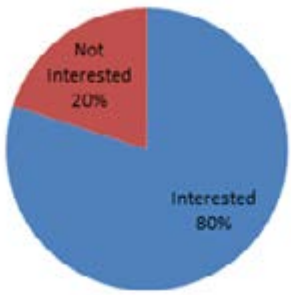

Fig. 3.4: Interest in buying products produced by organic farming

3.3 Constraints of organic farming in Daynna Union

To identify the core problems for organic farming in Daynna Union, a problem analysis was conducted. All the problems mentioned by the farmers and consumers, as well as personal

observations and summarized these in Table no.3.1 and Table no. 3.2 Organic farming has four core problems poor farmers, poor farmer knowledge of organic farming and its benefits, insufficiency of organic inputs, and poor marketing of organic foods and summarized in the following tables.

Table 3.1 Problems faced by organic farmers in Daynna Union

Problems	Percentage (%)
Lack of technical support	35%
Marketing problems	15%
Lack of technical knowledge	20%
Lack of training	5%
Price problems	25%

Problems	Percentage (%)
Organic produce not being certified	45%
Lack of trust of producers and sales personnel	25%
Insufficient supply of organic production	20%
Organic foods are available in a limited number of shops	10%

Table 3.2 Problems faced by the consumers of buying organic food in Daynna Union

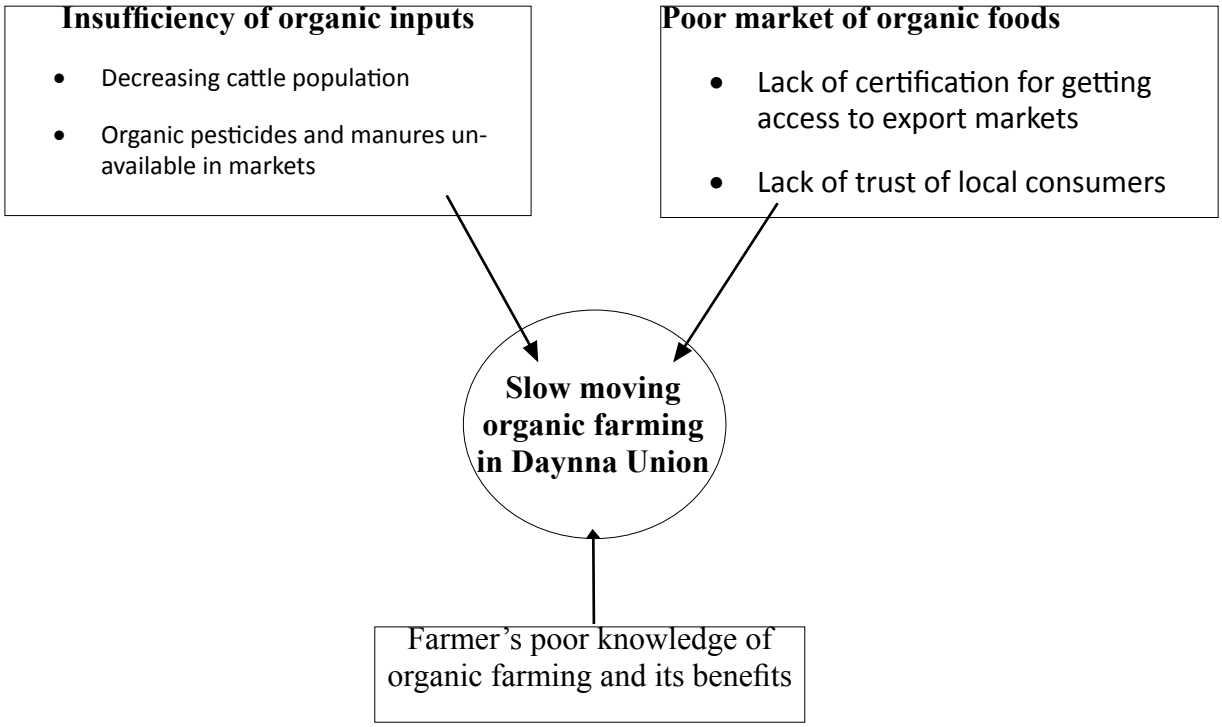

Fig. 3.5 Constraints of organic farming in Daynna Union

Conclusion

The current study, although the level of awareness about organic farming is low, did reveal that both farmers and consumers are aware of the toxic effect of chemical fertilizers and pesticides. With the introduction of organic farming and the assurance of some relevant factors (like price and quality), we expect an increase in the marketing of the production of organic farming in both domestic and overseas market. Results also indicate the constraints of organic farming in Daynna Union. Some major problems faced by organic farmers in Daynna Union such as lack of technical support, marketing problems, lack of technical knowledge, lack of training, price problems etc. Consumers also faced some Problems in Daynna Union such as organic produce not being certified, lack of trust of producers and sales personnel, insufficient supply of organic production, organic foods are available in a limited number of shops etc.

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Title: Energy for All: Access of the Poor to Sustainable Energy Systems

Shah Md. Ashraful Amin and Omar TarekChowdhury

Why Energy for the Poor

Access to sustainable energy is a prerequisite for development; but, till today; the majority of the rural population are 'income poor', 'food poor' and 'energy poor'. As these dimensions of poverty are closely interlinked, access to energy has been one of the major areas of development. It is well recognized that energy is the most essential factor for economic growth and human development in the modern world.[1] And it has been recognized in the Sustainable Development Goal 7 - 'ensure access to affordable, reliable, sustainable and modern energy for all'.

Despite substantial progress in energy production and supply in Bangladesh in last five years, still 40.4% population has no access to grid electricity.[2] Electrification rate is 90% in urban areas but just 43% in rural areas[3] which means that the rural areas that are most energy starved and will remain marginalized in the medium to long term.

This paper summarises the loopholes and limitations of the existing policies and programme framework of energy sector and put forward recommendations on actions required to ensure the right to access to energy by poor vulnerable communities.

Overview of Sector Situation

At present the total installed power generation capacity including private sector and Rural Electrification Board (REB) is 10,213 MW in 2015 while the highest generation does not exceed 6675 MW[4]. The share of different categories of fuels in electricity generation is natural gas 86.7%, petroleum 6.2%, coal 4.6%, and hydro-electricity constitute the remaining 2.5%.

Off-grid population living in remote and hard to reach areas struggle to access power and energy. The primary energy resources are mainly biomass and natural gas of which biomass is traditionally used for domestic cooking and small rural industries which is estimated to account for about 73% of the country's primary energy supply. Despite noticeable efforts to promote renewable energy, the rural-urban disparity in accessing power and energy is still very high.

The rural energy poverty in Bangladesh is still much higher compare to other SAARC countries[5]. Of the entire population, just 10% have access to natural gas. These are primarily residents of the country's few urban agglomerations. The rural population depend on biomass fuel, especially wood, biomass briquettes, cow dung and agricultural residues collected from the local area. Biomass accounts for 68 per cent of the primary energy supply, with over 90 per cent of households using fuel-wood for cooking. Due to the low level of economic development and disparity, many households cannot afford or access to modern energy services, depending instead on inefficient and polluting kerosene lamps, environmentally harmful dry-cell batteries for radios, and overpriced cell-phone charging services. Smoke and soot from the kerosene

1 Legros, G., Havet, I., Bruce, N., & Bonjour, S. (2009). The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa. New York, USA: United Nations Development Programme (UNDP), World Health Organization.

2 World Bank (2015). "Access to electricity (% of population)". URL: http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

3 World Bank (2011). "Scaling up Access to Electricity: The case of Bangladesh"

4 Power Development Board 2015. URL: http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=5&Itemid=6

5 International Energy Agency and Global Alliance for Clean Cookstoves. World Energy Outlook 2013. Cited in Christian Aid's 'Energy for Development in South Asia: addressing energy inequality sustainably. (February 2015).

lamps and conventional stoves cause eye problems and respiratory diseases.

1. At this backdrop, the Government of Bangladesh (GoB) has planned to generate 5% of generation (i.e., 800MW) by 2015 and subsequently 10% (i.e., 2000MW) by 2020 from renewable sources[6] for the energy poor population. Owing to the gradual depletion of natural energy resources the government has taken scores of initiative to adopt renewable energy (RE) at the off grid rural and remote areas in Bangladesh to meet the unmet demand. Among the potential possible sources of RE (Solar energy), the solar Energy has highest potential in Bangladesh. According to the map of global horizontal irradiance, based on the measured data, theoretical model and satellite image derived data shows that monthly average solar global radiation in Bangladesh is around 4.255 $KWhm^{-2}day^{-1}$ and wind speed at the coastal area is around 4.5ms^{-1}. Which indicates that Bangladesh is having abundant scopes of solar energy due to its position in the sphere[7]. According to the government policy on RE the REB has started installation of the PV-based 806 Solar Home Systems (SHSs) under the French financial assistance which was named as "Diffusion of Renewable Energy Technologies" as pilot project. In which three battery charging stations with a total capacity of 29.4 KWph (kilo watt per hour) and a number of standalone SHSs with a total capacity of 32.6 kWph have been installed in rural areas for the private owners through monthly pay back system. At the end of 2009, the REB has installed 14,000 SHSs in 18 rural utilities (known as Pally BidyutSamity or PBSs) with more than 138,000 households registered for future SHS installations. And since then, the SHS got its momentum in rural Bangladesh. Out of more than six million solar home systems worldwide, three million are in operation in Bangladesh alone.[8] Eventually with the passage of time, solar energy started appearing in different dimensions: cooker, irrigation, lantern[9].

A rural family can have bright light through avoiding kerosene fumes and fire-risk to improve the health of children, woman and other members of the house. In one study it was found that, middle income family can saves around BD Tk 800 for kerosene per month through installation of a SHS and subsequently low income family can save around Tk 200 per month[10]. SHS allow women to take part at home based income generating activities. Children can also study under bright light and get connected to the outside world through electronics devices.

However, the opportunities are there, but the demand is huge, and still unmet. The following sections elaborates the policy and institutional landscape, existing gaps and way forward to match the unmet gap in energy demand in rural Bangladesh.

Gender Dimension of Energy Disparity and 'Energy for Women'

Energy disparity is not confined to only in rural and urban areas or between well off and poor living in different urban clusters. Across the board, lack of access to energy impact on women's work load, health, safety and security, productivity, socio-economic potentials, overall quality of life, equality and empowerment. Unavailability of clean, sustainable and modern energy to women for lighting and cooking eventually affects overall quality of life of a family or community. Importance of women's access to clean energy for cooking can be better understood

6 Power Division 2014

7 REB Report 2014

8 IRENA. Working Paper: 'Off-grid renewable energy systems: status and methodological issues.' Cited in 'Energy Access Practitioner Network Newsletter ('Half the world's solar home systems are in Bangladesh'). May 2015

9 REB Website 2015. URL: http://www.reb.gov.bd/

10 Power Divison 2014. Alokito Bangladesh. Accessed online Power Division, 2014. Alokito Bangladesh. "Success in power sector during five years (2009-2014)".Power Division, Ministry of Power Energy Mineral Resources, the People"s Republic of Bangladesh.

from a recent ActionAid study[11] which has shown that 'woman would spend 12 years out of 72 years of her life on cooking'. Like all kind of poverty, women are the most 'energy poor'. Thus, any 'energy for poor' policy regime needs to must have a explicit focus on 'energy for women.'

Policy and institutional landscape

At the global level, the energy sector is addressed by Sustainable Development Goals 7 which is aimed at access to affordable, reliable, sustainable and modern energy for all. This goal encompasses five specific targets[12] which includes access, efficiency, international cooperation and technology enhancement and transfer. These targets also reflects the global tracking framework on Sustainable Energy for All (SE4All). To be in line with these global initiatives and targets, Bangladesh has also made good progress in policy formulation and institutional strengthening.

The development of power and energy in Bangladesh has already got its momentum and now the whole sector is guided by the Power Sector Master Plan (PSMP). Though there are sub-sectoral policies to manifest government's intentions on comprehensive power and energy development and switching towards clean and sustainable solutions. These are evidenced in the National Energy Policy 2004, Policy Guidelines for Enhancement of Private Participation in the Power Sector 2008, the Renewable Energy Policy 2009, the National Coal Policy 2007, the Petroleum Policy, the Building Code 2010, and the Country Action Plan for Clean Cook-stove 2013. In the context of the changing climatic condition, Bangladesh has portrayed its plan to promote clean energy in its Climate Change Strategy and Action Plan (BCCSAP) 2009.

The RE policy drew some incentives i.e. 15% VAT exemption on equipment's, lower tariff on per-capita power consumption, micro-credit; but these proved not to be enough to penetrate energy solutions in hard to reach areas. The PSMP encouraged the inclusion of energy poor people into on and off-grid power network through increasing power generation by various means inclusive of cross-border trade. The BCCSAP highlights the issues with efficiency in production; emphasizing gas based production and RE promotion. Whilst there have been efforts to develop appropriate policy and regulations to encourage RE and rural electrification, policy development is slow and weak in implementation. There is also a requirement for stronger policy frameworks that encourage investment and scale up of private sector engagement in the RE sector through provision of efficient financing facilities.

There are as many as 14 different government, autonomous and semi-autonomous organizations operating in power and energy domain, and all operates under the overall leadership of Ministry of Power, Energy and Mineral Resources. But the challenge remains in the areas of horizontal and vertical coordination among these agencies and overlapping of duties and responsibilities.

Identified Gaps

During the study, a number of constraints were identified which prevent the development of a more commercial RE sector and which limit access for poorer and more remotely located populations. These include poor incentivisation of the private sector to work in remote and hazard-prone areas, the risk of low return on investment, the low purchasing power of potential consumers and consequent insufficient demand, lack of synchronization in operational mode of commercial and social enterprises to reach the poor, limited private sector capacity, and the absence of an enabling policy and regulatory environment. The loopholes that are hindering the expansion of 'energy for the poor' also includes:

11 ActionAid: 'Time use of Adult Women and Men in Rural North: Pattern and Trend'. 2015. Daily Star. January 18, 2016.

12 SGDs 2015. URL: http://www.un.org/sustainabledevelopment/energy/

- The renewable energy market is dominated by NGOs and 'not for profit' organisations to outreach the energy poor community/regions. These social enterprises have the upper hand in term of outreach (having already established beneficiaries through historical development programmes) and an enabling regulatory environment due to more lenient policies relating to NGO distribution mechanisms. To encourage private sector necessary supporting capacity building, incentive, monitoring mechanism and in some cases necessary tie-up with local NGOs/CBOs, following the IDCOL model, is necessary.
- Whilst there are renewable energy programmes already established and being successfully implemented in Bangladesh, there are still significant financial barriers that restrict access to a large proportion of poorer households.
- Lack of marketing strategies to encourage people to adopt renewables.
- Poor distribution networks for more affordable technologies including improved cook stoves and solar lanterns.
- Available subsidy and refinancing schemes are still beyond the capacity of rural poor
- No social mobilization and poor presence of service providers and installers.

Pathways to promote sustainable and environment friendly rural energy supply

The many interactions involved demonstrate that sustainable energy production requires trans-sectoral, integrated, participatory and gender responsive approaches and an appropriate institutional framework. Accordingly, the following aspects can play a decisive role in rural development:

- Promotion of locally available renewable energy to meet basic electricity needs. Decentralized production units are appropriate wherever locally renewable sources of energy are available and where connection to a central power plant is too costly (while nevertheless retaining the option of subsequent connection to a power grid).
- Efficient use of traditional and commercial fuels. Together with promotion of RE, this will contribute to environmental protection at the local, regional and global levels, while also saving costs.
- Generation of value added and income for local populations through the productive use of energy. Value added is usually a condition for (economically) sustainable operation of the energy system. Sale of local energy – for example, biomass/biogas based power generation, – can constitute an additional form of income for local people, if the production unit is owned by the community.
- Priority in energy supply to social infrastructure such as schools, health-care facilities, local markets and community centres used by the entire population, above all by disadvantaged groups.
- Promotion of decentralized organization and operating models. When planning, operations and management in decentralized energy systems are in local hands as far as possible, greater account is taken of local conditions. This increases the responsibility for maintenance and hence the reliability of energy supply.

Way Forward

The following recommendations can be considered as immediate and long term action to ensure poor and women's access to clean, affordable and sustainable energy as *right*:

- 'Energy for All' and 'Energy for Women' motto should be mainstreamed in energy related policy-making and implementation bodies and national policies and guidelines;
- Emphasizing equity and considering gender equality while promoting modern energy both in disadvantaged rural and urban areas;
- Energy related goals should be redefined and focused to address development outcomes including health, gender equality and access to essential services;
- Investment in R&D to support locally appropriate renewable solutions which can be cost effective, environment-friendly and pro-poor;
- Effective negotiation with development partners for sharing appropriate, sustainable and environment-friendly technology, know-how and supporting capacity building of state agencies, private and social enterprises;
- Policy formulation and patronization to promote suitable technologies, commercially viable business models with social responsibility;
- Special initiative (policy support, capacity development and customized incentive package) for private sector for serving women and poor living in disadvantaged and under-served rural (hills, char, coastal, haor) and urban areas;
- Efficient and target subsidy mechanism to ensure energy for poor, women and destitute in under-served areas;
- Investment in social and behavior change initiatives/communications to inform, awareness raisining, behavior change and taking action by the community;
- Social mobilisation and strong local presence of service providers and technology installers in hard to reach and remote areas;
- Focus on decentralized power generation for rural and hard to reach areas based on local realities.

Title: Post 2015 Sustainable Development Agenda: Challenges of Inclusive Social and Economic Development in Bangladesh

Dr. Md. Abu Syed

Introduction

This paper is based on critical review of adopted 13 SDGs and its relevance to societal and development needs towards equity and justice in future Bangladesh, the MDGs, and on the Rio+20 Outcome Document, taking into account the shifts in the international context since 2000 and the global prospects ahead of 2030 and 2050. In a world experiencing strong demographic growth, grappling with challenges which undermine the improvement of our living conditions have proved to be major obstacles to development and the achievement of the MDGs, it is essential to include a pro-poor and poor inclusive aspect as an integral part of fully-inclusive sustainable development.

The Government of Bangladesh has formulated a total of 13 goals as a contribution to the global dialogue on the post-2015 agenda, based on Bangladesh's experiences, with suggested targets and indicators. Critically, this includes a separate nutrition goal, as well as a separate gender goal, to address two of the most pressing development challenges Bangladesh faces. The proposed goals to be taken forward are:

Goal 1: Secure economic growth that is inclusive, reduces poverty and inequality, creates sufficient numbers of decent jobs and is environmentally sustainable;

Goal 2: Ensure sustainable food security and good nutrition;

Goal3: Reduce social inequality, particularly among marginalized groups and improve living conditions;

Goal 4: Achieve equality between women and men;

Goal 5: Ensure health for all;

Goal 6: Provide high quality basic education;

Goal 7: Reduce social risks and vulnerabilities;

Goal 8: Ensure inclusive environment and natural resources management that promotes sustainable eco-systems, development and green growth, livelihoods and health;

Goal 9: Reduce risk and build resilience to disasters and climate change with a focus on adaptation;

Goal 10: Improve diversity of, and access to, clean and more efficient sources of energy;

Goal 11: Improve accountability of public institutions for equitable public service provision for all communities;

Goal 12: Ensure equal participation and effective representation of marginalized groups, thereby strengthening inclusive democratic governance;

Goal 13: Strengthen rule of law, access to justice and promotion and protection of human rights.

The challenges ahead of Bangladesh is mobilizing the required resources, prioritizing interventions areas and channelizing the resources those priority lagging behind areas. It is well known that resource constraint was one of the major impediments to achieve the MDGs. The encouraging factor is that the sectors like education, health, social welfare, labour, public administration and social infrastructure together with agriculture and rural development were receiving net ODA and their combined share was around 51 percent of the total ODA outlay received from 1990-91 to 2013-14. Hence, the anticipated resource requirement for attaining all the SDGs in Bangladesh call for generous support from development partners should Bangladesh's endeavor for achieving the targets set under SDGs.

Bangladesh civil society considers that the future agenda should aim to guarantee an inclusive society founded on equal access to resources and rights and on the thriving of individual capabilities, as well as a decent and sustainable living environment, while making faster economic development and industrialization a positive force for our society. Bangladesh civil society strongly feels that post-2015 agenda or SDGs need to the sustainable economic growth while taking account of the specific challenges of Bangladesh and NOT harming the environment andsociety. The unique challenges Bangladesh faceclimate change while development enablers (population dynamics, human mobility, equity and social justice for poor)as a first basis for Bangladesh' reflection.

The Future We Want for All in Bangladesh

The approach of MDGs assumed a "one size fits all" model that seemed to take little account of the complexities of development or differences in national circumstances. There is strong advocacy for a broader approach to measuring human progress, arguing for the need to complement standard economic measures with a range of indicators covering other dimensions of people's well-being and happiness. Some countries, such as Bangladesh, have not only adopted the Goals, but also adapted them to meet local needs; for example, Bangladesh set new targets and indicators for promoting women in local government bodies, as well as separate goals and targets on access to reproductive health services.

Despite remarkable development progress, increasing its real per-capita income by more than 130 percent, reducing its poverty rate by over 60 percent, estimate shows that 24 million peoplein Bangladesh are still below the poverty line, with a significant proportion living in households in remote areas (Chars, Haorsetc) or consisting of marginalized people; in addition, 43 percent of female-headed households are believed to be very poor.Poor people are severely disadvantaged in terms of ownership of assets and have inadequate access to basic services, including quality education, health care, water and sanitation. The poor, among them especially the women and children, are also disproportionately affected by natural disasters and the adverse effects of climate change. Social protection programmes, despite expansion,remain inadequate.

In recognition of the long-term development challenges, the Government has adopted its Vision 2021 and associated Perspective Plan 2010-2021, which have helped achieved Lower Middle

Income Status by 2015. In this light Bangladesh also has finalized its Seventh Five Year Plan incorporating more social safety net measures. However, to ensure equal access to resources and development benefits for the poor, corruptions need to be addressed in all sectors, scales and levels. To attain corruption free service delivery system appropriate institutions with clearly defined roles and responsibilities (for each of concerned individuals) have to be immediately functional. If these targets achieved, will further transform Bangladesh, so that people enjoy a higher standard of living, will be better educated, will face strengthened social justice, will have a more equitable socioeconomic environment, and will enjoy enhanced protection from climate change and natural disasters.

Equity, Sustainability and Human Rights for All: Bangladesh's Post-2015 Opportunities

The reduction of inequities in Bangladesh, as in all societies, is essential to a vision of inclusive, sustainable development. Such approaches need to give the highest priority to address the situation of all sections (women, youth, children, and older people) of population, while also reaching those groups marginalized by ethnicity, religion or other social classifications. They also need to seek the greatest potential for progress by removing social, cultural, legal, administrative and financial barriers in these groups' access to services, decent jobs and entrepreneurship, and land and other productive resources.

The noted economist AmartyaSen's fundamental development critique proposed that development should centre on capabilities – on what people can do or be, rather than what they have; on the ends of development, rather than the means; and on taking into account people's differing abilities to convert resources into outcomes. This broad view suggests that in addition to income, it is important to take into account other outcomes that have both intrinsic and instrumental value. Bangladesh endowed with multiple development opportunities in the post-2015 period that require not only a holistic vision, but also a broad approach to development, based on social justice, structural transformation, and economic diversification and growth. In Bangladesh, as elsewhere around the world, consultations have shown that poverty reduction, access to quality education, health, water and sanitation and equality between women and men are still high on their agenda, as are the need to reduce child under-nutrition, address different forms of inequalities, and ensure environmental sustainability and foster partnerships at national, regional and international levels. This can be done by building a framework that is based on the three fundamental principles of equity, sustainability and human rights for all particularly for poor, and by orienting key goals along highly interdependent dimensions of inclusive economic development, inclusive social development, environmental sustainability, and inclusive governance.

To be inclusive, a macroeconomic approach will be required which is aligned with broader development policies giving rise to adequate generation of productive employment and decent work, including development of a labour-intensive manufacturing sector; reduction of poverty; welfare protection; and green growth. Under inclusive social development, ensuring people's rights to education, health, nutrition and human security in Bangladesh is vital and will require adequate investments to realize unmet MDGs, facilitate sustainable employment generation, and close the gaps that perpetuate inequity and poverty. In environmental sustainability, immediate priorities include ensuring a more stable climate, improving scientific understanding and knowledge sharing on Disaster Risk Reduction, preventing land degradation, protecting the natural resource base, and transitioning to low-carbon energy sources while promoting energy-efficient technologies. Lastly, inclusive governance will need to focus on enabling policies in

critical governance areas, including effective governance of systems for social development and quality service delivery that is affordable to even the poorest groups. It also will make wide use of fundamental human rights enablers such as participation, accountability, empowerment and rule of law, all of which provide a strengthened foundation for inclusive development paths.

Key Development Enablers in Bangladesh Post-2015

4 a. Population Dynamics and Human Mobility

With an estimated population of 152 million in 2012, Bangladesh is the seventh most-populous nation on Earth, and with the highest population density at 960 people per square kilometer. All this occurs in a relatively small land area and amid difficult and complex hydrology at the confluence of two of the world's largest rivers. Despite a relative decline in fertility, the population is expected to reach 165 to 170 million by 2020. Access to reproductive health and protection of reproductive rights thereby continue to represent a critical challenge for achieving dignified human development and well-being for all.

Current population challenges are not only about numbers, but also growing deprivation and inequalities.Changes in the size, age and location of populations have important implications for the attainment of many development objectives, and all aspects of population dynamics will need to be considered in development planning towards achieving SDGsand indicators, as well as strategies, policies and programmes. The eradication of poverty and the assurance of environmental sustainability are today's greatest challenges and these are intrinsically linked to population dynamics: - population growth, aging, migration and urbanization which pose stand as challenges on the way to achieving SDGs.Thus, demography presents a complex challenge and in the post-2015 framework and a rare opportunity as wellfor Bangladesh with its young population which can serve as a demographic window of opportunities.

4b. Capturing Other Crosscutting Issues in the Bangladesh Context

Harnessing the power of knowledge, technology and innovation can advance national ambitions on robust economic growth, environment, food security, health and a variety of other public policies. There is alsoa clear linkage to wider social policies, in particular education, which is critical to developing the knowledge-intensive skills on which productivity, job creation and competitiveness depend. Another relevant factor to take into consideration is the need to improve access to technologies, in particular, to information and communication technologies (ICTs). It has been estimated that a 10 percent increase in the penetration of high-speed Internet broadband networks contributes to a 1.8 percent increase in GDP. Technology and innovation also can introduce significant improvement and services into health, education and agriculture extension services; one of the best examples in this regard is the use of ICTs to introduce telemedicine services and to improve the management of health records.

The rich cultural heritage and substantial labour, cultural and creative industries, sustainable cultural tourism, and cultural infrastructure can serve as strategic tools for revenue generation, particularly in a country such as Bangladesh. The sub-sectors can generate decent employment, stimulate local development and foster entrepreneurship. Culture-led development also encompasses a range of non-monetized benefits, including greater social inclusiveness and rootedness, resilience, innovation, creativity and entrepreneurship for individuals and communities, and the use of local resources, skills and knowledge.

4c. Developing New Metrics to Monitor Performance

It will be useful to assign differentiated responsibilities for achieving the post-2015 goals, at global, regional and national and sub-national levels, and including civil society and the private sector. For example, at global level the basis for a new approach could be the nascent Global Partnership for Development Effectiveness, a key output from the Fourth High Level Forum on Aid Effectiveness in 2011, held in Busan, Republic of Korea.

Furthermore, it will be essential to track progress of the post-2015 goals in a reliable, timely and comparable way. One particularly important objective must be to capture social inequities in data collection – based on gender or ethnicity, or geographical location. The use of averages and aggregates as the main measures or tracking progress on most MDG indicators has served to mask the series of major, persistent and often widening inequalities noted above. Advancements in the measurement of inequalities include the Multidimensional Poverty Indices, which show deprivations that a household or a child experiences simultaneously, highlighting the depth of marginalization among the poorest populations.

The new and interactive forms of data collection and feedback mechanisms such as "crowdsourcing," (collecting data directly from populations) can be utilized to capture "the longer static" statistics of mobile populations and economic risks. Complementing an upgrade of traditional data, new efforts could take advantage of advances in Internet and mobile technology, which could significantly reduce transactions costs and increase efficiency.

Inclusive Development in Bangladesh for the Post-2015 Agenda

Growth with equity – between income levels, gender, ethnic and other groups, localities and generations –are the hallmarks of genuinely inclusive development. Securing sustained growth has a direct relationship with the reduction of poverty and the elimination of hunger. This also creates enabling ecosystems for governments to deliver key public services in addition to expanding and improving livelihoods and lifestyle changes. The majority of the population, and especially, the poor and women, need to have access to work and to productive assets like education and health. It is also critical to give importance to inter-generational equity, and hence, the sustainability of economic growth. The process of lasting structural change, from a predominantly agricultural economy to an emergent industrial one, is well underway. As the country already reaches lower middle-income status, the fundamental economic forces in this transition involves will reshape the pattern of production both sectorally and geographically. Inevitably, this too will affect the distribution of income and human development outcomes, while placing huge strains on the environment.

Two sets of factors shape the nature of economic development, and in turn, its inclusiveness. First is the level of growth itself, and second its distributional dimensions in geographic and social class/structure terms. Bangladesh faces numerous challenges on these questions. Most notable are its relatively low savings ratio, FDI scarcity, constrained public investment and infrastructure and still-limited capacities policy and implementation of development programs. Aligning and integration of all the major planned or potential infrastructure projects would facilitate distribution development benefits to the peoples of different regions. For example, enhanced capacity and efficient ICT based court and case management system could save huge man hour which can be utilized for other productive purpose now wasted in finding labyrinth ways to get justice.

Bangladesh's growth acceleration of recent years is primarily anchored around the export of light manufactures (predominantly ready-made garments), rooted in core comparative advantages in labour supply and low wage costs; underpinning this has been rural-urban migration. These two processes, along with industrialization, have become symbiotic, with underemployed rural labour drawn progressively into the cities. However, critical questions remain over the quality of jobs, movement through the value chain, and the role of domestic demand.

Second, country's economic environment remains a very significant factor in policy issues, and the consensus has coalesced around two important features. The first is macroeconomic stability, in essence, low inflation and balance of payments equilibrium. This is a cornerstone of economic activity and central to the sustained expansion of productive activity and jobs. Rapid price inflation distorts markets and resource allocation signals, and serves to undermine confidence and prosperity. Yet it is also important to emphasize that macro-stability, while necessary for growth, is not sufficient. In addition, there are dangers in pursuing a strong policy response. The second issue is the quality of the regulatory environment and of wider economic governance. Red tape, corruption, and the difficulties of doing business are key challenges facing Bangladesh. These weaknesses directly harm competitiveness, distort investment decisions, and deter FDI. Introduction of ICT and transparent digital ICT based service delivery system at all levels of governance would surely reduce red-tape and corruption while enhance accountability as well.

Third, and directly pertinent to inclusiveness, is the extent to which production is labour-intensive and the economy is able to absorb unemployed and underemployed workers.

Existing patterns of asset ownership in Bangladesh remain a key issue in this regard, particularly since existing wealth is a primary driver of investment and capital markets remain weak. Meanwhile, to address challenges regarding the labor intensity of production, a matching process is required favoring staged industrialization, absorbing labor and generating higher productivity and improved working conditions; associated considerations include the need to recognize the continuing importance of agriculture as a major determinant of employment of the poor, and for formalization of the large informal sector to be phased and well-managed.

Macroeconomic stability is important for equity as well as growth, as rising prices often hurt the poorest most. In this regard, Bangladesh's policy stance has proven effective on the whole; monetary policy has been prudent and adopted a growth-supporting form of stability. As a next step, a regional policy to address east-west differences and support the Chittagong Hill Tracts, riverine char land along with targeted regeneration and poverty reduction schemes for highly challenged areas, may be needed. Fiscal decentralization and equalization between areas and local governments also will be a vital means for redistributing growth and responding directly to spatial inequities.

Group-based economic inequalities also can be significant; a special focus on marginalized groups is therefore required to offer special targeted assistance. Of all groups (marginalized ethnic groups, people with disabilities, other minorities), gender inequality emerges as a special priority in most LDCs. Bangladesh's data for employment bear this out very strongly: Women's labourforce participation rates, especially in non-farm employment, lag substantially behind men, at 36 percent versus 82.5 percent. Yet again, the drivers underpinning this run deep. Although limited, the literature on intra-household income and consumption allocations emphasizes the importance of social norms and conventions, and it is likely that gendered social

phenomena have an economic impact, with women's purchasing power often severely falling behind that of men.

Lastly, a number of regulatory and enabling actions need to be taken which may offer supplementary routes forward, and over time have substantial distributional payoffs. These include, for example, securing rural and urban poor, women's equitable access to the labour market; introducing regulatory controls over biases in the supply of services; regulating for better working conditions; freeing up the supply of credit via legal instruments; economic formalization, and specifically, the granting of property rights and land tenure to women and men; and challenging unfavourable social norms and processes. This will be highly dependent on not only the national context and the quality of regulation, but also on the quality of overall governance in Bangladesh.

Inclusive Social Development in Bangladesh for the Post-2015 Agenda

A new emphasis on poor people's experiences of deprivation also provides a way to prioritize the multiple dimensions that matter to well-being and casts light on aspects such as the importance of relationships and of being treated with dignity, as well as the value of trust and social cohesion. In addition, advances have occurred in measurement to focus on the joint distribution of deprivation, given that people often face multiple dimensions at the same time, and to understand the intra-household distribution of resources, which is particularly critical with regard to social development. Poor people and marginalized groups are experiencing the effects of climate change and environmental degradation on their circumstances and livelihoods, while these processes, in turn, deepen poverty and increase marginalization and vulnerability.

The concept of inclusive social development is anchored around the idea that balanced, sustainable development can only take place when development includes all (men, women, children, physically and mentally challenged or disabled) groups of people who collectively contribute to identify and address challenges, making decisions and creating opportunities. Overall, the quality of growth must be gauged by how much marginalized populations are enabled to enjoy effective coverage of key social services that define their rights to live, thrive and be safe from abuse, exploitation and violence.

Inclusive Governance in Bangladesh for the Post-2015

Inclusive governance has been a particularly significant omission from the MDGs which had profound impact on development programming across the globe, since concerted efforts have been focused on meeting the specific targets set out in the MDGs. For many development partners, support for inclusive governance, while important, was undermined by a lack of consensus between donors and developing countries on the metrics of inclusive governance. As a result, while many countries made good progress in achieving the MDGs, and consequently improved the lives of many, there has been less progress in improving governance, democratic participation and respect for the rule of law, which would sustain and enhance those gains. This deficit in the MDGs has increasingly been recognized by the international community, including at the MDG Summit in 2010.

The critical role of inclusive governance for realizing sustainable human development and poverty alleviation was highlighted in the most recent global Human Development Report. Growing evidence suggests that economic growth alone is not delivering the development outcomes expected, particularly since many countries, including Bangladesh, aspire to graduate

into higher middle-income status. Without effective State responses, growing inequality results in prosperity benefiting the few rather than the majority. Today, exclusion lies at the heart of critical development challenges related to State fragility, social and political violence, and the integrity, capacity and legitimacy of the State.

Inclusive governance also is essential to ensure effective policy development in areas vital for underpinning sustainable development, such as addressing climate change and environmental degradation, or managing population size. Inclusive governance likewise is critical for the development of innovative social policy responses, including sound health, nutrition and educational provision, and effective social protection. Building a capable State that is able to deploy diverse policy instruments is a fundamental priority for effective poverty alleviation and sustainable development, offering the ability to fully unlock a country's potential.

It also means that governance institutions and policies are accessible and accountable to marginalized groups, providing equal access to public services. In all, inclusive governance occurs when the rule of law is followed, access to justice is afforded, and discrimination is addressed. For Bangladesh as elsewhere, three central aspects of inclusive governance are: i) accountable public institutions that deliver public services to all, and especially the marginalized and poor, ii) participation and representation of all people in the democratic process, and iii) rule of law and respect for human rights.

First, accountable and effective public administration provides predictability and fairness in the actions of government. Public administration has a critical role in responding to inequality through fair and effective service delivery. A well-trained and effective workforce, coupled with sound budget planning and management institutions and processes, are critical for effective public administration. Thus, public administration is the "engine room" of government, supporting the development of policy, implementing laws passed by the parliament, ensuring proper revenue raising, and delivering important services such as education, nutrition, health, and water and sanitation. In a democracy, public administration must also be responsive, transparent and accountable.

At the same time, free and fair elections, strong institutions such as parliament and CSOs to highlight the voice of the people – coupled with the space and opportunity to debate and discuss public policy – are the critical elements of participation that ensure inclusive governance.

The rule of law is an inherent part of inclusive governance. Evidence suggests that establishing transparent, accountable and legitimate legal frameworks, ensuring predictable enforcement of rules and procedures, and reducing corruption have enabled effective delivery of health, education and other social services in realization of specific MDG targets.

Globally, evidence suggests that both access to, and the quality of, justice are major rule of law challenges. The World Development Report 2011 demonstrates that strengthening the rule of law is crucial to ensure security, justice, and economic prosperity. Corruption, undue influence, violence and fear each undermine the rule of law, national stability and prosperity. Overall, traditional development interventions focusing heavily on developing State capacities have proven inadequate. Rule of law institutions and services therefore will need to be more inclusive, innovative and accessible.

Lastly, respect for human rights is at the heart of legitimate governance. While the MDGs themselves do not explicitly reference human rights, many MDG targets reflect core human

rights norms such as the right to health and the right to education. Momentum is substantial for the post-2015 agenda to be fully aligned with international human rights standards and principles. Human rights are underpinned by universally recognized moral values and reinforced by international legal obligations. Accordingly, international human rights provide a compelling normative framework for the formulation of national and international policies, including inclusive development strategies. The linking of human rights and post-2015 goals would seek to deliver sustainable and inclusive development that supports the realization of human rights, particularly for the marginalized.

Recommendations:

Attainment of SDGs will require a strong and effective institutional mechanism involving all stakeholders including public representatives (central and local), government (executive and bureaucracy), private sector, civil society, knowledge community (academic and nonacademic), and development partners.

- Role of different actors including national government, LGIs, NGOs and civil society in the changing contexts (moving towards a middle income country) and emerging challenges need to defined andinstitutional mechanism has to be established to facilitate collaborative functioning of all aforementioned institutions.

- Institutional mechanism for implementation SDGs related development programs need to be in place with clear mandates of its activities and auditing systems.

- The System of Environmental Economic Accounts (SEEA) was developed to respond to this need at UN level and represents the integrated statistical framework to measure the environment and its relationship with the economy and society.

- In monitoring MDGsGED was involved in producing monitoring reports with the help of other government agencies.

- Bangladesh government needs to decide who should lead the process in SDG. Under the leadership of the Prime Minister's Office an inter-ministerial body may be formed for regular national level review of achievement against planned targets.

- The national budgetary process need also to be informed by the SDGs and resources allocation need to be made judiciously across different sectors.

- Adoption of a common conceptual framework in line with international standards, integration of environment statistics within the national statistical system requires a systems-wide approach to align the statistical production process for different sectoral statistics, and reconcile institutional arrangements for the production of an integrated information sets.

- As the SDGs formulation looked forward as guide to

    - COP21 in Paris (December 2015)

    - COP13 of the Convention on Biological Diversity (2016)

- United Nations Conference on Housing and Sustainable Urban Development (2016)

- Bangladesh Government may use COP21 Paris agreement and above mentioned conventions as an opportunity for negotiation at international fora. Climate agreement and resources (if made available) can be utilized in adaptation and mitigation keeping climate change and sustainable development in focus.

1. Synergies among MDGs, SDGs and adopted relevant policies by the Government of the Peoples' republic of Bangladesh

Integration of SDGs in National Policies and Planning process

MDGs			SDGs	National policies
MDGs	**Achievements**	**Challenges**	**SDGs**	
Goal 1: Eradicate Extreme Poverty and Hunger	The poverty headcount ratio for 2015 is estimated to be 24.8 percent. Bangladesh has already met one of the indicators of target-1 by bringing down the poverty gap ratio to 6.5 against 2015 target of 8.0. The estimated figures suggest that the MDG target of halving the population living below the poverty line (from 56.7 percent to 29.0 percent) has been achieved well ahead i.e. by 2012.	Unemployment as well as underemployment is still persistent especially among the young people between 15 to 24 years of age which are nearly 8.5 percent of the country's total population and 22 percent of the total labour force. The challenges with regard to reducing income inequality and the low economic participation of women also remain as matter of concerns.	**Goal 1:** Secure economic growth that is inclusive, reduces poverty and inequality, creates sufficient numbers of decent jobs and is environmentally sustainable;	

MDGs			SDGs	National policies
MDGs	**Achievements**	**Challenges**	**SDGs**	
Goal 2: Achieve Universal Primary Education	Significant progress has been made in increasing equitable access in education (NER: 97.7 percent), reduction of dropouts, improvement in completion of the cycle, and implementation of a number of quality enhancement measures in primary education. Bangladesh has already achieved gender parity in primary and secondary enrolment.	The challenges under MDG-2 include attaining the targets of primary education completion rate and the adult literacy rate. A large part of the physically and mentally retarded children remains out of the schooling system. Improvement of quality of education is also a challenge at the primary and higher secondary levels that need to be taken care of on priority basis.	**Goal 6:** Provide high quality basic education;	The government is in the process of implementing a comprehensive National Education Policy (2010) to achieve its objectives. The Constitution of Bangladesh has provision for free and compulsory primary education. The Government nationalized and took over 36,165 primary schools in 1973 and regularized it under the Primary Education (Taking Over) Act of 1974, and declared 157,724 primary school teachers as government employees. Primary education is free and made compulsory under the Primary Education (Compulsory) Act 1990. Bangladesh is a signatory to the World Declaration on Education for All (EFA) held at Jomtien, Thailand in March 1990. Bangladesh is also a signatory to the Summit of 9 high Population Countries held on 16 December 1993 in New Delhi. The country has also prepared a Non-formal Education Policy. The Education Assistance Trust Act, 2012 has been passed and the Education Assistance Trust established to benefit the underprivileged meritorious students.

MDGs			SDGs	National policies
MDGs	**Achievements**	**Challenges**	**SDGs**	
Goal 3: Promote Gender Equality and Empower Women	Bangladesh has already achieved the targets of gender parity in primary and secondary education at the national level. Bangladesh has made significant progress in promoting the objectives of ensuring gender equality and empowerment of women. There has been steady improvement in the social and political empowerment scenario of women in Bangladesh. The Bangladesh Government is committed to attaining the objective of CEDAW, Beijing Platform for Action and MDGs in conformity with the fundamental rights enshrined in the Constitution and adopted the National Policy for Women's Development (2011).	Wage employment for women in Bangladesh is still low. Only one woman out of every five is engaged in wage employment in the non-agricultural sector.	**1. Goal 3:** Reduce social inequality, particularly among marginalized groups and improve living conditions; 2. **3. Goal 7:** Reduce social risks and vulnerabilities; **4. Goal 12:** Ensure equal participation and effective representation of marginalized groups, thereby strengthening inclusive democratic governance; **5. Goal 13:** Strengthen rule of law, access to justice and promotion and protection of human rights.	The Bangladesh Government is committed to attaining the objective of CEDAW, Beijing Platform for Action and MDGs in conformity with the fundamental rights enshrined in the Bangladesh Constitution and National Policy for Women's Development (2011). The Education Assistance Trust Act, 2012 has been passed and the Education Assistance Trust established to benefit the underprivileged meritorious students.
Goal 4: Reduce Child Mortality	Bangladesh is on the verge of achieving the target. The under-five mortality rate was 151 per 1000 live birth in 1990 which has come down to 41 per 1000 live birth in 2013 and thereby achieving the MDG target before the stipulated time. Likewise, the infant mortality rate was 94 per 1000 live birth in 1990 which has reduced to 32 per 1000 live birth in 2013.	While the mortality rates have improved, major inequalities among the population segments still need to be addressed. Childhood injuries, especially drowning, have emerged as a considerable public health problem responsible for a full quarter of the deaths among children 1-4 years of age.	**Goal 2:** Ensure sustainable food security and good nutrition; **1. Goal 5**: Ensure health for all;	

MDGs			SDGs	National policies
MDGs	**Achievements**	**Challenges**	**SDGs**	
Goal 5: Improve Maternal Health	According to Bangladesh Maternal Mortality Survey (BMMS), maternal mortality declined from 322 in 2001 to 194 in 2010, a 40 percent decline in nine years. This was 574 per 100,000 live birth in the 1990/91. Theaverage rate of decline from the base year has been about 3.3 percent per year, compared with the average annual rate of reduction of 3.0 percent required for achieving the MDG in 2015. The Maternal Mortality Estimation Inter-agency Group (MMEIG), however, found the MMR as 170 per 100,000 live births in 2013.		**2. Goal 5**: Ensure health for all;	The government has framed the National Health Policy, 2011' with a view to revamping the health sector and the 'National population Policy 2012' has also been finalized. Moreover, in order to strengthen primary healthcare facilities, the government has launched 12,979 community clinics to reach out the grassroots level population.
Goal 6: Combat HIV/ AIDS, Malaria and Other Diseases	The prevalence of HIV/ AIDS in Bangladesh currently is less than 0.1 percent and thus is still below an epidemic level. According to National AIDS/STD Programmes (NASP), condom use rate at last high risk sex was 43.33 percent in 2013. According to National AIDS/STD Programmes (NASP), proportion of population aged 15-24 years with comprehensive correct knowledge of HIV/AIDS is 17.70 percent in 2013. The proportion of children under-5 with fever who are treated with appropriate anti-malarial drugs was 60 percent in 2008, which was recorded at 99.92 percent in 2014 and the target is to achieve 90 percent in 2015 has already been achieved.	The prevalence of TB per 100,000 population was 501 in 1990, which has reduced to 402 in 2014 against the target of 250 in 2015. The death rate associated with TB was 61 per 100,000 population in 1990, which has come down to 51 in 2014. The overall TB case notification rate was 53 per 100,000 population in 2014. The NTP adopted the DOTS strategy and started its field implementation in November 1993. The programme has been maintaining over 90 percent treatment success rate since 2006, and has successfully treated 92 percent of the new smear-positive cases registered in 2014.	**3. Goal 5**: Ensure health for all;	

MDGs			SDGs	National policies
MDGs	**Achievements**	**Challenges**	**SDGs**	
Goal 7: Ensure Environmental Sustainability	Data show that without considering the issue of arsenic contamination, 97.9 percent of the population of Bangladesh is using improved/safe drinking water; 55.9 percent of population is using improved sanitation in 2012-13. However, access to safe water for all is a challenge, as arsenic and salinity intrusion as a consequence of climate change fall out will exacerbate access to safe water especially for the poor.	At present there is only 13.40 percent of land in Bangladesh having tree cover with density of 30 percent and above. The area having tree cover is much lower than the target set for 2015. Since 1991, there has been a steady increase in CO2 emission in Bangladesh because of increasing development interventions and activities. In 2005, the emission was 0.23 tonne per capita. At present the proportion of terrestrial and marine areas protected is 1.81 percent and 1.34 percent respectively which is much less than the target of 5 percent.	1. **Goal 8:** Ensure inclusive environment and natural resources management that promotes sustainable eco-systems, development and green growth, livelihoods and health; 1. **Goal 9:** Reduce risk and build resilience to disasters and climate change with a focus on adaptation; 1. **Goal 10:** Improve diversity of, and access to, clean and more efficient sources of energy;	
Goal 8: Develop a Global Partnership for Development	During the last twenty four years, Bangladesh, on an average, received US$ 1.74 billion ODA per year. The disbursed ODA as a proportion of Bangladesh's GDP has declined from 5.69 percent in FY 90-91 to 1.78 percent in FY 13-14, implying yearly average of 2.84 percent. The MDGs sectors like education, health, social welfare, labour, public administration and social infrastructure together with agriculture and rural development constituted around 50.82 percent of the total ODA outlay received during 1990-91 to 2013-14		2. **Goal 17**: Partnership for the 3. goals	

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Title: Application of Sustainable Livelihood Framework at the Community Level:

An Indigenous Critique

Asfia Gulrukh Kamal

Introduction:

The association of resource-led development with topics such as capitalism, strategies of the colonial state, the rise of transnational market economies, neo-liberal policies of ecological, cultural genocide and corporate control over local resources is not a new phenomenon (Shiva, 2002; Escobar, 1995; Harvey, 2003). From Marxism to contemporary Indigenousstudies literature, theexploitation of natural resources and its disastrous impact over the culture and livelihoods of marginalized population has been documented (Marx 1976 [1867]; Churchill, 1983; Waldram, 1988; Escobar, 1995; Shiva, 2002; Harvey, 2005; Kulchyski, 2005; Kulchyski, 2013; Coulthard, 2014; Kamal, Linklater, Thompson, Dipple, & Ithinto Mechisowin Program, 2015).

Emerging studies in social and environmental science show that Indigenous communities, living in resourceful countries such as Canada, Australia, New Zealand, America are experiencing socioeconomic and cultural challenges within the newly reformed resource-led world order, often more than the third world countries and non-Indigenous population, due to state surveillance and unsupportive colonial regulations (Escobar, 1995; Hall & Patrinos, 2010; Gilberthorpe & Hilson, 2014).

Livelihood discourse connected with resource-led development not only expresses concerns over the damaging environmental and socioeconomic consequences but also finds its major analytical tool, the Sustainable Livelihood Framework (SLF) insufficient to study structural discrimination(Davies, White, Wright, Maru, & LaFlamme, 2008; Daskon, 2008; Scoon, 2009; Sakdapolrak, 2014; Wilshusen, 2014). SLF is linked with top down western development agenda, often promoting a narrow analysis of the term "capital" (ibid). Within this context our concern is to examine how successfully livelihoods studies can be used in a development-led framework while analyzing Indigenous livelihood challenges.

By sharing the story of *O-Pipon-Na-Piwin* Cree Nation (OPCN), an Indigenous community situated in remote northern Manitoba, Canada and its local food program *Ithinto Mechisowin* Program (IMP) we explore the ways in which Indigenous perspectives can contribute to livelihoods analysis. Indigenous culture in Canada embeds livelihoods and well being with peoples' deep relationship with the land (Adelson 2000;Kovach, 2005; Wilson, 2008; Hart, 2010; Simpson, 2011, Kamal et al., 2015). This relationship is being disrupted Canada-wide by resource-ledindustrial projects such as mining and hydroelectric dams within areas specified by the government for traditional land use, without proper consultation or adequate and meaningful compensation or mitigation plan (Waldram, 1988; Hoffman, 2008; Kulchyski, 2013;Kamal, Thompson, Linklater & Ithinto Mechisowin Program, 2014; Kamal et al. 2015).We argue that for an ethical understanding of development politics, livelihood studies related to Indigenous communities should take a bottom up approach, be supple and variable in its analysis, not use a fixed framework and provide culturally appropriate meaning of "asset"/"capitals."

To make these claims the first section of the article will discuss the concept of capital used in livelihood studies. Following this, the article will share the significance of Indigenous worldviews. Next, it will describe methodology and community history. Later, elaboration on how OPCN's collective cultural practices can contribute to livelihood studies will be presented.

The concluding section will summarize our argument.

Capital in the context of SLF:

From its origin the term capital is linked with "a material holding or monetary fund" (Williams, 1976, p.51). German sociologist Karl Marx defined capital in relation to "capitalism", an economic system that magnify natural resource exploitation by using capital to monopolize, control production price and manipulate wage-labour relation (Marx,1976 [1867]). Marxist understanding of capital paved ways for in-depth analysis on capital and its relationship with capitalism in resource-led economy in different disciplines. However, in livelihood studies, the understanding and functionality of the term "capital" has remained inadequate (Scoon, 2009; Wilshusen, 2014; Sakdapolrak, 2014). The concept is contested and being reviewedby contemporary scholars, particularly in the application of the SLF analysis (ibid).

The notion of capital was introduced in livelihood and development studies through World Bank's (WB) report "*Expanding the Measure of Wealth*"(World Bank, 1997;Wilshusen, 2014, p. 133).The report suggested that people's sustainable development could be assessed "based on relative endowment of four capitals: produced, human, natural and social" (World Bank ,1997, p. v ; Wilshusen, 2014, p.133). The interpretationemphasized on capitalist accumulation on resources rather than meaningful sustainability (Bebbington, 1999; Wilshusen, 2014). Reasonablyit is argued that the WB played a role of manufacturing information/knowledgeto benefit development-led capitalism (Esteva, 1992; Goldman, 2005; Wilshusen, 2014). The plan was to bring in a major shift in the language and mode of capitalist growth to maintain a continuously homogenous and liner reality of the world in which the developed West was authorized to plan, exploit and decide for the "underdeveloped" (Sachs, 1992, p. 2;Esteva, 1992, p.16).As Trinh (1989) said, "the concept that is currently named 'development' has gone through six stages of metamorphosis since late antiquity. The perception of the outsider as the one who needs help has taken on the successive forms of the barbarian, the pagan, the infidel, the wild man, the 'native', and the underdeveloped"(p. 54).

(Carney, 1998)

This argument attests how the camouflaging and manipulative nature of capital feeds on the "other" and the fact that WB's problematic involvement in development was actually, an investment of capitalist endeavor.

The WB's Department of International Development and Institute of Development Studies(DFID) in Sussex designedthe Sustainable Livelihoods Framework (SLF) as a key analytical tool of livelihood studies (Brockiesby & Fisher, 2003; Scoon, 2009; Sakdapolrak, 2014).SLF was introduced to measure assets/capitals (social, physical, natural, human and financial), adaptive strategies and technologies to mendasset insecurity in livelihood of marginalized population (Chambers & Conway, 1992). In some studies, culture is also considered as one of the capitals (Davies et al., 2008; Daskon & Mcgregor, 2012; Wilshusen, 2014). Table 1 summarizes definitions of capitals according to SLF and provides few examples of their use in livelihood activities.

Capitals/Assets	Definition of resources	Some examples
Natural	Supplies of natural resources	Fisheries, land, gas, minerals.
Physical	Man-made resources	School, office space, library etc.
Human	Knowledge, skills gained by training, education	Gardening, farming, hunting, fishing, reading, writing etc.
Economic/financial	Monetary supplies	Money, saving bonds, credits etc.
Social	Network of trust and reciprocity in a social group	Community safe walk group, women's rights groups, community coops, community kitchen etc.
Cultural	Everyday practices and communitarian interactions that shapes identity	Rituals, celebrations based on class, race, gender, ethnicity and religion.

Table One: Capitals in Sustainable Livelihoods Framework

(Inspired by Davies et al., 2008; Sakdapolrak, 2014; Wilshusen, 2014)

In SLF, livelihood is perceived as " the capabilities, assets and activities required for a means of living" (Chambers & Conway, 1992, p. 7). SLF suggests that alivelihood is sustainable "when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resources base" (ibid). The assets or capitals, which refer to stock of resources, is explained as "input", through a pentagon shape modeland used to measure availability of assets and enhance livelihood strategies of people as outcomes (DFID, 1997; DFID, 1999; DFID, 2000a; DFID, 2000b; DFID, 2000c; DFID, 2000d;Chamber & Conway, 1992; Brockiesby & Fisher, 2003; Davis et al. 2008; Scoon, 2009; Wilshusen, 2014). Analysis of cross-sectoral policies to improve livelihoods of the affected population is also a part of SLF analysis (Chamber, 2005).

Despite its wide application in development studies, SLF has been criticized for its limitations in mainstream research (Davis et al.. 2008; Daskon, 2008; Scoon, 2009; Wilshusen, 2014, Sakdapolrak, 2014, Kamal, et al., 2014). An elaborate discussion on the topic is beyond the scope of this paper. However, we will discuss some key points from the asset model.

At the early stage of SLF, peoples' livelihoods were analyzed through diagrams, charts or graphs, or guidance sheets (International Fund for Agricultural Development, 2011). In a technical analysis "measurable" (for example, physical, financial) and "non-measurable" (for example, social or cultural) capitals are kept on the same list (ibid). This gave an "illusionary equivalency" to all kinds of capitals and hence reduces the potential of an in depth analysis of historical and structural power relationships(Wilshusen, 2014, p. 138).

The asset model is marked for being narrowly focused andunelaborated (Daskon 2008; Scoon, 2009; Sakdapolrak, 2014, p. 21). It is argued that the simplified and static analysis of asset pentagon by DFIDshifts focus from people and sidelines disputes around the contested role of capital in the society (Sakdapolrak, 2014;Wilshusen, 2014). It limits livelihoods discussions in the "territory of economic analysis" (Scoon, 2009, p. 177), defines capital as a monetary object rather than an exploitative course of development (Harvey, 2010).

Additionally, livelihood comprises of both material and non-materialcharacteristics of well-being (Bebbington, 1999; Daskon, 2008; Sakdapolrak, 2014). As Bebbington (1999) said, assets can mean "hermeneutic" and "emancipatory" action through which people can define their unique

way of living and resist against socially embedded power structures (p. 2022). Daskon (2008) argues that for a holistic and deep understanding of sustainable livelihood "social, economic, cultural and spiritual needs of all members of a community, human, non-human, present and future" – and safeguarding their "cultural and biological diversity" is essential (p. 172). A holistic perception of livelihood can be acquired by local understanding/nuance of the livelihood and asset requirement without which a community is gravely misunderstood.

Indigenous Worldview and Indigenous livelihoods:

From an Indigenousworldview, sustainable livelihoods areviewed in terms of relationships emphasizing "the resource base, ecosystem services, people and other species" and "not just an efficient allocation of resources over time, but also a fair distribution of resources and opportunities between the current generation and between present and future generations" (Milne, Tregidga & Walton, 2004, p. 5-6).

Indigenous perception of livelihoods tend to rest on a sense of egalitarianism where all factors (physical, natural, economic, social, and human) in the sustainability wheel are perceived in the form of one bond or relationship (Manitoba Education and Training, 2000). This relationship exists between the physical environment and Indigenous knowledge where sustainability and a balanced ecosystem are shared responsibilities of all living beings (individual, community, animal, land, water, air, fire) (Manitoba Education and Training, 2000). People acting in accordance with cultural worldviews and values is key to maintaining a healthy livelihood and community.

Livelihood, for Indigenous people is more than subsistence economy; it involves the explicit cultural integration between nature and people, a respectful bond based on interdependency (Adelson, 2000; Hart, 2010; Simpson, 2011). For example, the Cree notion of sustainable well-being is defined by the term *mino-pimatisiwin* which means good life (Hart, 2002). It is an understanding based on sharing and tied with reciprocity with nature, balance, growth, and spirituality-some asset components that guide Cree community and individuals towards sustainable, healthy and healinglifecycle (ibid, 105). Any injustice related to this system, thus, is injustice to the people, their community and "upon Creation itself" (Mcgregor, 2009, p. 28 quoted in Connelly, Markey & Roseland, 2011, p. 43). This takes the Indigenous perception of sustainable livelihood beyond the classical notion of asset and capital defined in SLF.

With the growing acknowledgement of Indigenous knowledge and Indigenous worldview, the need for incorporating cultural viewpoints of livelihoods is more important than ever. Studies concerning Indigenous well being, sovereignty, culture and livelihoods in Canada are unfolding alarming sustenancecriseswhich need immediate attention (Frasera, Dougilla, Mabeeb, Reeda,& McAlpinec, 2006; Capistrano & Charles, 2012; Thompson, Gulrukh, Ballard, Beardy,, Islam, Lozeznik,& Wong, 2011; Thompson,Kamal, Wiebe, & Alam, 2012; Thompson& Ballard, 2013; Kamal et al., 2014; Parlee, 2015). However, it is important to realize that the gap in SLF will not be fulfilled until cultural integration in Indigenous livelihoods is meaningfully infused in such studies. Moreover, as Wilshusen (2014) said, any form of capital associated with human livelihood must challenge the dual nature of the term, essentially because of its ties with capitalist resource-led economy (p. 140).

Methodology:

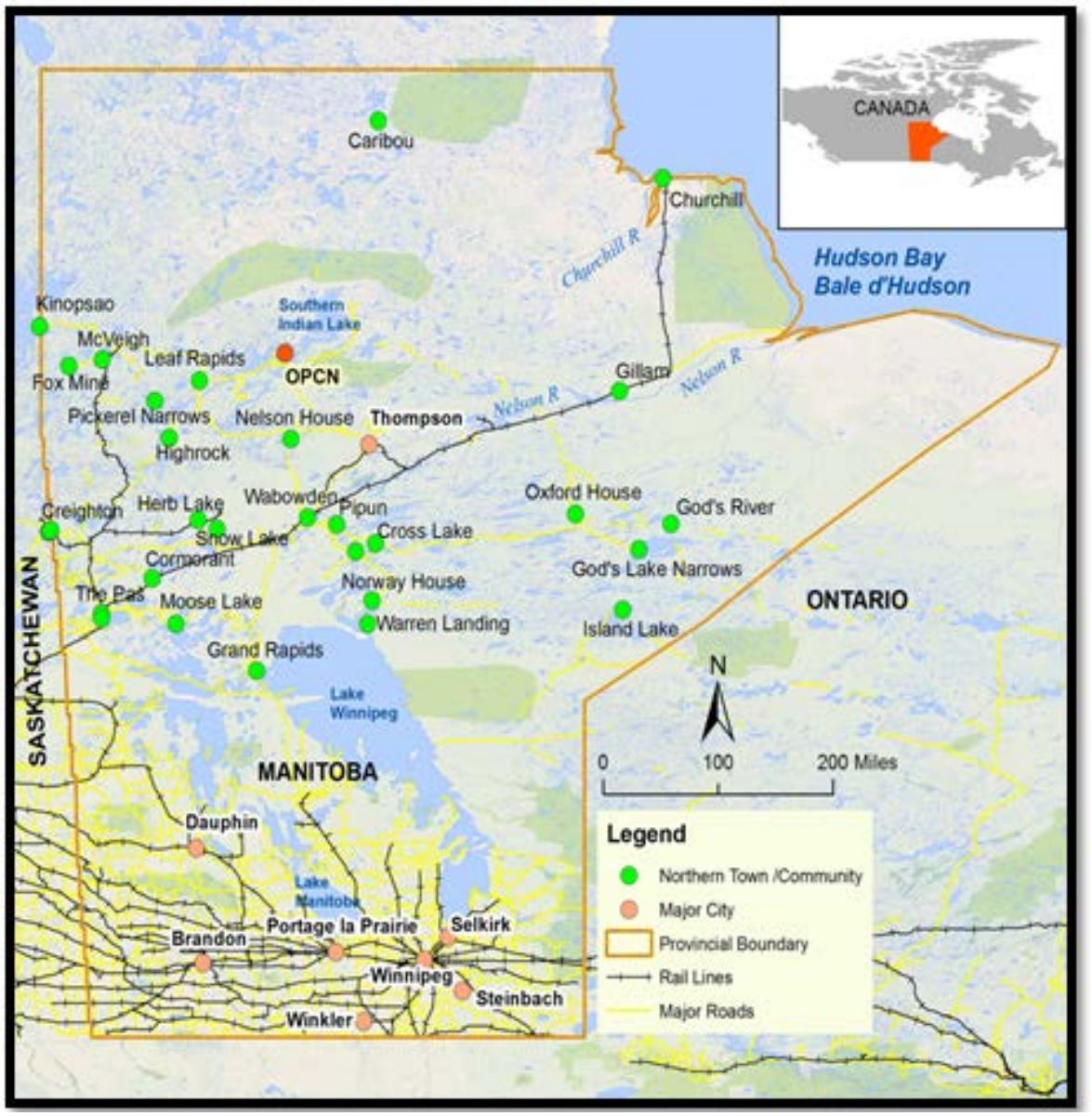
The study with OPCN is guided by Indigenous research methodology. Indigenous research methodology is founded on "relational accountability" and collective, collaborative way of acquiring knowledge (Kovach, 2005; Wilson, 2008; Hart, 2010, p. 9). Through relational

accountability, there is an acknowledgment that relationships exist between researchers and participants, but also to the land, water and beyond. Simpson provides five stages of Indigenous research: collaboration, consensual decision -making, apprenticeship with Elders and seeking out community experts and learning by doing (Simpson, 2000, p. 173-179).While conducting this study we have followed these steps.

Historically,Indigenous ways of knowing have been affronted and sidelined by western scientific research(Smith, 1999; Wilson, 2008; Hart, 2010). In contemporary academia, ethical and scholarly rights to Indigenous research aremost often established through OCAP (Ownership, Control, Access and Possession) principles (Schnarch, 2004).Participatory research is an integral part of livelihood studies (Scoon, 2009, p. 172). However, the idea of ethical participatory research is debated and labelled as "tyrannical" (Cooke & Kothari, 2001; Brock, 2002, Scoon, 2009). Indigenous research framework can enrich integration of participatory research in livelihood studies.

The study with OPCN was conducted using anIndigenous research methodology and led by OCAP. One of the objectives of the project was to collaborate with OPCN and to learn from their program and community while creating a local food harvesting and food sharing program to support their *mino-pimatisiwin*, or"good life." The fieldwork was conducted from 2012-2014. During the entire fieldwork period, the project was supervised, led and operated by community Elders and food champions, and a steering committee that was formed for consensual decision-making.

The program provides training on traditional food harvesting and preparation skills. The Elders share stories while teaching youth, thus promoting intergenerational knowledge. Harvested food is shared with low-income families, Elders and diabetes patients once a week. The study was a collaborative initiative between University of Manitoba and OPCN and was part of Asfia Kamal's doctoral research. Knowledge gathered for this paper came out of five years of relationship building with OPCN Elders, adults and youth and participation in traditional food harvesting activities.



(Map source: Kamal et al., 2014, p. 144)

Community history:

OPCN, a remote northern Manitoba Indigenous reserve community, suffered severe flooding caused by the construction of a hydroelectric dam in the region (Waldram, 1988; Hoffman, 2008; Kamal et al., 2014;Kamal et al., 2015) The flooding resulted in relocation of the community, disassociation from land-based culture, reduced access to wild food, unemployment, inadequate housing and health services (Thompson et al., 2011; Kamal et al., 2014; Kamal et al. 2015). Poverty, health crisis, food insecurity are major issues in the community (ibid). Despite these challenges, OPCN continues to practice their land-based culture by passing on knowledge to the youth (Kamal et al.,, 2014; Kamal et al., 2015). In order to do so, they have been participating in land-based activities through seasonal traditional gatherings. In 2013, a community-based food-harvesting program called *Ithinto Mechisowin* Program (IMP), which means food from the land, was created. The program was envisioned and planned solely by OPCN. It started with the in-kind support from community members and community based organizations and later received some funding from non-governmental organizations (ibid).

OPCN's livelihoods perspective:

It has been argued, specifically for food studies, that using traditional languages helps present a more complete story of the experiences of a community (Power, 2008). OPCN's way of living revolves around four major concepts, presented in this paper in their Cree language. They are; *Kistihdiminowok*, which means the foundation of relationship is respect. The concept describes a practice in the community that all living and natural beings are related to each other based on how they respect each other. *Okanatawewoh* is the second concept that indicates the major principle of understanding that a respectful relationship includes taking care of Mother Nature. The word refers to someone who responsibly cares for nature. The third concept is *wichihituwin* which explains the idea of resources in the community. The meaning of the word is something that is used to help another being in the community. This explains what people should do to maintain a respectful relationship, and demonstrates the value of caring for and helping others. *Wichihituwin* could be used to describe a number of things, from food to labour to a library or a book. This connotes the culture of being well collectively by the practice of sharing. *Pasekonekewin* is the word that refers to the outcome of the relationship. The word means taking someone by the hand and supporting him/her to stand. The outcome brings strength that helps people to sustain their challenges. Together, these four concepts define *Kakiesipimatisihk* which means "the way we live," or culture. In an ideal situation OPCN would like to have governance that is based on these understandings. The table below shows how IMP activities are enhancing livelihood relationship in OPCN.

Table Two:Enhancing livelihood relationship with IMP

OPCN world view	Concepts in Cree	Relationship	Elaboration	IMP's contribution to livelihoods relationship
Kakiesipimatisihk The way we live , culture of sharing	*Kistihdiminowok* *Respecting each other*	Relationship defined for individual	Individuals use of land and water and food and act towards community need	Bringing in community individuals in the program activities as trainer, volunteer and participants.
	Okanatawewoh *Taking care of Mother nature*	Relationship between a community and nature	Sustainable concept of conservation which means land, water, animals are part of the community	IMP has created a policy that is based on OPCN worldview- for example, harvest what you need and responsibly
	Wichihituwin *Something that helps another person*	Relationship between community, individuals and non-human	Purpose of money, food, labour, office space, book, social support, water, tree, medicine is validated when it is shared to help the other	IMP is contributing to the common culture of sharing. The hunting, fishing, berry picking activities strengthening bond between youth, elders and adults. As a community the IMP office has become a space of social gathering over food and traditional activities.
	Pasekonekewin *Taking someone by the hand and supporting him or her to stand*	Relationship between community, youth and knowledge	Purpose of relationship is to achieve good life and share knowledge with youth by teaching them why the *wichihituwin* concept is needed in a community	Low income families, Elders, single parents, diabetes patients are having access to healthy traditional food, which paves way for physical and mental healing.

Rethinking the Sustainable Livelihoods Approach:

The sustainable livelihood practiced through IMP is a process of well-being through relationships—personal, interpersonal and collective. The only factor or "capital" that matters in the livelihood process is relationship—how the relationship with the world is viewed and how people are taking care of this relationship. Importantly, despite being regarded as having a livelihood disorder and acute poverty, OPCN has dared to start a community initiative with no mention of material capital. As IMP advisor Elder Vivian Moose said, "we need a promise to come together for our future and a name in Cree" (personal communication, 2012).

Certainly, this brings the question of whether Indigenous people are denying the idea of using money for progress. The answer is no. However, they do not place excessive growth and economic advancement as the most essential part of their lives. OPCN people do not care that people are empowered by having enough of the material capitals, but rather what their relationship with the capitals is. Elder Vivian's statement attests to the fact that OPCN's notion of well-being is effective and meaningful only when the economic empowerment contributes to the cultural integrity, peoplehood and self-determination (Corntassel, 2012). Hence, even the metaphorical association of the term capital to assess their livelihood can be foreign and disempowering for them.

If we replace the term capital with the term relationship we bring about all possible answers to the livelihood wheel—relationships with society (community, land, water, animals), relationships with humans (how people use their labour for collective being), relationships with money (what role money is playing to keep the cultural practices) and relationships with nature (how relationships with nature is tied with food, friendship, families and health of nature). Indeed, as Anderson (2000) notes: "We exist because of and for the relationships we hold with everything around us" (p.46). The creation of IMP is the outcome of these relationships, reproduced knowledge that is helping them to heal from existing crises and shock.

OPCN's language in everyday life works as a metaphor that influences people's thoughts and actions. It helps to shape their worldview. For example, during a traditional food preparation workshop in IMP, OPCN food champion Hilda Dysart shared that the Cree word for medicinal Labrador tea is *Mawkopatikwa* which means something to keep forever. If this information were analysed by mainstream livelihoods research considering*Mawkopatikwa* as "natural capital", it would not explain the significance of the name of the medicine, nor why it has thrived for centuries as a medicine or the severity of loss that occurs when these medicines and other traditional food are flooded by hydroelectric dam construction. Establishment of IMP program is reproducing traditional knowledge providing opportunities for relationship.

Contextually, Indigenous livelihood factors should be identified based on their wellbeing perspective: which part of relationship is keeping them well, which relationships are creating barriers to their well-being and most importantly, those relationships that are nourishing their self-determination in the midst of what OPCN people consider to be such social, cultural, political, economic and environmental challenges. The emphasis should be in the process of gaining strength for livelihoods instead of the deficit and crisis aspect. Process is critical to the understanding of Indigenous knowledge and is necessary in understanding Indigenous research. This means SLF should be remodelled and used for assessing livelihoods and changing policies to benefit sustainable, thriving and culturally rich people instead of "maximizing the benefit of the poor, hungry and vulnerable" (Simmons, 2007, p. 29).

For a methodology to be essential to Indigenouscommunities it must be relevant and meaningful

rather than a definition composed of technical terms unrelated and unexplained to the people whose life is being analyzed. Hart (2010) has argued that Indigenous research values must include, in part, "Indigenous control over research, which can be demonstrated by having Indigenous people developing, approving, and implementing the research" (p.9). For example, while discussing sustainable livelihoods through IMP, OPCN people have used the tree as a metaphor to explain their roots, livelihoods and collective wellbeing, with the insight of IMP woven into this paper as a relation and an author.

Conclusion:

Throughout the article we have tried to emphasize that Indigenous livelihood is engraved in cultural practices, sovereignty and self- determination (Corntassel, 2008; Kamal et. al. 2015). For Indigenous peoples, livelihood is sustainable when cultural practices are performed in a sovereign land and the livelihood methods are self-determined. OPCN started IMP without little outside "capital" and started to work towards their self-determined needs using existing and new relationships in the community. IMP pave ways for livelihoods capability beyond capitalist aspirations, even within modern state regimes. This highlights the strength of culturally relevant participatory studies based onIndigenous relationships and sense of community.

Finally, our discussion reasserts the importance of enriching the body ofliterature that can invest in the methods of applying SLF for cultural integration of thoughts and making room for ethical, participatory and nonlinear approach. This process is crucial particularly in the era of contemporary colonialism as Indigenous views of sustainability and Indigenousknowledges are continually denied at the international level, withIndigenous sovereignty and cultural rights overshadowed by the state regulations (Corntassel, 2014; Kamal et al. 2015). The lacunae in the Millennium Development Goals, discriminatory modern treaties for Indigenous peoples at the state level are some examples in this context (Corntassel, 2014, p. 69). There is a need, and moreover, a great opportunity for Indigenous research and worldviews to contribute to livelihood analysis as presented by community, and in particular through traditional languages. It is here, that research on livelihood studies should shift and be part of the "decolonization" process (Settee, 2013; Absolon, 2010; Kovach, 2005; Smith, 1999).

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Flood hazard mapping using a nested flood simulation model: A case study of the Jamuna River Basin, Bangladesh

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Introduction

Continental-scale rivers provide benefits such as ship transportation and fishery industries to riverside residents; however, they can also triggers severe flooding disasters. These disasters cause more than just physical damage, as residents also suffer water-borne diseases and hunger due to agricultural losses caused by the flooding. Thus, clarifying the risk of flooding is crucial to the safety of these populations.

The Jamuna River, which flows through Bangladesh, is a typical continental-scale river. Although Bangladesh has several types of flooding including river, tidal, flash and urban floods, we focused on river floods from the Jamuna River in this study. Dyke breach is a serious problem for this river because of the erosion. Large-scale river flooding severely damages residential environments, and floodwater logging takes place during several months. In these situations, residents need information about the precise flooding situation around residential areas and appropriate routes to evacuation locations. It is therefore necessary to understand flooding phenomena on both a district scale and an inter-district scale.

Existing research focuses on flooding of the Jamuna River, and the risk of flooding was analyzed by satellite data (Blasco et al., 1992; Das et al., 2007; Islam et al., 2010) and forecasting (Islam, 2010). Additionally, risks were identified by embankment research (Best et al., 2003; Nakagawa et al., 2013). A study that focused on agricultural damage also exists (Paul, 1984). Risk analysis has also been carried out in relation to sand bar studies (Ashworth et al., 2000; Baki et al., 2012). However, studies conducted using flood simulations are rare. The Flood Forecasting and Warning Center (FFWC) performs flood simulations for the whole of Bangladesh; however, the resolution does not permit detailed descriptions of flood conditions. Therefore, the main objectives of this study are 1) to assess the risk of river flooding from the Jamuna River using a two-dimensional flood simulation model, 2) to map the flood hazard in Gaibadha District.

Methodology

In this study, flooding simulations were conducted using data obtained in 2007, assuming some dike breaches; some cases were simulated. We then analyzed the differences between various simulation results.

2.1. Flood simulation model

The flood model used in this study was a two-dimensional unsteady flow model with rainfall calculated according to a shallow-water equations (JSCE, 1999).

$$\frac{\partial h}{\partial t} + \frac{\partial M}{\partial x} + \frac{\partial N}{\partial y} = q_{rain} - q_{infil} - q_{evapo} \qquad (1)$$

$$\frac{\partial M}{\partial t} + \frac{\partial uM}{\partial x} + \frac{\partial vM}{\partial y} = -gh\frac{\partial H}{\partial x} - \frac{\tau_{xb}}{\rho} \quad (2)$$

$$\frac{\partial N}{\partial t} + \frac{\partial uN}{\partial x} + \frac{\partial vN}{\partial y} = -gh\frac{\partial H}{\partial y} - \frac{\tau_{yb}}{\rho} \quad (3)$$

where h is the water depth (m); M and N are the x- and y-direction fluxes (m2/s), respectively; u and v are velocities in the x- and y-directions (m/s), respectively; H is the water level (m); qrain is the rainfall intensity per unit area (m/s); qinfil is the infiltration capacity per unit area (m/s); qevapo is the amount of evapotranspiration per unit area (m/s); and g is the acceleration due to gravity (m/s2). To solve the equation, this method employed a leap-frog difference scheme using Cartesian coordinates. We also calculated river flow using this two-dimensional flow model.

The Green-Ampt model (Raws et al., 1992) is used to estimate infiltration rate. The basic equation is:

$$f = Ks\left(1 + \frac{Su \cdot IMD}{F}\right) \quad (4)$$

where f is the infiltration rate (m/s), F is the cumulative infiltration depth (m), Su is the average capillary suction at the wetting front (m), IMD is the initial moisture deficit (m/m), and Ks is the saturated hydraulic conductivity (m/s). In the case where there is no water on the ground surface the water volume in the soil (the cumulative infiltration) evaporates via evapotranspiration.

The Thornthwaite method (Thornthwaite, 1948) is used to calculate daily mean potential evapotranspiration, as given in Eqs. (5), (6), and (7).

$$E_p = 0.553D_0\left(\frac{10T_i}{J}\right)^a, J = \sum_{i=1}^{12}\left(\frac{T_i}{5}\right)^{1.514} \quad (5)$$

$$a = 0.000000675J^3 - 0.0000771J^2 + 0.01792J + 0.049293 \quad (6)$$

$$E_a = M \times E_p \quad (7)$$

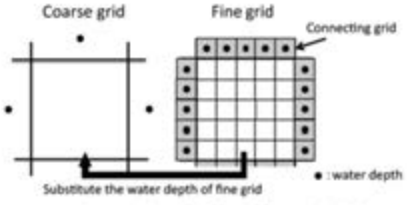


Figure 1 Simplified figure of the nested model

where Ea and Ep (mm/d) are the actual and potential evapotranspiration, respectively; Ti(0c) is the monthly average temperature, J is the heat index, D0 (h/12h) is the potential day duration, and M is the reduction coefficient. We used the monthly average temperature observed in Rampur. The average value is 4.15mm/day.

2.2. Nesting calculation

Nesting calculation methods are well-developed in coastal engineering (Debreu et al. (2008)); however, these methods are rarely utilized in flooding analysis. The nested calculation needs special treatment in the case where dry bed conditions are prevalent. Following a previous study conducted by Takeda et al. (2009), we employed a nested model that used flooding depth for the calculation.

Flooding depth from a coarse grid is assigned to the surrounding grids, and the outputs of each grid are calculated one by one. Then, the calculated output is returned to the boundary of the coarse grid. The calculation method is shown in Figure 1.

Infiltration and evapotransipiration are also considered, using the calculated value in the nested model. In the coarse grid area, neither value is not considered.

About the calculation time step, we applied a different time step to each area. As the model employed leap-frog scheme for the calculation, each parameter of the depth and the flux are exchanged alternately (Figure 2).

2.3. Study area

The Jamuna River basin, which includes the districts of Rampur, Gaibandha and Bogra was chosen for the target area. As a nested area, a flood prone area in Gaibandha was chosen.

Topographical data for the study area were obtained from the Shuttle Radar Topography Mission, with a spatial resolution of 930 m (Figure 3). Daily precipitation data were obtained from the Dewanganj precipitation observatory provided by the Bangladesh Water Development Board. Discharge of the Jamuna River was observed in Bahadurabad observatory. Cross sectional shapes were set from satellite images. Temperature data were obtained from statistical books held by the Department of Meteorology, Bangladesh. The embankment was assumed to be 2 m high, and was set between grids.

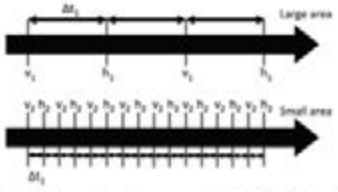


Figure 2 Image of exchange parameter of depth(h) and flux (v) between the large and small calculation area.

Figure 3 Target area. (a) Map of Bangladesh (the rectangle indicated by black lines, located in the central-western section, indicates the large calculation area); (b) large calculation area (the rectangle indicated by black lines, located in the central-west part section, indicates the small calculation area); and (c) small calculation area (the shaded area indicates a small river).

To simulate the flooding due to dyke breaches, we assumed three dyke breach points as indicated in Figure 3. Each point was chosen as a location where the river course nears an embankment. The three case simulations were performed beginning in the south.

Simulation result and validation

3.1. Simulation results and validations

Figure 6 shows a comparison between a simulation result and a satellite image. The simulation result showed good agreement on the flooding extent; however, some areas demonstrated overestimation and underestimation.

In the part of (A) in Figure 6, the simulation results underestimated the flooding extent, which may be due inaccuracies in the rainfall data. Because the model uniformly considers the rainfall observed at Dewanganj, some areas were influenced by this consideration method for the rainfall data. In particular, the south part of the Megaraya Mountains was underestimated because the rainfall intensity is high in that area.

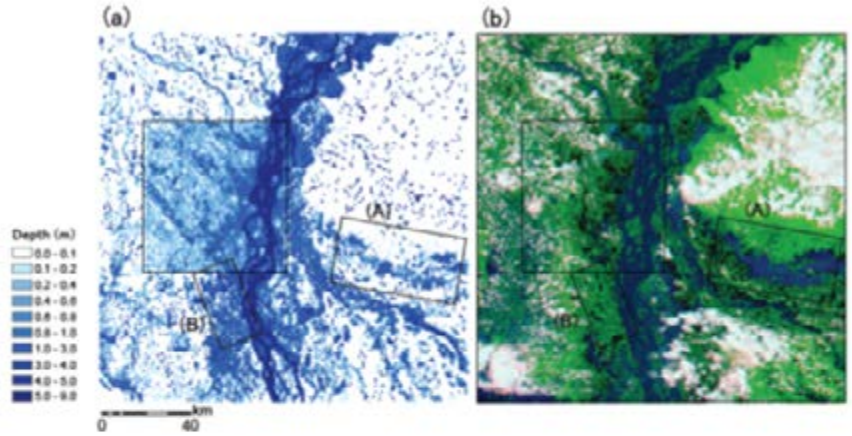


Figure 5 Simulation result and satellite image for August 3 2007

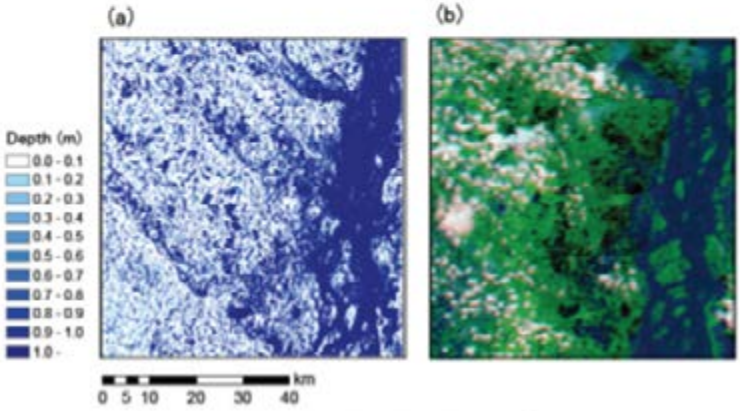


Figure 6 Simulation result and satellite image for August 3, 2007

In the part of (B), overestimations were observed, which may be due to the consideration method for the dyke height and the riverbed elevation. In this study, because the model did not consider any dyke breaches, flooding extent was underestimated for several flooding areas. In addition, owing to the overestimated riverbed elevation, the model overestimated the flooding extent. Changes in the riverbed elevation were reported by Ashworth et al. (2000), simulating these riverbed changes could lead to improved results.

3.2. Simulation result and validation in the nested area

Figure 5 shows a comparison between a nested simulation model result and a satellite image. Fine grids enable the model to delineate the flooding extent more precisely, and the results showed good agreement with the satellite image in this area. The flooding areas that showed a high flooding depth were simulated well; however, there are small flooding areas that can only be observed in the simulation result. To improve the simulation accuracy, the model should consider drainage systems in this area. In this case, the calculation time was 10 times smaller than or the case where fine grids were used for whole area.

Hazard mapping

4.1. Frequency Analysis

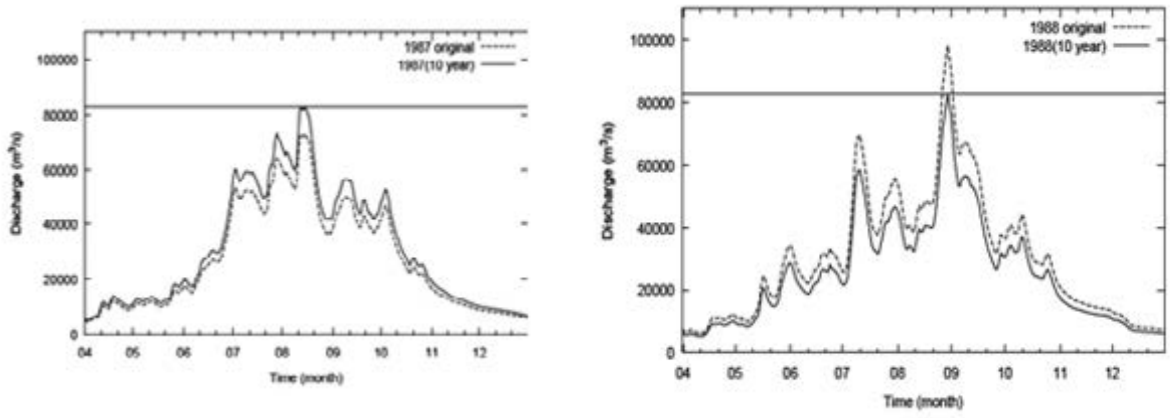
Normally, the discharge data for different return periods are produced conducting rainfall-runoff analysis based on the rainfall data for each of the return periods. However, we used an alternative method because the Jamuna River basin is quite large and a collecting hydrological data set is difficult..

First, we statistically analyzed the peak discharge at Bahadurabad observatory using the past data from 1960 to 2011. Table 1 shows the peak discharge values that were obtained by the frequency analysis.

Second, hydrograph patterns were selected from the years that witnessed significant flood damage such as 1987, 1988, 1998, and 2004. In order to choose the hydrograph pattern indicating most severe flooding, we conducted tentative flood analyses using edited hydrographs that were adjusted to fit the peak value equaling a 10-years return period. The multiplying factors were calculated by multiplying the peak values of each hydrograph and the peak value for a 10-years return period with the mean daily discharge values (Figure 8).

Table 1 Value of parameter for return period

	Return Period				
Year	2.33	10	20	50	100
Discharge(m3/s)	66553.02	82594.26	88759.18	96251.77	101544.2



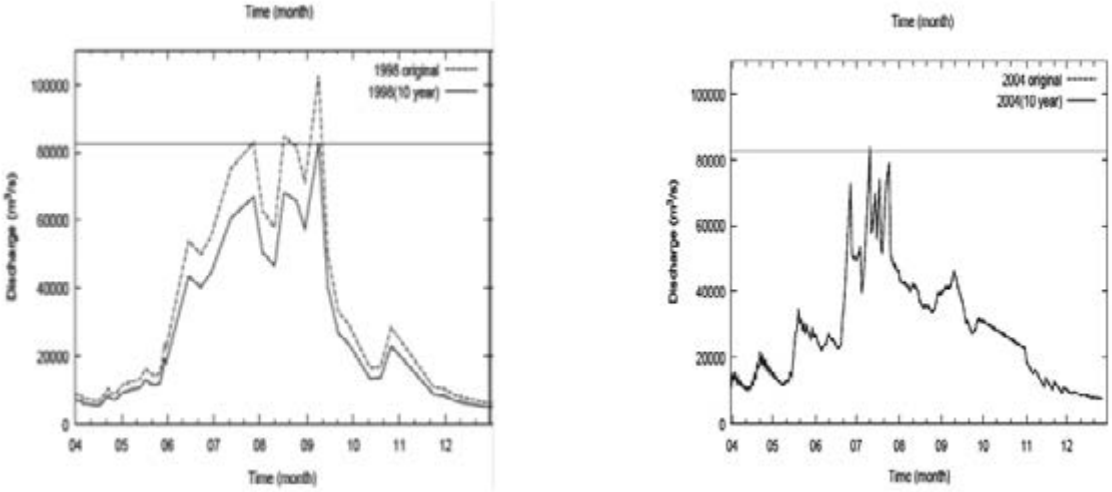
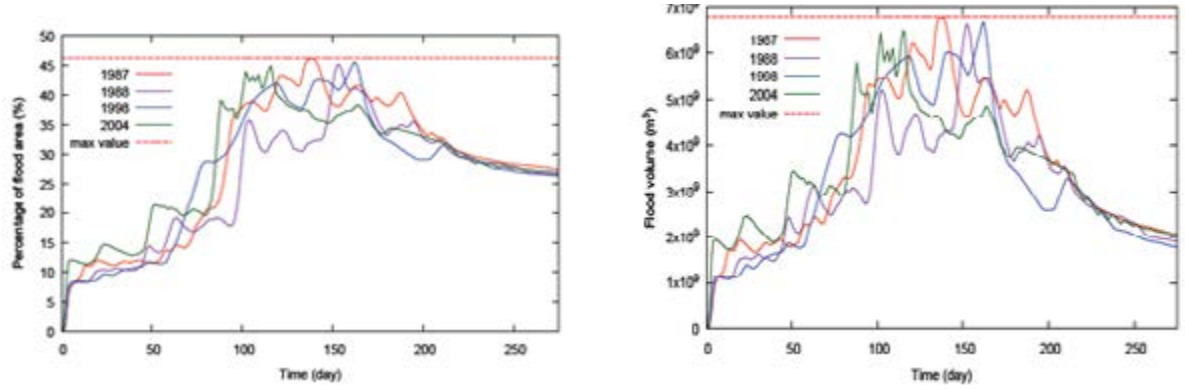


Figure 8 Selected hydrograph pattern



Calculations were performed for 275 days: from April 1 to December 31. Most severe flooding was observed in the case of discharge of 1987 (Figure 7). For this year, the percentage of the flooding area and the flood volume showed the highest value. Peak discharge continued to be observed for several days in 1987, and the hydrograph for this year thus represented the most severe flooding conditions. In the case of other hydrographs, peak discharge was not maintained for more than two days.

Finally, the external forces for flood simulations were obtained for all the return periods (Figure 10). The multiplying factors were: 0.91 for 2.33 years, 1.13 for 10 years, 1.22 for 20 years, 1.32 for 50 years and 1.39 for 100 years.

4.2. Flooding simulation result using return period

The hydrographs that were produced by the flood frequency analysis were applied to the Jamuna River to assess the hazard for Gaibandha District. For this purpose, rainfall was not considered to affect the analysis of flooding. In addition, evapotranspiration and infiltration were also not considered for evaluating the hazard.

Figure 11 Comparison with the flood volume of each return period.

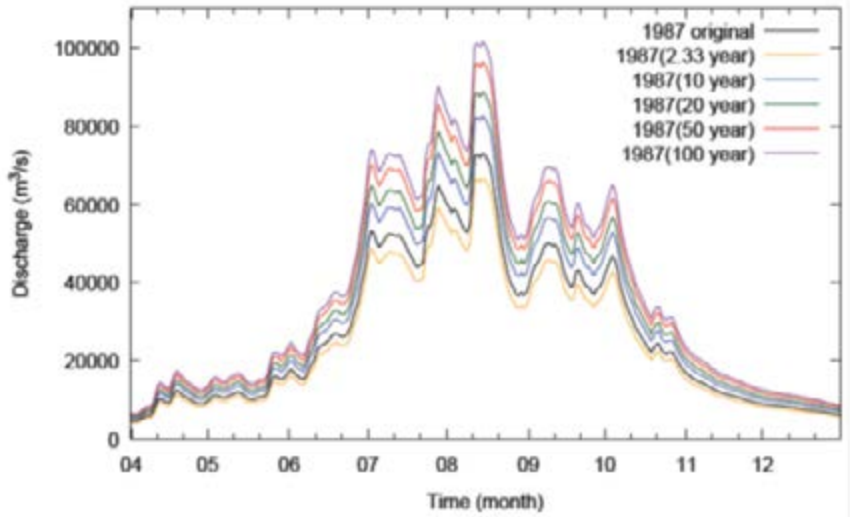


Figure 10 Discharge of each return period

Figure 13 shows the results of flooding simulation for all the return periods. Each figure shows the peak flood condition that resulted on 137th day from the start of the calculation. The differences in the extent and depth of flooding were obtained from the figures. This difference can be obtained from the flooding volume of the nested area as well (Figure 12).

In the case of a 2.33-years return period, a flooding area with a depth of 4-6 m was identified; however, the flooding was intermissive. On the other hand, the flooded areas in the case of 10-, 20-, and 50-years return periods, indicated continuous flooding. The data not only indicated the differences in the flooding depths but also in the flow velocities existing in the area.

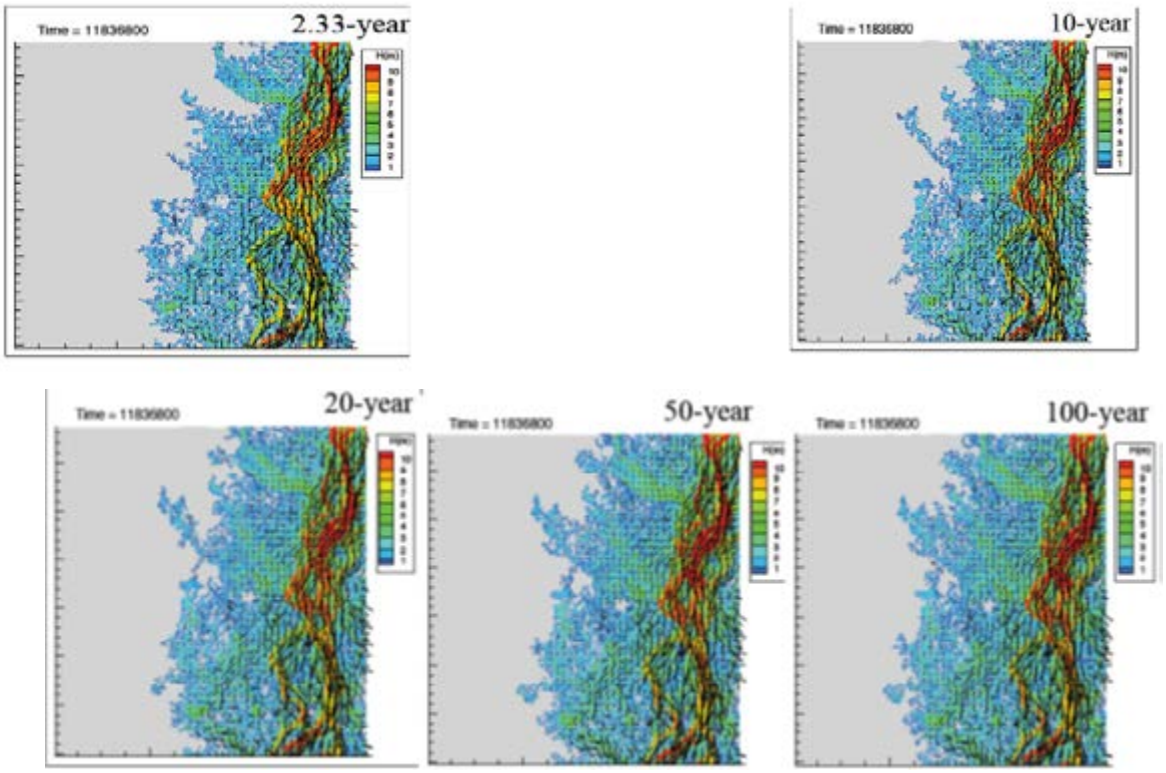


Figure 13Result of flooding simulation using each return period .

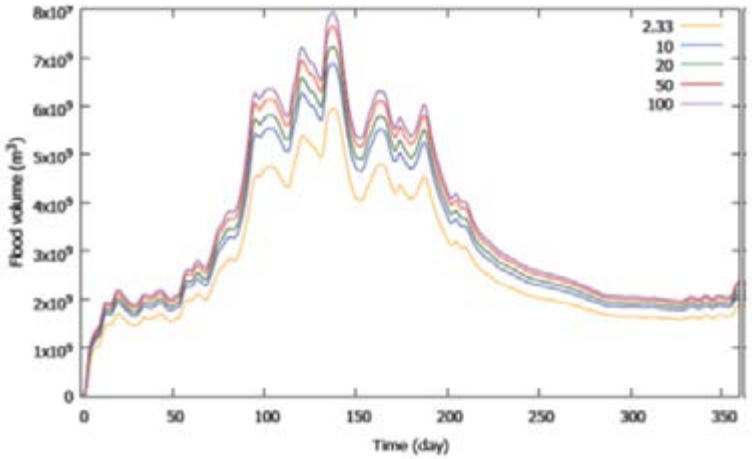


Figure 12 Flooding volume of the nested area.

In terms of flow velocity and direction, some parts showed a high velocity exceeding 1.0 m/s. In such situations, therefore, it would be difficult for the people to evacuate on foot. Evacuation by boats would also be challenging since the flow velocity and direction will affect the procedure.

One of the main limitations in terms of the abatement of fooding hazards is predicting the correct height of embankments and dyke breaches. The location of an embankment can be identified from a map, but the information regarding its height is hard to obtain.

4.3. Hazard mapping with a 100-years return period

Figure 14 shows a flood hazard map that was prepared based on the flood analysis for a 100-years return period. In this figure, high flow-velocity areas, embankments, main roads, and locations of hospitals are delineated in addition to the flooding depths.

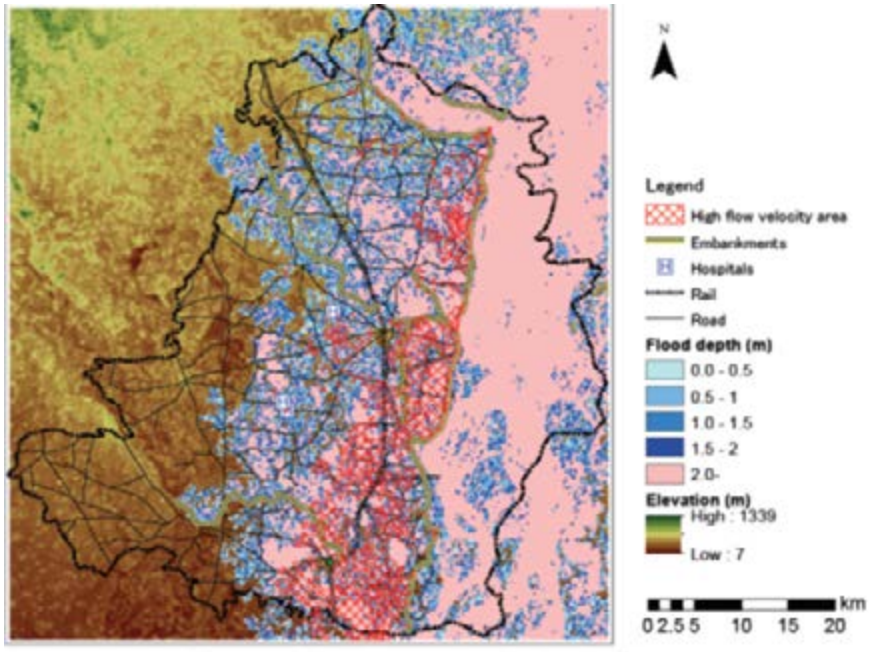


Figure 14 Hazard maping in Gaibandha District.

The areas with more than 0.4 m/s flow velocity were marked as high flow-velocity areas. The thresholds of flow velocity for evacuation by walking and boating were tentatively decided;

however, they would need to be reevaluated based on the actual circumstances and means of evacuation at the time of flooding. In this study, dyke breaches were not considered and the height of embankments was uniformly set as 2 m. The settings for embankments will thus need to be reconsidered in future research.

CONCLUSIONS

We conducted a flood simulation exercise for the Jamuna River. The results showed good agreement with the actual extent of flooding and the nested flood simulation model successfully simulated the flooding. Furthermore, this method has the advantage of lower calculation costs involved. Our work, thus, demonstrated the potential usefulness of this nesting calculation method. In addition, the risk assessment in terms of water depth, the risks associated with flow velocities and flow directions were also assessed for the populations in this area rely on boats for evacuation.

Using the model, the hazard in Gaibandha District due to flooding in the Jamuna River was assessed. A flood frequency analysis was conducted, and flood conditions for different return periods were predicted.

For a more accurate simulation, the following factors should be considered; 1) the elevation of the riverbed to evaluate the water level in the Jamuna River, 2) locations of dyke breaches, 3) an appropriate embankment height, 4) rainfall data considering a detailed spatial distribution, and 5) appropriate land uses to calculate infiltration. Furthermore, some of the parameters, such as the riverbed and riverbank, should be calculated in parallel because these parameters change with changes in the water flow.

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Best Paper Awardees

Paper Title: *Flood hazard mapping using a nested flood simulation model: A case study of the Jamuna River Basin, Bangladesh*

Authors: Masakazu Hashimoto, Kenji Kawaike, Arpan Paul, MashfiqusSalehinand Hajime Nakagawa

Masakazu Hashimoto presenting the paper

Paper Title:*Participatory modelling for conceptual system dynamic model of social-ecological system in Bangladesh delta*

Author: Md. SarwarHossain

Md. SarwarHossain receiving the award from the Chief Guest Mr. Kazi Anis

Glimpses of the International Conference on Sustainable Development (ICSD) 2016

Dr. A. Mustaque Chowdhury, Vice Chair, BRAC
Conference Inaugural Speaker

Conference Speakers, Guests, and Paper presenters

Professor Imran Rahman, Vice Chancellor of University of Liberal Arts Bangladesh

Chair of International Conference on Sustainable Development 2016

Professor Dr. Samsul Alam (Member, GED, Planning Commission, Government of Bangladesh), Prof. Dr. Rezaur Rahman (IWFM, BUET), Dr. Taibur Rahman (GED Planning Commission) Dr. Hamidul Huq, Professor & Director (Center for Sustainable Development, ULAB)

Professor Imran Rahman is handing over the crest to Conference Closing Speaker, Dr. Saleemul Huq, Director, ICCCAD, IUB

Chief Guest, Kazi Nabil Ahmed, M. P Member, ULAB board of Trustees handing over "Best paper Award to Md Sarwar Hossain

Conference Closing Session

Media Coverage

Speakers are seen at the conference.

International Conference on Sustainable Development Commences at ULAB

BUSINESS DESK

DHAKA: A two-day International Conference on Sustainable Development (ICSD) is going to commence tomorrow at the University of Liberal Arts Bangladesh (ULAB) Auditorium, Dhanmondi, Dhaka. A press conference was held yesterday at the ULAB auditorium to make the announcement about the conference.

Organized by Center for Sustainable Development (CSD) at the University of Liberal Arts Bangladesh (ULAB), the aim of the conference is to identify and share empirical research findings and/or practical, evidence-based solutions that can support the Sustainable Development Goals (SDGs). The conference will provides a unique opportunity to bring together stakeholders from the government, academia, international agencies, NGOs, and grassroots organizers to share practical solutions towards the achievement of more sustainable and inclusive societies.

This year's conference will be based on 12 themes: Gender and SDGs, Sustainable Agriculture and Food Security, Sustainable Livelihoods, Integrated Water Resource Management; Migration; Climate Change Adaptation; Coastal Zone Management, Disability and SDGs, Green Cities and Human Settlements, Public Health and Nutrition, Business and Sustainability, and Disaster Management. The conference will feature a total of 34 research paper presentations that has been selected from 100 applications.

The inaugural speech at the conference delivered by Dr. A Mustaque R Chowdhury, Vice Chair of BRAC, and a Professor of Population and Family Health at the Mailman School of Public Health, Columbia University, USA. Other speakers will be present at the conference include Margreet Zwarteveen, Professor of Water Governance at UNESCO-IHE, The Netherlands; Dr. Boris Braun, Professor of Human and Economic Geography, Department of Geography, University of Cologne; Rajib Shaw, Professor at the Graduate School of Global Environmental Studies, Kyoto University, Japan; Dr. Mahbuba Nasreen, Director and Professor at the Institute of Disaster Management and Vulnerability Studies, University of Dhaka; E.R. Ninal Gunawardena, Professor of Agricultural Engineering at the University of Peradeniya, Sri Lanka; Dr. Jeroen Warner is the Associate Professor Sociology of Development and Change Group at Wageningen University and Research Centre (WUR); and Dr. Hamidul Huq, Professor and Director of Center for Sustainable Development (CSD), University of Liberal Arts Bangladesh (ULAB).

ULAB confce on sustainable dev today

CITY DESK

A two-day international conference on Sustainable Development will be held today at the University of Liberal Arts Bangladesh (ULAB) in the capital's Dhanmondi, said a press release.

Organised by Center for Sustainable Development (CSD) at ULAB, the conference aims to identify and share empirical research findings and evidence-based solutions that can support the Sustainable Development Goals (SDGs).

The inaugural speech will be delivered by Dr A Mustaque R Chowdhury, Vice-Chair of BRAC and professor of Population and Family Health at the Mailman

Int'l confce on sustainable dev begins at ULAB

A two-day International Conference on Sustainable Development (ICSD) began on Thursday at the University of Liberal Arts Bangladesh (ULAB) Auditorium in city's Dhanmondi area, reports BSS.

Organized by Center for Sustainable Development (CSD) at the University of Liberal Arts Bangladesh (ULAB), the aim of the conference is to identify and share empirical research findings and/or practical, evidence-based solutions that can support the Sustainable Development Goals (SDGs), a press release said.

This year's conference is based on 12 themes: Gender and SDGs, Sustainable Agriculture and Food Security, Sustainable Livelihoods, Integrated Water Resource Management; Migration; Climate Change Adaptation; Coastal Zone Management, Disability and SDGs, Green Cities and Human Settlements, Public Health and Nutrition, Business and Sustainability, and Disaster Management.

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Sustainable Development 2016 at ULAB

International conference on Sustainable Development 2016 was held on February 3 at ULAB. This year's theme of the conference was "Societies on the brink of new challenges of sustainability"

Int'l confce on sustainable development at ULAB

Campus Report

A two-day international conference on Sustainable Development (ICSD) commenced at the University of Liberal Arts Bangladesh (ULAB) Auditorium, Dhanmondi in the capital recently.

Organized by Center for Sustainable Development (CSD) at the University of Liberal Arts Bangladesh (ULAB), the aim of the conference is to identify and share empirical research findings and/or practical, evidence-based solutions that can support the Sustainable Development Goals (SDGs). The conference provides a unique opportunity to bring together stakeholders from the government, academia, international agencies, NGOs, and grassroots organizers to share practical solutions towards the achievement of more sustainable and inclusive societies.

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After the inaugural session, a plenary session was held on "Sustainable Development & National Long-term Plan: Bangladesh Delta Plan 2100."

Dr Rezaur Rahman, Professor of IWFM, BUET was the chairman of this session. Prof Dr Shamsul Alam, Member, GED, Planning Commission, Government of Bangladesh was the chief guest of the plenary session. Dr Alam said that Bangladesh is a rapidly developing country, faces major inter-related delta challenges in water safety, food security and socio-economic development and is prone to natural calamities such as floods, cyclones, and droughts. He wishes, after the recommendation of this conference, it will be helpful to formulate a long term plan for management of the Bangladesh delta.

The closing speech of the conference will be delivered by Dr Saleemul Haq, Senior Fellow, Climate Change Group, International Institute for Environment and Development Director, ICCCAD. A total of 200 participants and observers will partake in this conference.

The Theme Speaker at a 2-day international conference on Sustainable Development at the University of Liberal Arts Bangladesh Auditorium, Dhanmondi in the capital recently.

ULAB
Hosts International Conference on Sustainable Development

SIFAT MOSADDEK BHUIYAN

'Sustainable Development', according to the United Nations, means development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Realising the need to bring about social and economic development that sustains comes from the ambitions set on the success of the Millennium Development Goals (MDGs) and aims to go further to end all sorts of poverty.

Setting goals is one thing, however, and achieving them entirely another. Being familiar with this reality, the Center for Sustainable Development (CSD), at the University of Liberal Arts Bangladesh (ULAB), organised a two-day International Conference on Sustainable Development (ICSD) earlier this month. The aim of the conference was to identify and share empirical research findings and/or practical, evidence-based solutions that can support the Sustainable Development Goals. The conference also provided a unique opportunity to stakeholders – from the government, academia, international agencies, NGOs, and grassroots organisers – to share practical solutions towards the achievement of more sustainable and inclusive societies.

This year's conference was based on 12 themes: Gender and SDGs, Sustainable Agriculture and Food Security, Sustainable Livelihoods, Integrated Water Resource Management, Migration, Climate Change Adaptation, Coastal Zone Management, Disability and SDGs, Green Cities and Human Settlements, Public Health and Nutrition, Business and Sustainability, and Disaster Management. The conference featured a total of 34 research paper presentations that had been selected from 100 applications.

Eminent scholars from around the world participated in the conference to share highly relevant and valuable insights. Dr. A Mustaque R Chowdhury, Vice Chair of BRAC, and Professor of Population and Family Health at the Mailman School of Public Health, Columbia University, USA; Margreet Zwarteveen, Professor of Water Governance at UNESCO-IHE, The Netherlands; Dr. Boris Braun, Professor of Human and Economic Geography, Department of Geography, University of Cologne; Rajib Shaw, Professor at the Graduate School of Global Environmental Studies, Kyoto University, Japan; Dr. Mahbuba Nasreen, Director and Professor at the Institute of Disaster Management and Vulnerability Studies, University of Dhaka; E.R. Nimal Gunawardena, Professor of Agricultural Engineering at the University of Peradeniya, Sri Lanka; Dr. Jeroen Warner, Associate Professor, Sociology of Development and Change Group at Wageningen University and Research Centre (WUR); Dr. Saleemul Haq, Senior Fellow, Climate Change Group, International Institute for Environment and Development Director, ICCCAD; and Dr. Hamidul Huq, Professor and Director of Center for Sustainable Development (CSD), University of Liberal Arts Bangladesh (ULAB), shared their views on issues relevant to effective achievement of Sustainable Development Goals.

A plenary session was also held on 'Sustainable Development & National Long-term Plan: Bangladesh Delta Plan 2100.' Dr. Rezaur Rahman, Professor of IWFM, BUET chaired the session. Professor Dr. Shamsul Alam, Member, GED, Planning Commission, Government of Bangladesh, and chief guest at the session, said that Bangladesh being a rapidly developing country, faces major inter-related delta challenges in water safety, food security and socio-economic development, and is prone to natural calamities such as floods, cyclones and droughts. He expressed hope that the recommendation of this conference will be helpful for formulation of a long-term plan for management of the Bangladesh delta.

A total of 200 participants and observers took part in the conference.

a mentally ill person.

2-day int'l confce on sustainable dev ends at ULAB

The two-day International Conference on Sustainable Development (ICSD) concluded at University of Liberal Arts Bangladesh (ULAB) on Friday, reports UNB.

Center for Sustainable Development (CSD) of the university organised the conference aiming to identify and share empirical research findings or evidence-based solutions that can support the Sustainable Development Goals (SDGs).

The conference brought together stakeholders from the government, academia, international agencies, NGOs, and grassroots organisers to share practical solutions towards the achievement of more sustainable and inclusive societies.

Senior fellow of the International Institute for Environment and Development (IIED) Dr Saleemul Haq spoke at the closing day. A total of 200 participants and observers attended the conference.

কেক কেটে ইউল্যাবের সিএসডির এক দশক পালন

ইউনিভার্সিটি অব লিবারেল আর্টস বাংলাদেশের (ইউল্যাব) টেকসই উন্নয়নবিষয়ক গবেষণা প্রতিষ্ঠান সেন্টার ফর সাসটেইনেবল ডেভেলপমেন্টের (সিএসডি) এক দশক পালন করা হলো গতকাল বুধবার।

২০০৬ সালের ৩ ফেব্রুয়ারি সিএসডি) যাত্রা শুরুর পর থেকেই দেশ-বিদেশের বিভিন্ন বিশ্ববিদ্যালয়, গবেষণা প্রতিষ্ঠান, আন্তর্জাতিক উন্নয়ন সংস্থা, সরকারি-বেসরকারি প্রতিষ্ঠানের সঙ্গে যৌথভাবে গবেষণা কার্যক্রম পরিচালনা করে আসছে।

এক দশক পূর্তি উপলক্ষে গতকাল ১০ পাউন্ডের একটি কেক কাটা হয়। পরে সিএসডি থেকে *প্রকাশিত জেন্ডার ইন অ্যাকোয়াকালচার* বইয়ের মোড়ক উন্মোচন করেন ইউল্যাবের উপাচার্য অধ্যাপক ইমরান রহমান। অনুষ্ঠানে সিএসডির পরিচালক অধ্যাপক হামিদুল হক বলেন, টেকসই উন্নয়নবিষয়ক গবেষণায় ইউল্যাব-সিএসডি বাংলাদেশের অগ্রদূত। সিএসডিতে বর্তমানে আটটি গবেষণা প্রকল্প চলমান রয়েছে। ১৫টি গবেষণা প্রকল্প ইতিমধ্যেই শেষ হয়েছে। বিজ্ঞপ্তি।

ইউল্যাবে টেকসই উন্নয়নবিষয়ক ইন্টারন্যাশনাল কনফারেন্স শুরু

● নিজস্ব প্রতিবেদক

ইউনিভার্সিটি অব লিবারেল আর্টস বাংলাদেশ (ইউল্যাব) অডিটোরিয়ামে দুই দিনব্যাপী ইন্টারন্যাশনাল কনফারেন্স অন সাসটেইনেবল ডেভেলপমেন্ট (আইসিএসডি) গতকাল শুরু হয়েছে। ইউল্যাবের সেন্টার ফর সাসটেইনেবল ডেভেলপমেন্টের (সিএসডি) উদ্যোগে এই ইন্টারন্যাশনাল কনফারেন্স অনুষ্ঠিত হচ্ছে। টেকসই উন্নয়নবিষয়ক বাস্তব অভিজ্ঞতা, তথ্য-উপাত্তনির্ভর গবেষণা ও গবেষণালব্ধ সুপারিশমালা সবার মধ্যে ছড়িয়ে দেয়া সর্বোপরি জাতিসঙ্ঘঘোষিত টেকসই উন্নয়ন লক্ষ্যমাত্রা অর্জনে সহায়ক ভূমিকা পালনের লক্ষ্যে এই কনফারেন্সের আয়োজন করা হয়েছে।

কনফারেন্সে উদ্বোধনী বক্তব্য প্রদান করেন ব্র্যাকের ভাইস চেয়ারম্যান এবং যুক্তরাষ্ট্রের কলাম্বিয়া বিশ্ববিদ্যালয়ের মেইলম্যান পপুলেশন অ্যান্ড ফ্যামিলি হেলথের অধ্যাপক ড. এ মুশতাক আর চৌধুরী। অনুষ্ঠানে অন্যদের মধ্যে বক্তব্য দেন নেদারল্যান্ডসের ইউনেস্কো আইএইচই ও আমস্টারডাম বিশ্ববিদ্যালয়ের ওয়াটার গভর্নেন্সের অধ্যাপক ড. মার্গারেট জুয়ার্টাভেন, জার্মানির ইউনিভার্সিটি অব কোলনের জিওগ্রাফি বিভাগের অধ্যাপক ড. বোরিস ব্রাউন, জাপানের কিয়োটো বিশ্ববিদ্যালয়ের গ্লোবাল এনভায়রনমেন্টাল স্টাডিজের অধ্যাপক ড. রাজিব শ, ঢাকা বিশ্ববিদ্যালয়ের ইনস্টিটিউট অব ডিজাস্টার ম্যানেজমেন্ট অ্যান্ড ভালনারেবিলিটি স্টাডিজের পরিচালক অধ্যাপক ড. মাহবুবা নাসরিন, শ্রীলঙ্কার ইউনিভার্সিটি অব প্যারাডেনিয়ার এগ্রিকালচার ইঞ্জিনিয়ারিং বিভাগের অধ্যাপক ই আর নিমাল চন্দ্রাওয়ারদেনা, নেদারল্যান্ডসের ওয়াগেনিংগেন ইউনিভার্সিটি অ্যান্ড রিসার্চ সেন্টারের (ডব্লিউইউআর) সোশিওলজি অব ডেভেলপমেন্ট অ্যান্ড চেঞ্জ গ্রুপের অধ্যাপক ড. জেরোন ওয়ার্নার এবং ইউল্যাবের সেন্টার ফর সাসটেইনেবল ডেভেলপমেন্টের (সিএসডি) পরিচালক ও কনফারেন্সের আহ্বায়ক অধ্যাপক ড. হামিদুল হক।

'টেকসই উন্নয়ন ও জাতীয় দীর্ঘ মেয়াদি পরিকল্পনা : বাংলাদেশ ডেল্টা প্ল্যান-২১০০' বিষয়ক একটি প্ল্যানারি সেশন অনুষ্ঠিত হয়। এতে প্রধান অতিথি ছিলেন পরিকল্পনা কমিশনের সাধারণ অর্থনীতি বিভাগের সদস্য অধ্যাপক ড. শামসুল আলম।

এ কনফারেন্সে যুক্তরাজ্য, কানাডা, নেদারল্যান্ডস, জার্মানি, জাপান, ভারত, শ্রীলঙ্কা ও বাংলাদেশসহ বিভিন্ন দেশের প্রায় ২০০ জন শিক্ষাবিদ, গবেষক, সম্প্রসারণকর্মী, সমাজকর্মী ও উচ্চ শিক্ষার্থীরা অংশ নিয়েছেন।

Speakers are seen at the conference.

International Conference on Sustainable Development Commences at ULAB

BUSINESS DESK

DHAKA: A two-day International Conference on Sustainable Development (ICSD) is going to commence tomorrow at the University of Liberal Arts Bangladesh (ULAB) Auditorium, Dhanmondi, Dhaka. A press conference was held yesterday at the ULAB auditorium to make the announcement about the conference.

Organized by Center for Sustainable Development (CSD) at the University of Liberal Arts Bangladesh (ULAB), the aim of the conference is to identify and share empirical research findings and/or practical, evidence-based solutions that can support the Sustainable Development Goals (SDGs). The conference will provides a unique opportunity to bring together stakeholders from the government, academia, international agencies, NGOs, and grassroots organizers to share practical solutions towards the achievement of more sustainable and inclusive societies.

This year's conference will be based on 12 themes: Gender and SDGs, Sustainable Agriculture and Food Security, Sustainable Livelihoods, Integrated Water Resource Management; Migration; Climate Change Adaptation; Coastal Zone Management, Disability and SDGs, Green Cities and Human Settlements, Public Health and Nutrition, Business and Sustainability, and Disaster Management. The conference will feature a total of 34 research paper presentations that has been selected from 100 applications.

The inaugural speech at the conference delivered by Dr. A Mustaque R Chowdhury, Vice Chair of BRAC, and a Professor of Population and Family Health at the Mailman School of Public Health, Columbia University, USA. Other speakers will be present at the conference include Margreet Zwarteveen, Professor of Water Governance at UNESCO-IHE, The Netherlands; Dr. Boris Braun, Professor of Human and Economic Geography, Department of Geography, University of Cologne; Rajib Shaw, Professor at the Graduate School of Global Environmental Studies, Kyoto University, Japan; Dr. Mahbuba Nasreen, Director and Professor at the Institute of Disaster Management and Vulnerability Studies, University of Dhaka; E.R. Ninal Gunawardena, Professor of Agricultural Engineering at the University of Peradeniya, Sri Lanka; Dr. Jeroen Warner is the Associate Professor Sociology of Development and Change Group at Wageningen University and Research Centre (WUR); and Dr. Hamidul Huq, Professor and Director of Center for Sustainable Development (CSD), University of Liberal Arts Bangladesh (ULAB).

ইউল্যাবে টেকসই উন্নয়নবিষয়ক ইন্টারন্যাশনাল কনফারেন্স শুরু

● নিজস্ব প্রতিবেদক

ইউনিভার্সিটি অব লিবারেল আর্টস বাংলাদেশ (ইউল্যাব) অডিটোরিয়ামে দুই দিনব্যাপী ইন্টারন্যাশনাল কনফারেন্স অন সাসটেইন্যাবল ডেভেলপমেন্ট (আইসিএসডি) গতকাল শুরু হয়েছে। ইউল্যাবের সেন্টার ফর সাসটেইন্যাবল ডেভেলপমেন্টের (সিএসডি) উদ্যোগে এই ইন্টারন্যাশনাল কনফারেন্স অনুষ্ঠিত হচ্ছে। টেকসই উন্নয়নবিষয়ক বাস্তব অভিজ্ঞতা, তথ্য-উপাত্তনির্ভর গবেষণা ও গবেষণালব্ধ সুপারিশমালা সবার মধ্যে ছড়িয়ে দেয়া সর্বোপরি জাতিসঙ্ঘঘোষিত টেকসই উন্নয়ন লক্ষ্যমাত্রা অর্জনে সহায়ক ভূমিকা পালনের লক্ষ্যে এই কনফারেন্সের আয়োজন করা হয়েছে।

কনফারেন্সে উদ্বোধনী বক্তব্য প্রদান করেন ব্র্যাকের ভাইস চেয়ারম্যান এবং যুক্তরাষ্ট্রের কলাম্বিয়া বিশ্ববিদ্যালয়ের মেইলম্যান পপুলেশন অ্যান্ড ফ্যামিলি হেলথের অধ্যাপক ড. এ মুশতাক আর চৌধুরী। অনুষ্ঠানে অন্যদের মধ্যে বক্তব্য দেন নেদারল্যান্ডসের ইউনেস্কো আইএইচই ও আমস্টারডাম বিশ্ববিদ্যালয়ের ওয়াটার গভর্নেন্সের অধ্যাপক ড. মার্গারেট জুয়ার্টাভেন, জার্মানির ইউনিভার্সিটি অব কোলনের জিওগ্রাফি বিভাগের অধ্যাপক ড. বোরিস ব্রাউন, জাপানের কিয়োটো বিশ্ববিদ্যালয়ের গ্লোবাল এনভায়রনমেন্টাল স্টাডিজের অধ্যাপক ড. রাজিব শ, ঢাকা বিশ্ববিদ্যালয়ের ইনস্টিটিউট অব ডিজাস্টার ম্যানেজমেন্ট অ্যান্ড ভালনারিবিলিটি স্টাডিজের পরিচালক অধ্যাপক ড. মাহবুবা নাসরিন, শ্রীলঙ্কার ইউনিভার্সিটি অব প্যারাদেনিয়ার এগ্রিকালচার ইঞ্জিনিয়ারিং বিভাগের অধ্যাপক ই আর নিমাল গুনাওয়ারদেনা, নেদারল্যান্ডসের ওয়াগেনিংগেন ইউনিভার্সিটি অ্যান্ড রিসার্চ সেন্টারের (ডব্লিউইউআর) সোশিওলজি অব ডেভেলপমেন্ট অ্যান্ড চেঞ্জ গ্রুপের অধ্যাপক ড. জেরোন ওয়ার্নার এবং ইউল্যাবের সেন্টার ফর সাসটেইনেবল ডেভেলপমেন্টের (সিএসডি) পরিচালক ও কনফারেন্সের আহ্বায়ক অধ্যাপক ড. হামিদুল হক।

'টেকসই উন্নয়ন ও জাতীয় দীর্ঘ মেয়াদি পরিকল্পনা : বাংলাদেশ ডেল্টা প্ল্যান-২১০০' বিষয়ক একটি প্ল্যানারি সেশন অনুষ্ঠিত হয়। এতে প্রধান অতিথি ছিলেন পরিকল্পনা কমিশনের সাধারণ অর্থনীতি বিভাগের সদস্য অধ্যাপক ড. শামসুল আলম।

এ কনফারেন্সে যুক্তরাজ্য, কানাডা, নেদারল্যান্ডস, জার্মানি, জাপান, ভারত, শ্রীলঙ্কা ও বাংলাদেশসহ বিভিন্ন দেশের প্রায় ২০০ জন শিক্ষাবিদ, গবেষক, সম্প্রসারণকর্মী, সমাজকর্মী ও উচ্চ শিক্ষার্থীরা অংশ নিয়েছেন।

10 Years of CSD

ULAB launched the Center for Sustainable Development (CSD) on 3rd February 2006 to carry out research pertaining to sustainability and to serve the national interests. CSD is dedicated to interdisciplinary research which unfolds the complexities of development and explores practices of sustainable development. CSD's interdisciplinary researches contribute strengthening ULAB's Liberal Arts teaching, and attaining UN Sustainable Development Goals (SDGs) in Bangladesh.CSD's strengths are rooted in its multidisciplinary team as well as academics, researchers, and scientists from ULAB's research centers and academic departments and partnerships with other knowledge institutions. CSD envisions a knowledge-based society. The University of Liberal Arts Bangladesh (ULAB) believes in working towards sustainable development practices in Bangladesh.

In the last 10 years CSD has grown from being a small institute at the heart of social research on sustainability to a large center with research capacities in designing sustainable projects, conducting qualitative research and contributing to the policy process. CSD recognizes that all societies struggle with heterogeneities, conflicts and complexities of development and thus require special efforts to develop knowledge-based societies.CSD's research and academic initiatives have attempted to address these ambiguities in knowledge – from positively impacting people's livelihoods, using new and traditional practices, and effecting national sustainable development policies.CSD is devoted to interdisciplinary research, quality teaching, producing and disseminating knowledge, establishing networks with universities and research centers for collaborative research, and organizing actions to promote the greening of Bangladesh.

CSD runs its research projects in partnership with Bangladesh Government, public and private universities, foreign universities and research centers, business sector institutions, finance sector institutions, foreign missions in Bangladesh, and national/international NGOs. The research contributes to policy processes ensuring sustainable development. Research findings are used for quality teaching of all disciplines as well as strengthening capacity of the faculty members.The center is run by a multidisciplinary team under leadership of its director, accountable to the Vice Chancellor of ULAB. CSD is enriched in its values, philosophical ideas, policy guidelines and strategic moves with advice and knowledge sharing by the ULAB Board of Trustees.

The first International Conference on Sustainable Development was launched along with the completion of 10 years of CSD. As a pioneering center dedicated to sustainability, in the next decade CSD hopes to reinvent and establish itself at the forefront of research in Bangladesh and the world.

10 Years of **ULAB** Center for Sustainable Development

Center for Sustainable Development (CSD) of University of Liberal Arts Bangladesh (ULAB) celebrated one decade of establishment. The Center for Sustainable Development (CSD) was officially launched on 3rd February, 2006 as the first research center of ULAB. CSD is dedicated in interdisciplinary research with central notions to explore and document practices of sustainable development. CSD's research and academic initiatives attempt to contribute in addressing the ambiguities in knowledge world starting from people's livelihoods to sustainable development processes.

Director of the CSD, Prof. Dr. Hamidul Huq informed that UN has declared Sustainable Development Goals (SDGs) in 2015. ULAB CSD was established in 2006. Therefore, ULAB CSD is the pioneer for sustainability research in Bangladesh. Dr. Huq also mentioned that 08 research projects is now going on, 15 research projects have already been completed. After the findings on those research projects, 31 papers and books has already been published in national and international journals.

A newly published book of CSD namely "Gender in Aquaculture" was launched also at this celebration. University VC Prof. Imran Rahman, Members of BOT, distinguished guests from home and abroad and students joined that ceremony.

10 yrs of ULAB centre for sustainable dev

Guests and participants pose for a photograph at a programme of 10 years celebration of ULAB Centre for Sustainable Development on the university campus in the capital on February 3. PHOTO: COURTESY

Centre for Sustainable Development (CSD) of University of Liberal Arts Bangladesh (ULAB) celebrated its one decade of establishment on February 3, says a press release.

Founded in 2004, ULAB has established itself as a top-tier private university in Bangladesh. The Centre for Sustainable Development (CSD) was officially launched on February 3, 2006 as the first research centre of ULAB. Director of the CSD Professor Dr Hamidul Huq informed that UN has declared Sustainable Development Goals (SDGs) in 2015. ULAB CSD has been established in 2006. Therefore, ULAB CSD is the pioneer for sustainability research in Bangladesh. Dr Huq also mentioned that 8 research projects is now going on, 15 research projects have already been completed. After the findings on those research projects, 31 papers and books have already been published in national and international journals.

ULABCSD releases 'Gender in Aquaculture' on its 10 anniversary

The Center for Sustainable Development (CSD) of University of Liberal Arts Bangladesh (ULAB) celebrated its first decade of establishment on February 3. On the occasion of 10 years of the sustainable development centre, the university launched the centre's latest book titled 'Gender in Aquaculture'.

The Center for Sustainable Development (CSD) was launched on February 3, 2006 as the first research centre of ULAB. CSD is dedicated in interdisciplinary research with central notions to explore and document practices of sustainable development. CSD's research and academic initiatives attempt to contribute in addressing the ambiguities in knowledge world starting from people's livelihoods to sustainable development processes, says a ULAB statement. CSD runs its research projects in partnership with the government, public and private universities, foreign universities and research centres, business sector institutions, finance sector institutions, foreign missions in Bangladesh, and national/international NGOs.

Director of the CSD Professor Hamidul Huq said the research facility is currently working on eight research projects and 15 research projects have already been completed. After the findings on those research projects, 31 papers and books have been published in national and international journals.

Professor Imran Rahman, vice chancellor of ULAB and members of trustee boards, distinguished from home and abroad and students joined that ceremony.

- Youth Desk


CSD
CENTER FOR
SUSTAINABLE
DEVELOPMENT
UNIVERSITY OF LIBERAL ARTS BANGLADESH
10th Year Celebration Of
CSD


ULAB


ULAB
We go Green
CELEBRATION

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