

edited by
Zahidul Islam
Hasan Shafie
Raasheed Mahmood



CULTURE, ADAPTATION AND RESILIENCE

Essays on Climate Change Regime in South Asia

CULTURE/ CLIMATE/ ADAPTATION/ RESILIENCE/ SOUTH ASIA



This book highlights the relevance of anthropological perspectives to climate science. Anthropology has long-standing legacies of studying spatial and temporal processes of human-environment interactions and adaptations. This book, however, comprises a set of research articles reflecting different aspects of climate change impacts, adaptations and sustainability issues in the contexts of South Asia. All the essays extensively surveyed the existing policy priorities, contested issues, and practical challenges of devising successful strategies to bring about equitable access to and maximized use of resources under changing climatic conditions. At large, these articles highlight the relevance of anthropological research and engagements to bring climate science and policy closer to the needs of vulnerable groups living in this region. At the same time, the issues raised in these articles point to substantial gaps in knowledge and perspectives that may be the challenges at the forefront of addressing climate change impacts in South Asia. It is expected that a wide variety of readers including professionals, scholars, and researchers may all alike find this book readable, and of some interest and value.

ZAHIDUL ISLAM is Professor of Anthropology at the University of Dhaka. He is the author of a number of books including 'ANTHROPOLOGY ON THE MOVE: Contextualizing Culture Studies in Bangladesh' and 'ANTHROPOLOGY OF CLIMATE CHANGE: Culture and Adaptation in Bangladesh'. His major areas of research interest include Climate change Adaptation, Natural Resource Management, Ethnicity and Social Exclusion, and Sustainable Development.

HASAN SHAFIE is Professor of Anthropology at the University of Dhaka. He authored several books including 'ANTHROPOLOGY OF CLIMATE CHANGE: Culture and Adaptation in Bangladesh', 'ENDOWED WISDOM: Knowledge of Nature and Coping with Disasters in Bangladesh', 'INDIGENOUS WISDOM: Local Practices for Mitigating Disaster Loss', 'PRACTICING GENDER AND SOCIAL INCLUSION IN DISASTER RISK REDUCTION', 'VOICES FROM AFAR: Assessing the Inclusion of Disable People in Disaster Response' and 'ANTHROPOLOGY ON THE MOVE: Contextualizing Culture Studies in Bangladesh'.

RAASHEED MAHMOOD is Associate Professor at the University of Dhaka. He authored several articles and book chapters. His major areas of research interest include Adaptation and Resilience, Ethnicity and Nationalism, and Development Issues in Postcolonial Era.

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Zahidul Islam
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Raasheed Mahmood

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Bangladesh Climate Change Trust (BCCT)
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and
Department of Anthropology
University of Dhaka

Bangladesh Climate Change Trust (BCCT),
Ministry of Environment and Forests (MoEF) and
Department of Anthropology,
University of Dhaka, Bangladesh.

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**Bangladesh Climate Change Trust (BCCT)
and
Department of Anthropology**

Preface

‘Culture, Adaptation and Resilience: Essays on Climate Change Regime in South Asia’ is an outcome of selected articles presented in the “International Conference on Anthropology, Adaptation and Resilience in Climate Change Regime 2016” held in the University of Dhaka from October 22-23, 2016. The Department of Anthropology at the University of Dhaka organized this conference with an aim to facilitate and bring adaptation thinkers and practitioners together, allowing them to disseminate their knowledge and to learn from each other and to outline relationship between them. The conference was part of an ongoing project on Adaptation and Resilience that the Department of Anthropology at the University of Dhaka successfully conducted in collaboration with the Bangladesh Climate Change Trust of the Ministry of Environment and Forests, Government of the Peoples’ Republic of Bangladesh.

Speakers from around the world joined the conference and shared their experiences on adaptation and resilience in relation to climate change. Eighty four papers had been presented in the conference that prompted debate and stimulated new thinking and challenges while encountering the climate change regime. Of these papers, 16 have been selected to be published in this compilation. A prudent panel of editorial advisors contributed their time and intellectual energy to find out the best papers. The selected papers were sent for peer-reviewing and expert opinions.

The essays in this volume represent some reflective and integrative thinking that is dimmed critical to widen the horizon of dilemmas, debates, and contestations, while incorporating contemporary theoretical and practical challenges of dealing with culture, adaptation and resilience in climate change regime. Contributors to this book collectively provide answers to some critical questions: to what extent the transnational nature of climate change is producing vulnerabilities for people who are not predominantly responsible for the said event? How can the affected people make adaptation attempts and what the short-term and long-term effects of those strategies? What role does migration play in limiting or strengthening peoples’ capacities to be resilient and adaptive to climate change induced adversities? How community based adaptation strategies can bring better outcomes to ensure co-existence with climate change induced vulnerabilities? How indigenous and local level knowledge can be accommodated with scientific knowledge in order to build a shared learning process while addressing climate change impacts and adaptation options? What are ways to prove changing facets of climatic conditions? How climate change impacts are felt across gender and age? And last but not the

least, to what extent the discourses of colonial records regarding climate change can be connected to contemporary discourses on global climate change? We are hopeful that this book will provide the readers with critical insights into the questions raised above. We believe that the interdisciplinary and inter-regional coverage of the essays published in this book will come of great value to academicians, development practitioners, policy makers and many so on.

Finally, we appreciate the relentless work of all the faculty members, students, and office staffs of the Department of Anthropology, University of Dhaka who poured their sincere dedication to take many steps not only to turn the conference into a success but also to produce the manuscript of this book. We must also acknowledge all the authors who significantly contributed their time and energy to shape up newer forms of understanding on climate change regime. We would like to extend our heartfelt gratitude to the editorial advisors and expert reviewers who, despite their many other important preoccupations, have played significant roles in selecting high quality collection of papers. We wish to express our warm gratitude to the officials of Bangladesh Climate Change Trust for providing the required funding.

Zahidul Islam
Hasan Shafie
Raasheed Mahmood
Editors

List of Authors

- Ahmed, Zahir** Zahir Ahmed, PhD, is Professor at the Department of Anthropology of Jahangirnagar university, Savar, Dhaka, Bangladesh.
- Alom, Kazi Robiul** Kazi Robiul Alom is Associate Professor at the Department of Anthropology of the University of Rajshahi, Rajshahi, Bangladesh.
- Banerjee, Santanu** Santanu Banerjee, PhD, is Assistant Professor of English and Deputy Director at the Nazrul Centre for Social and Cultural Studies of the Kazi Nazrul University, Asansol, Bengal, India. He can be reached at bccsantanu@gmail.com
- Bashar, Fatema** Fatema Bashar is Assistant Professor at the Department of Anthropology of Jagannath University, Dhaka, Bangladesh.
- Bishokarma, Nirmal Kumar** Nirmal Kumar Bishokarma, PhD, is with the Forest Action, Nakhudobato, Lalitpur, PO Box: 12207, Kathmandu, Nepal. He has done his PhD from Zurich University, Switzerland in collaboration with Kathmandu University, Nepal. His areas of research interest are livelihood, resource scarcity and exclusion issues. Earlier, he has worked with the Department of International Development of UK, United Nations in Nepal and German Development Cooperation.
- Chowdhury, N. M. Rabiul Awal** N. M. Rabiul Awal Chowdhury is Assistant Professor, Department of Anthropology, Comilla University, Comilla, Bangladesh. He can be reached at: robi285@hotmail.com.
- Ferdous, Tahsina** Tahsina Ferdous is Lecturer at the Department of Anthropology of Jagannath University, Dhaka.
- Haque, Mahfuzul** Mahfuzul Haque, PhD, is former Secretary, Government of Bangladesh and currently serving as Adjunct Faculty at the Department of Development Studies, University of Dhaka. His areas of interest are natural resource management; biodiversity conservation; climate change; disaster risk reduction; environment; sustainable development; ethnicity and indigenous knowledge and practices. He can be reached at: drmahfuzulhaque@yahoo.com.
- Haque, Md. Ainul** Mohammad Ainul Haque is Assistant Professor, Department of Anthropology, Comilla University, Comilla, Bangladesh.
- Hasan, Md. Sharif** Md. Sharif Hasan is independent researcher. Earlier, he was affiliated to Research Initiatives Bangladesh (RIB). He can be reached at: sharif.hasan50@yahoo.com.
- Hossain, Md. Noor** Md. Noor Hossain is Independent Researcher, Dhaka, Bangladesh.
- Islam, Tanjila** Tanjila Islam currently serves as a MEAL Officer in the Climate Change Adaptation Project at the Save the Children, Bangladesh. She did her BSc in Urban and Rural Planning and MA in Development Studies from Khulna University. Her areas of research interest are climate change and children's vulnerabilities, capacities and rights.

Islam, Zahidul	Zahidul Islam is Professor of Anthropology at the University of Dhaka. He is the author a number of books including ANTHROPOLOGY ON THE MOVE: Contextualizing Culture Studies in Bangladesh. His major areas of research interest include Climate change Adaptation, Natural Resource Management, Ethnicity and Social Exclusion, and Sustainable Development.
Kadir, Sumayyah	Sumayyah Kadir is affiliated to the Humanitarian wing of the Save the Children, Bangladesh. She did BA in Geography and MA in International Development and Rights from Goldsmiths, University of London. Her areas of research interest are human geography, cultural and social anthropology, and ethnographic film.
Khan, Shahriar	Shahriar Khan, PhD, is with the School of Engineering and Computer Science of the Independent University, Dhaka, Bangladesh.
Khatun, Asma	Asma Khatun is affiliated to the Independent University, Dhaka, Bangladesh.
Lipa, Israt Jahan	Israt Jahan Lipa is Independent Researcher, Comilla, Bangladesh.
Madhuwanthi, R.M.B.	R. M. B. Madhuwanthi is affiliated to the Department of Geography of the University of Colombo, Sri Lanka. She can be reached at: rmbhagyamadhuwanthi@gmail.com
Mahmood, Raasheed	Raasheed Mahmood is Associate Professor at the University of Dhaka. He authored several articles and book chapters. His major areas of research interest include Adaptation and Resilience, Ethnicity and Nationalism, and Development Issues in Postcolonial Era.
Mahmud, S. M. Arif	S. M. Arif Mahmud, PhD, is Associate Professor at the Department of Anthropology of the University of Dhaka. He can be reached at: arif_et1226@du.ac.bd
Manawadu, L.	L. Manawadu is affiliated to the Department of Geography, Faculty of Arts, University of Colombo, Sri Lanka
Mostaque, Lam-ya	Lam-ya Mostaque is Independent Researcher. Earlier she worked as Research Associate at Centre for policy Dialogue (CPD), Dhaka, Bangladesh.
Nandaseela, S. M. A. T. de S.	S.M.A.T. de S. Nandaseela is Lecturer at the Department of Geography, Faculty of Arts, University of Colombo, Sri Lanka.
Piyadasa, R. U. K.	Ranjana U.K. Piyadasa, PhD, is Senior Lecturer at the Department of Geography of the University of Colombo, Sri Lanka. He can be reached at: ranjana@geo.cmb.ac.lk.
Rahman, Md. Saidur	Md. Saidur Rahman is Assistant Professor in the Forestry and Wood Technology Discipline of Khulna University. He had completed M.Sc. in Forest and Nature Conservation from Wageningen University and Research Centre, The Netherlands and M.Sc. in Forestry and B. Sc. in Forestry from Khulna University, Bangladesh.
Samanmali, M.A.D.	M.A.D. Samanmali, Department of Geography, University of Colombo, Sri Lanka.
Sanjeeewani, R. M. S. S.	R.M.S.S. Sanjeeewani is affiliated to the Department of Transport and Logistics Management, Faculty of Engineering, University of Moratuwa, Sri Lanka. She can be reached at: ranabahu.sss@gmail.com.

Sarker, Md. Golam Faruk	Md. Golam Faruk Sarker is Assistant Professor, Department of Anthropology, University of Rajshahi, Rajshahi, Bangladesh.
Sarma, Haribondhu	Haribondhu Sarma is the Head of the Nutrition Program Evaluation Unit and Project Coordinator of the Nutrition and Clinical Services Division, ICDDR,B Mohakhali, Dhaka- 1212, Bangladesh
Sendanayake, DRP	D. R. P. Sendanayake, Department of Geography, University of Colombo, Sri Lanka.
Shabbir, Shahab	Shahab Shabbir, PhD, is Senior Lecturer at the Department of Law of the Faculty of Shari'a & Law at the Maldives National University, Male' Republic of Maldives. He did his PhD in International Environmental Law. He can be reached at: shahabshabbir@gmail.com.
Shafie, Hasan	Hasan Shafie is Professor of Anthropology at the University of Dhaka. He authored several books including 'Endowed Wisdom: Knowledge of Nature and Coping with Disasters in Bangladesh' and 'Anthropology of Climate Change: Culture and Adaptation in Bangladesh'. His areas of research interest are: Human Ecology and Sustainability, Climate Change Adaptation, Indigenous Environmental Knowledge, and Social Protection and Justice.
Shanu, Shamima Akter	Shamima Akter Shanu is with the Earth System Science Group of Wageningen University and Research Centre, The Netherlands. She did her M.Sc. in Climate Studies from Wageningen University and Research Centre, the Netherlands. She also had completed M.S. in Disaster Management from University of Dhaka and B. Sc. in Forestry from Khulna University.
Sharior, Fazle	Fazle Sharior is Independent Researcher, Comilla, Bangladesh.
Uddin, Md. Borhan	Md. Borhan Uddin is an Independent Researcher. Currently he is doing M.Phil. Research at the Department of Anthropology of the University of Dhaka. He can be researched at: robi_borhan@yahoo.com

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Chapter One

Anthropology, Adaptation and Resilience: Reinventing Cultural Perspective in Climate Change Regime

Hasan Shafie, Zahidul Islam and Raasheed Mahmood

Abstract

This book comprises a set of research articles reflecting different aspects of climate change impacts and adaptations in the contexts of South Asia. All the articles extensively surveyed the priority issues in climate change, depicting areas of activities and concerns, from anthropological perspectives. Anthropology has a long-standing tradition of studying vulnerability and adaptation to environmental stresses, particularly from social and cultural perspectives. Anthropology appears to be a discipline or even perhaps the most relevant discipline to explain how humans have evolved into the present state and suggest alternative possible routes to move forwards. The anthropological lens focuses on humans holistically and cross-culturally without losing sight of long-term historical processes. At large, these articles highlight the relevance of anthropological research, scholarship and engagements to bring climate science and policy closer to the needs of vulnerable groups in South Asian region. This introduction calls for due attention on cultural perspectives in the study of climate change, adaptation and resilience in the upcoming time. A cultural perspective would provide significant insights into the problem-field as well as achieve a scientific understanding and effective interventions to build on factors that allow individuals, communities, and societies to enhance resilience. At the same time, the issues raised in these articles point to substantial gaps in knowledge and perspectives that may be the challenges at the forefront of addressing climate change impacts in South Asia.

Keywords: Culture, Adaptation, Resilience, Climate Change, Anthropology

1.1. Introduction

The research articles, included in this book, reflect different aspects of climate change impacts, adaptation and sustainability issues in the contexts of South Asia¹. The importance of historical narratives, religious texts, hymns

and discourses, and archival documentary sources for exploring the interconnectedness of natural events, climatic variability and extreme weather events have been the subject matters of several articles in this volume. Some other articles elucidate the dynamics of livelihood strategies under changing climatic regimes, while a few articles have eloquently captured the experiences of community-based adaptation initiatives from different countries and ecologies encompassing South Asian region. Couple of research articles in this book have focused on the potentials of cross-country and cross regional sharing of experience and learnings to develop effective adaptation programs with policy solutions for these countries. At large, these articles highlight the relevance of anthropological research, scholarship and engagements to bring climate science and policy closer to the needs of vulnerable groups living in this region.

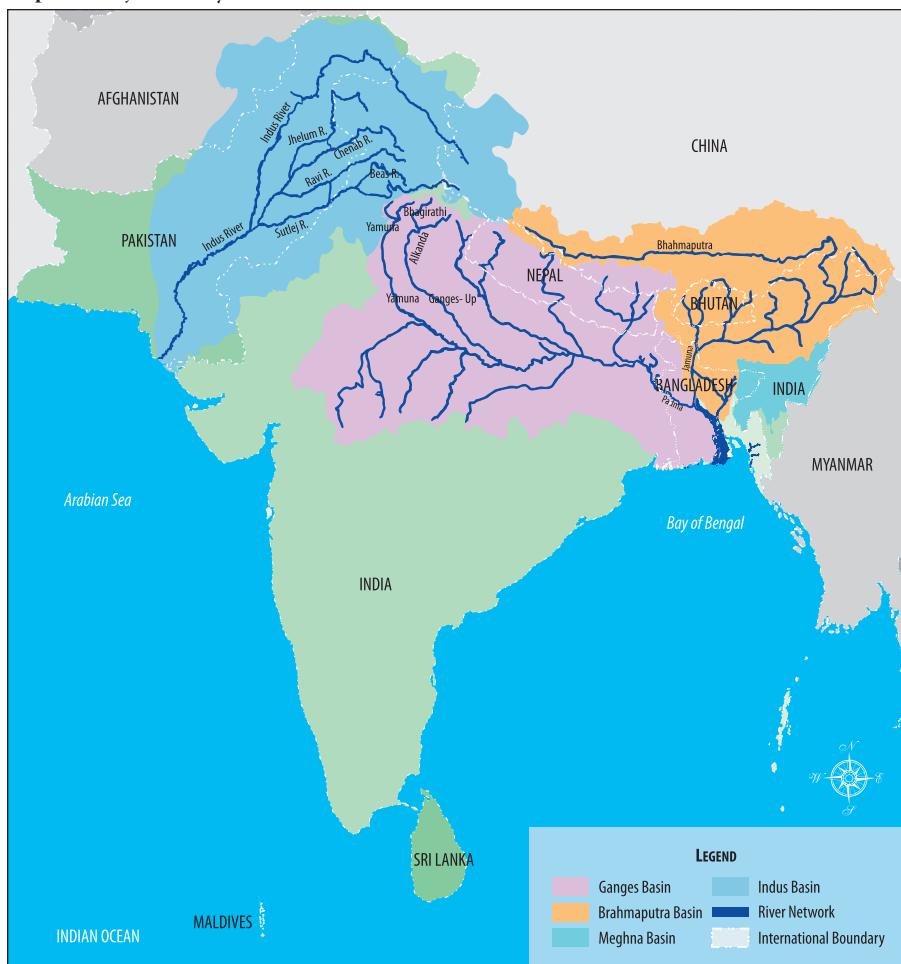
The articles in this book provide an excellent opening for future reference on climate change issues from social and cultural perspectives, empirically grounded in South Asian countries. All the articles extensively surveyed the priority issues in climate change, depicting areas of activities and concerns, from anthropological perspectives. The object and context of anthropology have changed since its birth, and so have been the ways of knowing and doing anthropology. The conditions of the new world order posed anew challenges for anthropology to encounter theoretically. The expanding power of the nation-state, market and economy, and environmental changes in this increasingly connected world, have altered the state and formation of anthropological objects. Besides, anthropology has a long-standing legacy of studying vulnerability and adaptation to environmental stresses. However, the essays in this volume identify and critically analyze some of the existing policy priorities, contested issues, and practical challenges of devising successful strategies to bring about equitable access to and maximized use of resources under changing climatic conditions in the context of South Asia.

Collectively, the articles in this book are on environmental concerns, representing a distillate of contemporary concerns, priorities, theory and practice without the detailed approach of the highly technical aspects of the treatises. These articles address some significant questions related to climate change impacts, adaptation options and resilience issues in South Asian contexts. Some of these grand questions: what are the current propositions in the understanding of climate change impacts that are expected to transform and change the conditions of making our future living? How can the cultural understanding be grounded and made relevant to identify innovative adaptation solutions in response to the evolving environmental demands? How can anthropologists respond to these demands with greater efficiency and effectiveness in formulating, implementing, and delivering adaptation policies and programs? How can we integrate the principles of social equality, equity, and participation while implementing feasible approaches and programs? We are hopeful that a wide variety of readers including professionals, scholars, and university students may all alike find this book readable, and of some interest and value.

1.2. South Asia: Contexts and Challenges

What makes South Asia a separate region? Despite the fact that this region comprises diversities on numerous scales, yet similarities in the geologic formation history suggest that the Indian landmass left Australian coastline, around 220 million years ago, and traveled thousands of kilometers northwards before it finally collided with Eurasian plate between 60 and 58.5 million years ago (DeCelles, Kapp, Gehrels, & Ding, 2014; Jain *et al.*, 2012). The Himalayan orogenic belt is the result of this intercontinental collision between Asia and continental lithosphere of India. The great Himalaya, the world's tallest mountain range, separates South Asia from the rest of Asia. South of the Himalaya, the land gradually descends to fertile lowlands, which forms the catchments of mighty rivers like Indus, Ganges, Brahmaputra and Meghna.

Map– 1.1: Major River Systems in South Asia



Meghna (Map– 1.1). The south of South Asia is delineated by the Arabian Sea, the Indian Ocean and the Bay of Bengal.

South Asia has a variety of climate zones ranging from snowy highlands to sunny deserts and composed of numerous mountain ranges and plateaus. The climate of this region is largely affected by monsoon since the Miocene, and seasonal winds bring wet and dry spells in the monsoonal environment. Monsoonal shifts and seasonal changes in wet and dry periods are registered throughout the Pleistocene (James *et al.*, 2005). Paleoclimatic data indicate, ecological changes as part of climatic oscillations, a trend toward increasing aridity during late Pleistocene, and grassland and brackish swamps ecosystems during middle Pleistocene (Misra, 2001 *cf.* James *et al.*, 2005). According to James *et. al.*, these climatic and environmental fluctuations had significant influence over the demographic characteristics, settlement pattern and cultural innovations of South Asia's ancient populations (James *et al.*, 2005).

Although changes in the paleoclimate and present climate change may be attributed to different reasons, but they tend to have similar impacts on human conditions, lives and societies. Recent studies on regional climate change vulnerability and modeling suggest considerable evidence of physical impacts on key sectors including agriculture, water, energy, forestry, coastal and marine, and human health (Ahmed & Suphachalasai, 2014). Being consistent with global temperature trends, an increase of about 0.75°C mean temperature warming has been observed over South Asia and, by the end of 21st century, the rise would be around 3°C–5°C under different projection scenarios (*ibid*). The Fifth Assessment Report (IPCC, 2014) projects increase of mean surface temperatures for 2081–2100 relative to 1986–2005 will be 0.3°C to 1.7°C (RCP2.6), 1.1°C to 2.6°C (RCP4.5), 1.4°C to 3.1°C (RCP6.0), 2.6°C to 4.8°C (RCP8.5). Moreover, climate change will also affect the water cycle unevenly over the 21st century, while the changes in precipitation between wet and dry regions and between wet and dry seasons will increase with some regional variations (*ibid*). The FAR also predicts that the Arctic sea ice cover will continue to shrink and glacier volume will further decrease as global mean surface temperature rises. As a result, global mean sea level will continue to rise under all RCP scenarios. Globally, the mean sea level rise for 2081–2100 relative to 1986–2005 will be in the ranges of 0.26 to 0.55 m (RCP2.6), 0.32 to 0.63 m (RCP4.5), 0.33 to 0.63 m (RCP6.0), and 0.45 to 0.82 m (RCP8.5). Sea level changes in South Asian coastline are complex to account and predict as any local level discernment depends on the interplay of different factors including tectonic movements of landmass, land subsidence, accretion and sedimentation. Among others, climate change will affect carbon cycle processes in a way that will exacerbate the increase of CO₂ in the atmosphere and uptake of carbon by the ocean will increase ocean acidification (*ibid*).

South Asia is and will be experiencing the devastating impacts of climate change, according to the United Nations. The socioeconomic development

processes in South Asian countries have been recurrently intercepted by multitudinous natural disasters and impacts of climate change. Most of these countries are exposed to natural hazards of all possible sorts, such as, floods, riverbank erosion, cyclones, droughts, water logging, arsenic contamination, salinity intrusion, tornadoes, cold waves, earthquakes etc. The southern coastline of South Asia region is highly vulnerable to climate change driven impacts of cyclone and subsequent storm surge. The IPCC's Fifth Assessment Report (AR5) unequivocally validates the warming of the climate system since the 1950s, while many of the observed changes are unprecedented over decades to millennia (IPCC, 2014). The AR5 also warns by projecting that "continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system" (IPCC, 2013: 19). Given the present trends of changes in global environment combined with the projections of AR5, we can assume the climate risk and susceptibility of South Asian countries to natural disasters and climate change impacts. The AR5 also projects that climate change will turn South Asia into a home to the "largest numbers of food-insecure people" by the mid of 21st century because of the shifting monsoons having direct bearing upon the amount of water available for irrigation. The Global Climate Risk Index 2018 has accounted the weather-related loss events for different countries (see Table 1.1 for the ranking of South Asian countries).

Population and poverty are key features of vulnerability to climate change impacts in South Asia. The situation becomes increasingly worse due to the multiplying effects of other social vulnerabilities including ineffective governance, weak institutions, relative deprivation, exploitation and denial of fundamental human rights including highly polarized access to resources and vested-interest groups. The (co)occurrence of extreme natural events are often coupled and multiplied with the high base vulnerabilities of the individuals, households and communities, results in disasters that further drive the region towards greater environmental degradation, hunger, poverty,

Table– 1.1: Climate Risk Index for 2018.

Country	CRI score	CRI Rank	Fatalities in 2016		Fatalities per 100 000 inhabitants		Losses per unit GDP in %	
			Total	Rank	Total	Rank	Total	Rank
Bangladesh	27.00	13	222	7	0.137	34	0.1754	33
Bhutan	67.17	75	4	77	0.506	8	0.0047	100
India	18.33	6	2 119	1	0.163	30	0.2469	23
Nepal	29.50	14	179	9	0.620	6	0.0851	47
Pakistan	50.83	40	566	4	0.292	17	0.0048	99
Maldives	109.50	120	0	99	0.000	99	0.0000	120
Sri Lanka	11.50	4	99	15	0.466	9	0.6217	11

Note: CRI = Climate Risk Index; GDP = Gross Domestic Product. Source: (Eckstein, Künzel, & Schäfer, 2017)

social deprivation and political conflicts. Most of the countries in South Asia belong to low- or lower-middle income categories and their immediate concern is to meet the needs of growing populations. However, the articles in this book intend to contribute in the understanding of the multifaceted challenges that these countries are undergoing and likely to encounter in the upcoming future.

1.3. Culture, Adaptation and Resilience

Defining concepts like ‘culture’, ‘adaptation’ or ‘resilience’ with precision and clarity are quite problematic, as the scholars, who use them, communicate different meanings by these terms. Rappaport remarked, with an effort to define adaptation, “in remaining vague it itself remains adaptive” (1979: 145). However, ‘culture’, the central concept in anthropology, has also many meanings as does ‘adaptation’. Yet there is no agreement among anthropologists despite a century of efforts to define culture adequately (Apte, 1994: 2001). Culture is ‘a way of life’, ‘an adaptation tool’, ‘a complex whole’, ‘a knowledge system’, ‘an individual construct and a social construct’, ‘a nurturing system’, ‘a collective programming of the mind’, etc. Tylor’s famous 1871 definition of culture (Tylor, 1958 [1871]), perhaps remained with anthropology for the longest time. According to that definition, culture is “that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society” (Tylor, 1958 [1871]: 1 *cf.* Boellstorff, 2006: 30). However, in a recent attempt, culture is defined as “a fuzzy set of basic assumptions and values, orientations to life, beliefs, policies, procedures and behavioral conventions that are shared by a group of people, and that influence (but do not determine) each member’s behavior and his/ her interpretations of the ‘meaning’ of other people’s behavior” (Spencer-Oatey, 2008: 3).

Culture teaches to adapt to or cope with a given environment. The nature and patterns of interactions between culture and environment influence the adaptive processes enough to impact the chance of survival of a group. Adaptation is a culturally-informed understanding of the nature, responding to the natural conditions and adopting a highly important subsistence activity that has been practiced for thousands of years. Culture is also dynamic and changes in order to adjust to the changing environmental conditions as well as to enhance people’s chances of survival.

The concept of adaptation is being increasingly used in the context of global environmental change since the 1990s. Literature on adaptation knowledge domain in relation to climate change have less citation of the anthropological works on adaptation from 1960s. Otherwise spoken, the anthropological perspective is not directly connected to the dominant use of the term adaptation since the 1990s in the climate change research (Janssen, Schoon, Ke, & Börner, 2006). The anthropological perspective on adaptation begins with

the cultural framework of interpretation and understanding of the nature. According to Rappaport:

Nature is seen by men through a screen composed of beliefs, knowledge, and purposes, and it is in terms of their cultural images of nature, rather than in terms of the actual structure of nature, that men act. Therefore...if we are to understand the environmental relations of men [it is necessary] to take into account their knowledge and beliefs concerning the world around them, and their culturally defined motives for acting as they do. But...although it is in terms of their conceptions and wishes that men act in nature it is upon nature herself that they do act, and it is nature herself that acts upon men, nurturing or destroying them (R. Rappaport, 1971: 246).

Rappaport goes on to say that a cultural group has its own ‘distinctive means of maintaining itself in its environment’ (R. Rappaport, 1971: 247). This is part of the cultural ‘cognized model’ of the environment, which is to be analyzed in terms of “functional and adaptive effectiveness” rather than its accuracy (*ibid*).

The concept of resilience has emerged in the field of ecology during early seventies (Holling, 1973; Janssen *et al.*, 2006). The root for the English word “resilience” is the word “resile,” which means “to bounce or spring back” (from re- “back” + salire- “to jump, leap”; (Agnes, 2003 *cf.* Smith *et al.*, 2008). In ecological studies, “resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb change of state variable, driving variables, and parameters, and still persist. ... [here] resilience is the property of the system and persistence or probability of extinction is the result.” (Holling, 1973: 17). Resilience embodies the qualities that enable an individual to thrive in the face of adversity (Connor & Davidson, 2003). A series of research over the years has demonstrated that resilience is a multidimensional phenomenon that varies with context, time, age, gender, and cultural origin, as well as within an individual subjected to different life circumstances (Connor & Davidson, 2003; Seligman & Csikszentmihalyi, 2014).

Since the late 1970s, a number of key application areas developed for the knowledge domain resilience. The concept has been made instrumental to explain the human dimensions of environmental change and ecosystem management (Holling, 1986; Holling & Meffe, 1996; Janssen *et al.*, 2006; Walters & Holling, 1990). Some other papers on resilience have focused on comparing case studies of various regional social-ecological systems to understand how systems can deal with change and disturbances (Janssen *et al.*, 2006). However, the idea of resilience has been frequently cross-cited by scholars of a varied disciplinary background. Psychologists have also turned their attention to amplify human strengths rather than repair their weaknesses. “The major psychological theories have changed to undergird a new science of strength and resilience. No longer do the dominant theories view the individual as a passive vessel responding to stimuli; rather, individuals are now seen as decision makers, with choices, preferences, and the possibility of becoming masterful, efficacious, or in malignant circumstances, helpless and hopeless” (Seligman & Csikszentmihalyi, 2014: 8). However, the term

resilience refers to broad range of academic issues including the ability of a system (natural, built and cultural), groups, community or society exposed or susceptible to shocks (economic, social political, environmental etc.) to protect, absorb, accommodate to and recover from the effects of the shocks in a timely and efficient manner, including through the preservation and restoration of ecosystems from dynamic changes in relation to shocks and aftermath without compromising (and potentially enhancing) long term prospects (ISDR, 2009). Resilience is not a fixed end state, but is a dynamic set of conditions and processes (Mukuna & Shisanya, 2016).

1.4. Interplay of Cultural and Natural Processes

Anthropology has a long-standing legacies of studying culture as being the key factor mediating interactions between humans and climate as part of the wider environment. Mankind has always been dependent upon nature to meet their needs. During the last two hundred years or more, particularly after the Industrial Revolution, which is regarded as the commencement of modern industrial civilization, this dependence has further increased, as industrialization and urbanization demanded ever-increasing supply of raw materials to be extracted or harvested from nature. Throughout this period, the natural resources have been treated as free or implicitly free goods and as passive partner in the development process. Natural resources provide the basis of human actions, while human potentials for being organized, knowledge, technology and cognition provide another resource base (Salisbury, 1973: 92). Several alternative levels of production are possible within a specific natural condition, but the selection procedures depend on how the individuals evaluate and take decisions in terms of the existing knowledge and experience along with the structure of local opportunity cost. People make choices based on their cognition of resources, organization for resource use, and strategies to enhance the chances of survival. The choices people make may appear to be the most efficient strategy from economic standpoint of profit maximization while, at the same time, might have ecological consequences as being destructive or exploitative in spatial-temporal context. However, imperatives of human existence, after industrial revolution, reflect the omnipresent destruction of irreplaceable natural resources. The spirits of rationality and maximization have transformed the images of peace and happiness of eighteenth century to the pursuit of pleasure and luxury. The essence of economic growth-oriented, 'rational choice' philosophy, has posed a major threat to the environment. The economic rationality of the individuals may entail PP-CC (privatized profits-commonized costs) game followed by the 'tragedy of the commons' (Hardin, 2009). These processes have posed major threats to the environment, while at the same time apparent to satisfy human needs on an increasing scale. Additionally, the growth of population and increasing life span has also added to the pressure on the rate of exploitation of natural resources. The environment, a set of natural conditions, that provide humans with living space, is now moving into the realms of scarcity— the greatest source of alarm.

The recent trend in newer ecology is directed towards the dynamic nature of ecosystems, and the individual decisions and actions. The individuals make choices and decisions for action, and these choices become generalized as processes. Our present concern is about how these individual actions, when aggregated, have their greater or lesser consequences on the structure and function of the ecosystems and bring changes in them. Adaptation has increased human capacity not only to explain natural events but also to misapprehend that often along with technological evolution lead actions to the destruction of an encompassing nature. These acts are to be understood within a cultural framework of meaning (Barth, 1993: 158), on the other hand, natural events are objective. Rappaport addressed this point as, “humanity must encompass both law and meaning, for humanity is a species that lives, and can only live, in terms of meanings it itself must construct only loosely constrained by its nature from fashioning self-destructive or world-destroying follies, in a world devoid of intrinsic meaning but subject to physical laws that can neither be changed nor, perhaps, ever fully understood” (R. A. Rappaport, 1994: 162-63). These physical laws are to be discovered and meaning must be constructed. The world is increasingly an outcome of their interaction.

The way for understanding the separation of ‘natural laws’ and ‘constructed meaning’, both of which condition our lives and livings, have largely been paved by the rejection of absolutism coupled with the emergence of post-modernism and interpretive critiques. The changing ideoscape has produced intellectual crisis in terms of theoretical and methodological contextualization in anthropology. The challenge is to address the question whether, ‘culture is a symbolic means to organic ends or organisms are living means to cultural ends’ (Rappaport 1990: 56). This question is an outcome of the long continued controversies, in anthropology, precipitated from the discipline’s positivist\interpretivist debate and, of late, ‘between the “science” of Harris and the “interpretation” of Geertz’ (Borofsky 1994: 5). Rappaport addresses this point as:

... any radical separation of the two [traditions] is misguided, not only because meaning are often causal and causes are often meaningful but because, more fundamentally, the relationship between them, in all its difficulty, tension, and ambiguity, expresses the condition of a species that lives and can only live, in terms of meaning it itself must construct in a world devoid of intrinsic meaning but subject to natural law. ... that can neither be changed nor, perhaps, ever fully understood. ... the lawful and meaningful are not coextensive, and they are differently known. If physical laws and the states of affairs they constitute are to be known they must be discovered. In contrast humankind's meanings must be constructed and accepted (R. A. Rappaport, 1994: 154-63).

Discernment of important interactions between natural laws and cultural constructions involving various forms of adaptive strategies is inevitable to locate our position and human condition as a whole, and to explore the level of interconnectedness of all human activities. Popper, in a similar stance, takes on the intentional causation situated of human action, based on interpreted meaning, which is taking place in an externally structured environment (Oakley, 2002). On the epistemological level, Popper suggests that “Quantitatively and

qualitatively by far the most important source of our knowledge— apart from inborn knowledge— is tradition” (Popper, 2014 [1962]: 27). People “tend both to create traditions [and institutions] and to reaffirm those they find by carefully conforming to them and by anxiously insisting that others conform to them also” (*ibid*: 132). He considers traditions and institutions as virtual structures operate as pervasive force influencing, but not determining, human actions. Traditions, according to him, “describe a uniformity of people’s attitudes, or ways of behavior, or aims or values, or tastes.... [and] at any moment of time we, and our values, are the products of existing institutions and past traditions” (*ibid*: 133). Mann proposes a framework of three distinct aspects to explain human actions: “the intentions of the actor; the meaning of the act . . . and its structural context” (Mann, 1999: 165). Multi-level or multi-scale analysis of the human activities and their consequences can be done methodologically with what Vayda called ‘progressive contextualization’, explicating further, scaling ‘backward in time and outward in space’, which will give us a broad perspective of time, and place, and circumstances (Andrew P. Vayda, 1983; Andrew P Vayda, 1988, 1994). Therefore, we have to recognize the ontological significance of scale as a variable of analysis.

1.5. Analytical Scales and Micro–Macro Architecture of Adaptation

Conditions of human adaptation to climate change depend on understanding the scale of the problem: most environmental perception is local rather than global, and is manifested in experience with changes in precipitation and temperature and observation of crop responses to current conditions (Magistro & Roncoli, 2001 *cf.* Brondizio and Moran 2008). The existing literature on human–environment interaction has had a tendency to treat human responses to change at a local, self-contained level, but limited in capturing the linkages and vertical interplay created by a growing functional interdependency of resource use systems and ecosystems (Berkes, 2006; Brondizio & Moran, 2008; Young, 2006). The linkages between local and global understanding of climate change sometimes become conflicting when the national and global forecasts contradict local experience, which raise the question of authenticity leading people to resist believing either of them because they do not match personal understanding and experiences of climate patterns. People’s interpretation and trust of such information depend on the spatial and temporal scopes with which it is presented, its significance to local–level decision making, and clarity of language and terminology. The roles of institutions, culture, social class and perception are significant variable for determining how people respond to forecasts (Lemos, Finan, Fox, Nelson, & Tucker, 2002; Moran, Adams, Bakoyéma, Fiorini, & Boucek, 2006; Nelson & Finan, 2000; Shafie, 2017; Shafie, Halder, Rashid, Lisa, & Mita, 2009). Adaptation is likely to be quicker if there exists effective connections between climate factors and cultural practices (Magistro & Roncoli, 2001). However, this line of reasoning suggests that we should pay due attention to processes those mediate the perception of change in climate and differ at individual, household, community and regional scales.

The diversity in human actions and processes, and their relation to the environment involve micro level analysis to cognize purpose and context of action, and macro modeling to explore the modes of change resulting from many actions (Barth, 1990, 2002; Andrew P Vayda, 1994). In this connection, it is important to understand the involvement of both micro and macro organization of processes in the study of man-environment interactions. The localized aspect of the carrying capacity of natural resources and their exploitative processes are not only related to the micro-level local processes but also to macro processes or external factors outside the local system. In general, the process of exploitation is usually accelerated by demands generated outside the local system (Bennett, 1976: 276). For instance, in a peasant society, control of resources and mode of involution are often vested in corporate agents outside of their own communities that often lead to overexploitation. “Local groups participate in, and are the locus of conjunction between local ecological processes and regional, social, economic and political processes.... Events in regional systems can and do affect local ecological processes and vice versa” (R. A. Rappaport, 1990: 61). Antithetically, ecological sustainability is achieved in simple technology or ethnic communities because of low technology input and social arrangements of small populations, and highly localized nature of the adaptations restrain serious environmental impairment (Haaland, 1990). However, Individual adaptive strategies and actions and their relation to the environment require two levels of analysis: the micro level, the study of actions in specific contexts of purpose and macro level, the meaning of such behavior for social systems including processes of change resulting from many actions.

An example of globalized food flows, in recent decades, would shed light on the micro–meso–macro architecture of scales in ecological studies. The globalization of food-flows has interrupted the natural flow of nutrients. Mechanization in agriculture and rapid development of communication system have radically snipped open the organic loops. Last 40 years are the golden age of green revolution for the unprecedented growth in agricultural output. Markedly, the surge in agricultural trade grew even faster than production. World grain output, for instance, doubled between 1960 and 1995, antithetically, growth in international trade tripled during the same period (Gardner, 1997: 40). The recent growth in agricultural trade inevitably entails an uneven redistribution of nutrients that generates net losses, in some areas, and net surpluses, in others. The cost of linear flows of nutrients crossing national or regional borders and closing organic loops involves a diverse set of problems, from waste pollution to the overuse of chemical fertilizer declining soil fertility— our argument is scale matters. We recognize the importance of micro–meso–macro analytical framework as having greater potentials for enhancing the focus, clarity, and, ultimately, power, of anthropological understanding of climate change adaptation.

This line of reasoning certainly advocates the relevance of both economies and ‘ecologies of scale’ (Gardner 1997: 45) to interpret sustainability with precision. The proper meaning of scale refers to size, number and extension

in space of units. Hence, scale can range from a single act at village level to the regional or world system. We need an analytical extension to explicate and evaluate the significant impact of such empirical events and study the processes of change to identify the potential relations and interrelations that ultimately become more or less essential in the lives of the encompassing people. Hence, the appropriate place to start observation is at the bottom of a system with social actors and tracing their activities and impacts—‘following loops’. Events at micro level will only be the locus, not the focus of the study (Barth, 1981, 1992, 1993). Both continuity and change in the system can be identified from the resulting emergent forms as a precipitation of interaction between man, environment and institutions in various contexts. The dynamism is, therefore, critical for our understanding of a complete picture of cost and benefits of any operations at different scales.

1.6. Culture and Climate: Local Experience and Global Modeling

Anthropology appears to be a discipline or even perhaps the most relevant discipline to explain the way humans evolved into present state, and suggests alternative possible routes to move forward. The anthropological lens focuses on humans holistically and cross-culturally, without losing sight of long-term historical processes. Anthropology integrates culture, language, biology, and history to answer questions about humans and the societies they have made. Besides, preceding discussion suggests that the global modeling of climate change is lacking the understanding of complexities about how real life decisions are made, which means that such modeling would remain incomplete without the localized scales of analysis (Taddei, 2007). Microanalysis of risk management and decision-making strategies can complement the global modeling of climate science and inform policies to make them effective (Magistro & Roncoli, 2001; Taddei, 2007). The concept of culture, the hallmark of anthropology, is the key dimension that mediates the interaction between humans and climate at different levels. Moreover, the methodological virtue of anthropological fieldwork is that it gives us an opportunity to transcend received theories, knowledge, and wisdom, and allow us to learn from the only and fully valid source: ‘people speaking and acting in a living society’ (Barth, 1993: 25).

Ecological Anthropology adopted the principles of general ecology following the work of Leslie White. Critiques of Steward’s cultural ecology paradigm focused on environment–culture–behavior nexus, and led anthropologists towards a more biologically–oriented ecological anthropology that regards humans as parts of the ecosystem, and examines human adaptability in terms of physiological, biological and behavioral reactions arising from interactions with environmental conditions. This perspective analyses cultural characteristics by applying the principles of biological ecology (Geertz, 1963; A. Vayda & Rappaport, 1968; Andrew P Vayda, 1976; Andrew P Vayda & McCay, 1975). Geertz first argued for the usefulness of the ecosystem as a unit of analysis by

stating that ‘systems theory’ provides a broad framework, essentially qualitative and descriptive, that emphasized the internal dynamics of such systems and how they develop and change (Geertz 1963). Barth, even before that in 1956, applied the concept of the “niche” to explain the ecologic relationships of adjacent groups and the maintenance of ethnic boundaries (Barth, 1956). Methods of ecological anthropology incorporated core biological issues such as ‘population’ or ‘ecosystem’ and explored the functional role of different organisms in shaping environmental conditions and, in particular, the interaction with other human groups. According to Orlove, ecological anthropology is the “study of the relations among population dynamics, social organization, and culture of human populations and the environments in which they live. It includes comparative research as well as analyses of specific populations from both synchronic and diachronic perspectives.” (Orlove, 1980: 235). He goes on to suggest that ecological anthropology provides a materialist interpretations of human activities and thus bears an affinity to other materialistic approaches in the social, natural and biological sciences (Orlove 1980).

Humans, like other organisms, interact with their environmental settings in different intensities and at various levels. The idea of ecosystem explains the relations between groups of organisms, and organisms and the environment acting at these different levels of integration. Ecosystem is a self-contained entity which, in a given area, encompasses all organisms interacting with the physical and chemical environment, so that there is diversity of biological relations and material cycles, and energy flow that create clearly defined food chains (Begon, Harper, & Townsend, 1986; Ellen, 1990; Odum, 1983; Schutkowski, 2006). An ecosystem is composed of a set of components, biotic and abiotic, which are connected through structuring principles within the system. Accordingly, ecosystems are characterized by the spatial and temporal distribution patterns of their components, by the circulation of material (flow of matter) and utilization of energy (energy flow), by the exchanging and passing-on of information (information flow) and by the properties of change and evolution (Schutkowski, 2006). The key ecological categories are units of space, time, matter, information and energy (*ibid.*).

Holism is the ontology of ‘systemic approach’ in ecological anthropology and assumes that the components and elements of the ecosystem are intimately interconnected and that they represent certain conditions and degrees of organization whose development can be adjusted by feedback mechanisms. Explaining and understanding the variability of human reactions to given environmental conditions would thus have to consider the interrelation between the realms of cultural, biotic and abiotic factors within the system or habitat. The idea of homeostasis is also applied to understand to self-regulating properties of the ecosystem, which fostered the much-celebrated work on the Tsembaga of highland New Guinea by Rappaport in 1968 (R. A. Rappaport, 1968). Rappaport explored the Tsembaga society that had established a culture trait of self-adjusting homeostatic mechanism through the cyclical nature of certain feast ceremonies (R. A. Rappaport, 1968). The Tsembaga people, during these

celebrations, slaughter the growing pig population as part of their ritual and thus maintain a balance within the ecosystem by reducing the overexploitation of natural resources. According to this perspective, systemic correlates of homoeostasis refers to the maintenance of general ecosystem properties, which corresponds to the idea of resilience.

Human ecosystems are considered open and characterized by positive feedback, non-linear oscillating processes and intentional intervention. Homoeostasis and dynamic equilibrium are not equivalent to the absence or the impossibility of change. Homoeostasis or dynamic equilibrium requires constant adjustment of parts within the system or complete structures. Systems, therefore, possess low-level mechanisms, which aim at the maintenance of stability, and other mechanisms which have an effect at a higher general level and which maintain the system as a whole. In order to be able to follow and analyze such processes, ecological anthropology is thus explicitly oriented towards a diachronic method with an emphasis on the study of change (Orlove, 1980). Although the application of an ecosystem perspective to human populations provides relevant insights into the complex situations of local populations at the micro level, but many scholars have argued its validity in explaining the overall context of human behavior and human adaptability (Schutkowski, 2006). However, individual decisions and strategies are being increasingly included in ecological studies as, when aggregated, having effects on the population at the macro level (Barth, 1981; Moran, 2000, 2016).

Human adaptability approach is concerned with the macro-level influence of the natural and cultural environments on the biological characteristics of human populations based on the ontological assumption that humans are a product of natural evolution and in their genetic make-up would reflect the outcome of adaptations to their respective environments. According to this approach, adaptation is understood as any kind of biological reaction which reduces environmental stress and/ or increases resilience against the stressor, which might take the form of population-specific genetic characteristics, physiological acclimatization and learned behaviors (Baker, 1988; Schutkowski, 2006). However, in this approach, the concept of environment is not limited to the natural conditions only rather the meaning of environment also embraces the cultural, social, political and economic reality of humans (Schutkowski, 2006). Human adaptation, therefore from an anthropological perspective, means man–environment relations including all human requirements encompassing all the environmental conditions, together with social milieu, that are necessary for viable maintenance and the amount of different resources. Adaptation is a process through which, “human population with all its collective and statistical social features, and a set of cultural ideas in terms of which these people try to understand and cope with themselves and their habitat” (Barth, 1987).

Human adaptive responses are ‘strategic actions’ within the framework of options and constraints in the decision-making process. An adaptive strategy,

may or may not be made explicit by an actor, includes both intended and unintended and/or perceived and unperceived acts to adjust to or cope with constraints. Strategies to adapt may pursue both continuity and change in relation to ecological patterns, economic situation, socio-cultural presentations, and political processes. However, ‘strategic action’ refers to specific actions designed to achieve ends and consume resources in the process and sometime centers around the concepts like ‘rationality,’ ‘maximization,’ ‘achievement,’ ‘output-oriented’ and many others which imply approaching environment with the concept of private property followed by cumulative effects. Adaptive strategies do not always imply success in ecological, socio-cultural, or politico-economic contexts rather these are of vital importance to the analysis of sustainability within the framework of ‘system-maintaining’ activities or ‘system-changing’ activities.

1.7. Outlining the Articles

This book may be said to have been divided thematically into several parts. Articles compiled under thematic sections are structured internally like blocks holding articles together, so that they can effectively communicate the theme of the book. The articles encompass a wide range of assortment; starting from historical and colonial legacies of climate studies to the cultural construction of climate risk perception; from mediating science and society to the assessment of risks; and from community-based adaptation to resilient development.

As editors of this book, we have tried to be inclusive without being redundant. The selection of articles was based on broad overviews with cross-disciplinary links and the potentials for practical applications. The 16 articles that follow this introduction depict an amazingly diverse and complex image of the orientation in the study of climate change in South Asia, more generally from social sciences perspective. Collectively this compilation, like many others, may be said to be incomplete. Yet, we hope that the compilation would stimulate the reader’s appetite to choose from a wider offerings of the field of climate change impacts in South Asia. A brief introduction to the articles in this book follows.

Climate Discourse: Legacies of the Past

The second chapter on ‘Colonial Legacy of Climatic Discourse’ examines archival documentary sources for exploring the nature of climatic variability and extreme weather events during colonial era in Bangladesh. Referring to District Magistrates’ narratives and other archival documents from colonial era, the authors have argued that the climate change discourse has been rediscovered from the past and calls for the needs to unveil the politics behind. Banerjee, in the third chapter, aims at unleashing the potentials of “religious discourses” like Bangla Bratakathas in anticipating environmental catastrophes in the Anthropocene. The author has lucidly made the point that such texts had remained marginalized in the established histories of Bangla literature and the worth of those texts need to be recognized as they tell us about the “unthinkable” interconnectedness of natural events.

Climate Risk Perception: Adaptation and Resilience

Peoples' responses and decision-making factors under risks and uncertainties induced by natural hazards and extreme climatic events constitute significant area of investigation in the study of climate change from anthropological perspective. CCA decision-making in communities are largely mediated by social interactions and cultural worldviews including peoples' beliefs about society and nature (McNeeley & Lazarus, 2014). The way in which people perceive climate change risks influences the feasibility and acceptability of climate adaptation planning, policy-making, and implementation. The cultural aspects and perceived realism of risks have remained discounted in the technical models of climate risk analysis and assessment. Studies of risk have raised the challenges of incorporating cultural and technical considerations into the understanding of climate risk management (Fischhoff, 1984, 1990; Kahneman & Tversky, 2013; McNeeley & Lazarus, 2014; Rayner, 1992; Sitkin & Pablo, 1992; Sitkin & Weingart, 1995; Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1984, 1985; Slovic & Gregory, 1999). Factors altering the perceptions of people may lead the community people to underrate or even not perceive risks even though the actual risk might be out there. Risk perception assumes that the perceiver, within a social setting, selects certain risks for addressing, while suppresses some others from attention (Douglas, 1986). Therefore, understanding the factors that contribute to form and change risk perceptions has significant bearing upon policy outcomes and program implementations for climate risk management and adaptation. Psychological and cultural theory of risk, and risk perception give us a richer context to understand factors contributing to community understandings of, and responses to, climate risks and impacts.

Chapters four and five of this book have addressed the role of culture in contemporary climate change adaptation. Kadir and Islam's paper explores the social dynamics of adaptive capacity and how society perceives and responds to climate change impacts. The authors suggest that adaptation is highly context-specific whereby socioeconomic factors, local knowledge and social networks play significant influence in shaping people's perception and consequently adaptation measures. They have also found that identity and the sense of belongingness to a place are important aspects of culture and have implications for adaptation as well as for the impacts of climate change. Kadir and Islam also explore the importance of engaging children, as being agents for change, in developing effective adaption measures and building community resilience. Although children bear the greatest burden of climate change impacts and are the most vulnerable group to natural disasters, yet they mostly remain excluded from adaptation policies and plans. The authors have successfully made the point that the inclusion of children's perspective and integrating their specific needs in a child-centered approach to climate change adaptation can greatly reduce vulnerability and enhance community resilience.

The article by Mahmud and Uddin explores local perceptions of climate change including their beliefs, values and practices associated with local

adaptation strategies. In general, the elderly peoples believe that the changes in the climate are God's will in the form of punishment for committing sins and wrongdoings. The authors concluded that local knowledge, beliefs, and perceptions of people about climate change are significant and need to be accounted in the course of developing effective adaptation measures at the community level.

Assessing Climate Risks: Geoinformatics and Remote Sensing

Four articles, starting from chapter six, focused on Geoinformatics, GIS and visual interpretation of remotely sensed data to understand and visually project of climate change impacts. Chapter six, seven and eight have explored different aspects of climate change impacts and trends in Sri Lanka. Sanjeeewani and Manawadu presented on the spatial variations of land surface temperature over Kandy city of Sri Lanka. Based on thermal bands of Landsat TM 5, Landsat ETM+ and Landsat 8 OLI/ TRIS data, the authors have identified the anthropogenic factors contributing to increased land surface temperature (LST) variation between 1988 and 2015 over Kandy city, Sri Lanka. They have also found that higher Normalized Difference Built-up Index (NDBI), population density and traffic count have strong positive correlation with increased LST levels. Madhuwanthi, Piyadasa and Nandaseela have explored the implication of changing rainfall patterns on abandoning paddy cultivation in a particular region of Sri Lanka. This study explores the spatial distribution of abandoned paddy lands, and identifies that abandonment results from sea water intrusion, water logging, soil related problems, flood hazards, use of poor salinity irrigation water, poor maintenance of irrigation and drainage systems, water logging as a result of infrastructure development and so on. The third article on Sri Lanka projects the spatial and temporal (seasonal) distribution of dengue fever in the country between 2010 and 2016. The authors have significantly made the point that spatial and temporal changes of dengue incidences correlate with climate change and short-term weather streams. However, chapter nine analyzed earth's cloud cover for last 50 years from satellite images. Khan and Khatun suggest that the cloud cover has declined from about 33 % to about 5 % and a decline of 95% by volume in the last 50 years having severe implications for earth's surface vegetation.

Cyclone Early Warning System: Mediating Science and Society

The Bangladesh Meteorological Department (BMD) generates the warning of cyclone and storm surge as well as passes this on to public media and preparedness units for dissemination and follow-up action at periodic intervals. Modern technology has been used for the detection and monitoring of cyclones from the forming stage to respective landfall sites. Warning messages are coined according to the information on the physical aspects of the cyclone when it remains at a far distance such as: tropical cyclone location, its motion, tropical cyclone wind speed and the probability of storm surge. However, the weakness of the present cyclone forecasting system in Bangladesh requires

significant attention to explore the need of the indigenous forecasting knowledge. The existing cyclone warning dissemination mechanism of the country is difficult to comprehend by local people, even by the most of educated segment of the society. Due to limitations of cyclone warning, Bangladesh cannot provide meaningful and effective early warnings of cyclone as well as storm surge. However, the indigenous indicators has potentials to facilitate the warning system to be implemented effectively. Chowdhury *et al.*, in chapter ten, indicates that effective forecast system needs to incorporate people's perceptions, explanations, and their own interpretations about the probability of disaster. The authors have emphasized on the significance of local knowledge in the context of effective early warning system. Because local knowledge is compiled through cumulative and collective experience, while it is checked, validated and revised daily and seasonally through the annual cycle of activities performed by local people.

Uneven Distribution of Climate Risks: Inequality Matters

Issues of climate refugees and forced displacement of people have become serious concerns of today. Mostaque and Hasan, in chapter eleven, argue that climate change induced migration is contributing to the increasing number of slums in cities in developing countries. The authors have explored different factors influencing peoples' choices of migration due to effects of climate change and suggested policy measures to be taken under similar conditions. In chapter twelve, Alom, Sarma and Sarker have addressed risks and vulnerabilities of adolescents' sexual and reproductive health during and after disaster situations. According to the authors, because of societal normative ideas, adolescents' sexual and reproductive health issues are always under-communicated, which gets further complicated when disaster strikes. This is risky situation for the adolescents as they have to take on adult's role without preparation and without support networks. In this context, community and parental acceptance and involvement in sexual and reproductive health issues of adolescents are crucial to minimize their SRH risks. The article of Tahsina Ferdous, in chapter thirteen, addressed gender issues related to the unequal distribution of climate change impacts. The author has explored relation between climate change and gender role in the northern part of Bangladesh where flood and river bank erosion are the most frequent natural hazards. Ferdous, however, suggests that women are more severely affected than male and are highly vulnerable to climate change impacts.

Community-based Adaptation and Resilient Development

The frontline people and rural communities are the first to have observed changes to seasonal weather patterns and extreme events. They are also becoming increasingly vulnerable in the context of relying on traditional environmental knowledge and livelihood practices, such as planting calendars, pest/ disease control methods, or animal husbandry (Jonathan Ensor & Berger,

2009; JE Ensor, Park, Attwood, Kaminski, & Johnson, 2018). In response to such observations, the community people have themselves initiated adaptive measures to stabilize their livelihoods. These local initiatives and associated lessons learned are the foundations of Community-based adaptation (CBA). CBA is “a community-led process, based on communities’ priorities, needs, knowledge and capacities” (H Reid, Cannon, Berger, Alam, & Milligan, 2009). A recent study, conducted in Timor-Leste and Solomon Islands, has argued that CBA can build resilience in target communities, revealing the inherent strengths of CBA in relation to resilience (JE Ensor *et al.*, 2018). Likewise, in recent years, there has been a significant growth in the academic literature on CBA, while practitioners have also showed raising interest on the same issue (Ayers & Forsyth, 2009; Behrman, 2013; Jonathan Ensor & Berger, 2009; Kelman, Mercer, & West, 2009; Mitchell & Tanner, 2006; Hannah Reid, 2009; Hannah Reid *et al.*, 2009). The CBA has the potentials for capturing local knowledge and understanding the complex connection between extreme climatic events and different livelihoods strategies (Pringle & Conway, 2012). CBA addresses the highly context specific nature of social, cultural and political relations those are situated in and responsive to local realities (JE Ensor *et al.*, 2018).

The paper by Haque, in chapter fourteen, reflects on CBA experience from the Coastline of Bangladesh. According to the author, the coastal zone of Bangladesh is characterized by a vast network of rivers and tidal channels; erosion and accretion processes continue, siltation takes place on water courses and river beds; and the area is prone to cyclone, storm surges and salinity intrusion. Haque argues that the people of coastal Bangladesh have developed a process of innovation and practices, a variety of coping strategies and community-based adaptation measures that are well-suited to the local environment, economy and socio-cultural system because these practices are based on indigenous knowledge acquired from their forefathers over the years. Bishokarma, in another article on CBA, sheds light on the community forestry program in Nepal. Although there are a few limiting conditions, yet the article argues that the program is suitable for planned, decentralized, cost-effective, linked and inclusive adaptation. Political influences, conflicts in land tenure, interest-conflicts among user-group members, high economic value of forest resources are the major challenges of management and conservation of forest, according to the article of Bishokarma. Chapter sixteen explores the challenges of cross-sectoral adaptation in the coastal areas of Bangladesh. Shanu and Rahman suggest that cyclone, salinity intrusion and rise of land surface temperature are the major climatic challenges for developing adaptation measures in the south-western coastal areas of Bangladesh. However, the authors claimed that onshore adaptation practices are under-explored in relation to existing possibilities due to impeded support services from both GO and NGO sources. The article makes the point that addressing the existing challenges faced by different local actors are crucial for developing long-term climate-resilient adaptation planning.

Comparative Policy Efficiency

Sharing of knowledge and experience among South Asian countries would certainly enhance the existing national and regional capacities to address these disaster and climate change concerns. Cross-country sharing of experience and lessons learnt on making and implementing policy and legal instruments would help us achieve shared policy objectives of reducing the vulnerability of communities and contribute to sustainable development by improving ability to better anticipate, resist, prepare for, respond to and recover from climate change impacts and natural hazards. Shabbir's article highlights such need of cross-nations leanings on legal protection and management of aqua biodiversity between Maldives and Bangladesh. The author has extensively reviewed the existing policy and legal instruments and their implications for coastal area conservation and development in Bangladesh. He makes the point that learnings from Bangladesh can help shaping the future legal mechanism for the preservation and management of marine ecosystem in the Maldives.

1.8. Conclusion

We end this introduction by tendering a call for due attention on cultural perspectives in the study of climate change, adaptation and resilience in the upcoming time. A cultural perspective would provide significant insights into the problem-field as well as achieve a scientific understanding and effective interventions to build on factors that allow individuals, communities, and societies to enhance resilience. The 16 articles, contained in this book, make a compelling contribution to the study of climate change in this region. At the same time, the issues raised in these articles point to substantial gaps in knowledge and perspectives that may be the challenges at the forefront of addressing climate change impacts in South Asia.

Endnotes

1. *Nations in South Asia include Bangladesh, Bhutan, India, the Maldives (islands), Nepal, Pakistan and Sri Lanka (island).*
2. *A niche is a distinct feeding strategy, the place of a group in the total environment, its relations to resources and competitors (Barth 1981: 3; Hardesty 1977: 109).*

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Chapter Two

The Colonial Legacy of Climatic Discourse: The Case of Bengal

Zahir Ahmed, Fatema Bashar, and Md. Noor Hossain

Abstract

This paper examines some published archival documentary sources for exploring the nature of climatic variability and extreme weather events during colonial era in Noakhali char (newly accreted land) areas in Bangladesh. Attention focuses on these contingent areas, both physical and social, covering a variety of natural risks such as gale, floods, droughts, storms and cyclones. A number of themes are considered. First, the evidence of varied climate events as triggers of agrarian risks. Second, correspondences of the District Magistrates to London where devastating climate induced extreme rainfalls, droughts and cyclones were described. Third, the impacts of selected historical climate variable events are explored in order to highlight how the degree of impact of an event was a function of particular environmental context in which the event took place. An overview of the vulnerability to climatic variations and extreme weather conditions is then provided, presenting those colonial recorded events that could potentially relate to today's discourses on global climate changes. The district Magistrates' narratives suggested variants of climate change even within a short span of time. We suggest that historically the term climate change is no longer new. Far from being new discovery, the term now simply recycles the past- and it is therefore high time to unveil its politics.

Keywords: Narratives, Climate Change, Ethnography, Colonial Legacy

2.1. Introduction

The issue of climate change is now all the rage of in various disciplines. Scholars in geography used to talk about the issue under the sub-discipline of physical geography. Now policymakers, researchers, NGOs, scholars, activists, state heads seem to be interested, and have embraced climate issues with an uncritical fervor. This article offers some critical historical reflections on this current climatic vogue.¹

Nobody seems to know exactly what climate change is, and one advocates even admits guilt feelings about using the term as ‘carbon dioxide centric climate change discourse’ (Fleming, 2005), but its effects on humans enable the anthropologists to take it seriously. Anthropologists’ interests on climate issues have been quite remarkable. It has always reflected a diverse range of adaptation, settlement, resilience and seen as a functional analysis.²

It is rare, therefore, to find sources that can reach records of past climate essential for providing a stronger basis for evaluating the historical context of extreme events helping us define our natural range of climate variability. Currently, our description of climate change such as rainfall and temperature patterns are largely confined to the 20th century. It is astounding to learn that in the early 21st century, we still do not have a robust, long-term history of climate variability in Bangladesh. Colonial diaries, letters, reports are crucial in that they act as both quantitative environmental data, particularly on weather and climate, and descriptions – that is, data to produce social and cultural information on climate occurrences and discourse. These sources were generally codified in meteorological records, but often not intended for wider readership. The information within them can be of variable quantity and quality. They range from descriptions of extreme events, through information on the daily/monthly climate variability on agricultural practices emanated from farmers’ fields, to notes on general weather conditions written by the district collectors/magistrates with a passion for weather responsible for poor yields and thus poor tax payment. Some meteorological data is also recorded through using modern scientific instruments. The material within the narratives of the colonial administrators can therefore say as much about the observers as the conditions observed. As information on past climate variability, colonial narratives were not free from bias and thus can therefore be challenging sources.

Nevertheless, the narratives of daily activities render attractive materials.³ The observers’ records were not ‘objective’ climatic realities, but also their own ‘embodied experiences’ within climate and their interactions with climate in their daily lives, as well as those around them.⁴ Thus historical reading of climate is needed for us to enrich our intimate understanding of *climate–people–place* interactions and to move climate change beyond the political impasse that it currently faces. This includes the ‘historicization’ of climate. In what follows we see colonial administrators’ reports provide us as sources of quantitative meteorological, social, cultural and economic information. They can provide ‘scientific’ data on rainfall, wind, temperature, humidity indicating climate extremes, and their personal insights into local lives.

This paper is an effort to highlight the ways in which colonial narratives can be used in the broad field of climate change research. The first part of the paper will deal with presentation of climate variability, including discussion of the administrators’ comments. The second will open up a discussion on methodology. The final section will address the ways that colonial documents can be analyzed to produce social, cultural and public health information on

climate, including monthly data on climate variability and social narratives of climate. In general, we argue that published and archival colonial reports, personal diaries and letters provide us with rich accounts about past rainfall, drought, floods and other significant weather events in a contingent coastal setting in *Noacally* (emphasis in original) during colonial period.

2.2. Missionary Narratives of Climate in Archival Research

Historically, the servants of the East India Company carried a preoccupation with the recording and classification of natural environments.⁵ During the early-mid nineteenth century the East India Company established the first systematic meteorological observatories in several territories under their control, including (in chronological order of opening) Madras, Calcutta, St Helena, Bombay and Singapore. However, the tradition of recording meteorological observations extended back significantly at the beginning of colonial expedition in India. We find weather chronologies in numerous archives including India Office Library, London, National Archives of Bangladesh, District Revenue Record Rooms and many Gazetteers. In the context of Bombay, Adamson has provided a list of secondary sources such as medical observations, travel writings, military records, ships' logs and a variety of personal diaries and correspondences.⁶

This is particularly true of weather and climate in Bangladesh as well. The colonial records such as diaries, letters and government's reports are particularly useful to reconstruct our past climate data. Using particular content such as heat, temperature or rainfall one can compare one source with others taken place over the periods. In our case we have used a number of colonial official letters and reports to reconstruct monsoon variation and intensity of temperature concomitant with the state of public health in relation to extreme weather over the years. These reconstructions are providing greater information on long-term climatic variability in the coastal areas, particularly the influence on the devastating natural disasters in *Noacally*. The reason to choose greater *Noacally* is that it has long standing colonial legacy through navigation and the district was located in coastal south where various natural calamities were common.

In such contingent conditions, both natural and social, we have found fascinating sources on weather variability codified in colonial records. The main aim of this paper is to present some preliminary evidence of climate and weather condition in different 'colonial stations' in *Noacally* between 1849-1878 using various corresponding letters and reports written by district Collectors or Magistrates. Noma and Chakraborty (1990) have compiled some "Select Records on Agriculture, Land Revenue, Economy and Society of *Noacally* District, 1849-1878" supply considerable information regarding the economic and social development of the 19th century Bengal. This work has basically compiled some colonial government's correspondences regarding jurisdiction, crime, economy, commerce, health, and a number of letters on weather and

climate condition in Chittagong, *Noacally* and Comilla regions. But this work has not been undertaken to analyze within colonial climate discourse, overlooking the significance of substantial monitoring and recording meteorological data in localities.

The extreme weather can tell us a great deal about the public health related with devastating cyclones, tides, cold or heat at different points in history, and the ways that these interacted with colonial discourse on governance. Jan Golinski (2007) has previously demonstrated the way that meteorological recording was used in Enlightenment Europe to demonstrate the intellectual authority of the educated elites. The Bengal weather information provided a contrast to the interest of maximizing revenues in particular geography and history. Therefore, concern about public health, agricultural productivity and the infrastructure were crafted with the very notion of everyday weather condition of localities in Bengal. Many correspondence letters illustrate this by showing how local colonial district collectors or Magistrates were advocating exempting the farmers for not paying revenues considering great losses they face during or after disasters.

The selective climate information we have gathered describes climatic variability which had a direct influence on public health. For our purpose, we have only confined to extreme weather and its impact on people and place. The colonial government was interested in relying on regular monthly reports and letters about the weather observations that in turn helped the government to the management of their estates. Of those weather data was not same quality. Some were produced by the district Civil Surgeons. Others were Police officers, Sailors, local *nazirs* or *chowkidars*. Most (although not all) information was emanated from the direct observation reports on particular incident of extreme weather. The Civil Surgeon attributes the high mortality partly to the large number of immigrants, who suffer from fever brought on by exposure and bad water, and partly to the ravages of cholera (District Gezeteer, 1911). Let us quote the narratives of a Civil Surgeon in *Noacally*:

Generally speaking the rainy months show the fewest deaths from fever, and the cold months, November to January, when the country is drying up, most; but the highest recorded fever mortality in any one month in the last five years, 3,722, was in May 1909 and the next highest in May 1905. Cholera is spread fairly evenly over the year; the great number of deaths in any month during the recent outbreaks being 1,073 in March 1907, but there were 963 and 759 deaths in November and December of that year, and 862 in August 1906. (ibid. 11).

2.3. Colonial Reports, Letters and Diaries as Ethnographies

If participant observation involves establishing rapport in a new continuum, learning to act so that people go about their business as usual when you show up, and engaging yourself everyday life, most of the colonial administrators tried to reach at the interiors to observe directly. This is the way of intellectualizing what the administrators learned, put into perspective and write about it descriptively.

Climate data, public health condition and many other aspects of everyday life of the native people had been taken what we now call as 'Field notes' (Sanjek, 1990). They collected specific information about things they saw and observed in natural settings; compared with other settings including Europe; asking civil surgeons, jail superintendent, police commissioners, chowkidars (guards), collectors and even prisoners to collect first hand data on weather.

Through these methodological endeavors, the colonial officials also relied on diaries, letters and personal experiences in drafting monthly report to be submitted to high officials. Without having academic analysis, it is possible to gain interesting information regarding the nature of weather events. For the colonial officials, the weather observations for preparing their monthly reports contributed to the management of the station in order to ensure their revenue.

This direct observation can tell us a great deal about the responsibility of a bureaucrat behind engagement with the situation of devastating disaster including the extreme weather at different times in history, and the ways that these interacted with broader colonial discourse to control over place and people.⁷ In his "Annual Cold Weather Tour" report, the then District Magistrate of Noacally Mr. Price informed us that he was out of the district head quarter of Noacally from the 13th to the 27th December in 1867 and visited the police station of Ameerganj. He narrated that he went to into the Mofussil (outside the head quarter) on 7th February and returned on the 13th March. During that time he visited and travelled considerable portions of the island of Sandeep, Hatia, Dakhin Shahbazpur and Monpura. At Sundeep he inspected the police station. At one stage he sailed round the island and saw a new island of Kalialirs Kangali char at Hatia. He lived in kacherry (An office from where revenue collections were made) for some days. With respect to weather he wrote:

The island is being rapidly washed away on the south and east sides and I saw many fields and homestead which had half gone into the sea. The lands near the east shore had become quite barren from being saturated with salt water and the suparee and coconut trees were dying from the same cause and several rayots had left or were leaving for chur Siddee and other places (Noma and Chakraborty, 1990: 306).

Beveridge has previously demonstrated this and his colleague used direct observations to demonstrate the governance of the area. The ethnographic observation was carried out in such risky areas. Beveridge himself stayed at Doulat Khan in the Head Quarters of the Dakhin Shahbazpur sub-division for several days. According to him, 'it is an ugly place and the town is dirty and disorderly built'. He also went round nearly the whole of the island in company with Mr. Domoyle, the then Deputy Magistrate and they visited the island of Monpoorah. The core narratives about the weather are:

The rains were late in beginning last year and the consequence was that tanks become more or less dried up and their water becomes bad. There was a good deal of fever and other sickness and it is supported that the drying up of the tanks had something to do with it. Noacally used to be a very healthy district but of late years it has cost its

reputation and both natives and Europeans suffer frequently from fever. The native of course suffer the most for they live in damp huts surrounded by suparee (betel nuts) trees and jungle.

These narratives can be confirmed if we look at the weather diary of Mr. Price, who remarked in his diary, “.. all circulation of air is impossible owing to the dense *suparee* gardens all round”. The district civil surgeon also kept a weather diary, or rather a private diary that included detailed daily weather observations (*ibid.*, 307). In his tour, Mr. Beveridge also observed that the weather observations are taken in Noacally at the police hospital. Unlike other districts, the jail doctor was unable to keep the weather information update. Alternatively, the prisoners were told to record the observations. One of the advantages of taking records by the prisoners, as Beveridge informed us, was that they were always on the spot. (*ibid.*, 308).

These kinds of records on weather observations may not be methodical and scientific. In other words, the ‘scientific’ approach carried out to observe weather condition systematically was limited to the real ‘facts’, such as rainfalls, temperature and cold. Generally, no attempt was made to link extremes weather upon health.

A more scientific approach had been undertaken by a District Magistrate called Mr. L.B.B. King presented systematic monthly meteorological data in 1872. He recorded regular meteorological observations in his report to the Commissioner alongside notes on the scientific public health, demography, prices of labour, and the like. His weather data shows the mean temperature, the rainfall and the direction of wind for each month. His records also show a changing nature of climate based on meteorological data that is absent in others, evidence of a new scientific endeavor. He also narrated that the rain lasted from the 2 May to 26 October. The total fall 132.815 inches was greater than that many years past, the average fall being 98 inches. The cold weather was more severe than in 1870. In the hot weather there was the usual pleasant sea breeze from the South which made the heat less felt (*ibid.*, 316).

Such colonial narratives demand special attention for assessing the historical context of extreme events, which will help us to apprehend current climate variability, just as the evolution of discourses such as the concept of ‘adaptation’ and ‘resilience’ are receiving attention today. What has been left out from these narratives was to understand how climate was embedded in everyday lives. This has strong ground for digging out the ethnography of climate narratives⁸. For example, climate and colonial observations are intimately related in order to keep records on agricultural productivity that was necessary to collect revenues. In addition public health was also intimately connected with the local inhabitants who were the keys to enhance revenues. The regular monitoring report on agriculture, climate, and public health were essential to obtain first hand data by colonial administrators themselves in order to understand first, the nature of calamities and second how to overcome these calamities during the period. The Collectors and Magistrates wrote of the effects of

weather extremes on local agricultural activities; they were also concerned about the health condition. They also accommodated systematic scientific approach regarding modern meteorological instruments released from Europe. The administrators got accurate scientific data on climate variability based on their personal visits to the affected areas in *Noacally*.

Numerous officials' diaries and notes demand for personal experience of weather and climate, which we do not have. Similarly, we do not have data on local inhabitants' views and experiences in understanding climate stories that were based on supernatural stories, socio-cultural beliefs, and everyday experience with the calamities. However, it is equally important to understand local responses to scientific explanation and instruments of climate measurement practiced by the colonial officials. Like the European colonists mentioned in the narratives above, we need to hear the voices of local people who used to explain the unusual weather, and showed little interest in colonialists' scientific observations.⁹

Analyses such as these do not just contribute to a deeper understanding of nineteenth-century colonial narratives of natural calamities, or vulnerability to climatic extremes. The narratives remind us that climate is, and always has been, an embodied experience. These colonial narratives containing in diaries, reports and letters also demonstrate that experiences of climate can never be separated from the context in which they were experienced, and that these contexts are intimately related with agricultural production and public health.¹⁰ Climate variability is not static; it is in flux and constantly changing. The nineteenth century colonial narratives may have important implications when addressing current climate variability.

2.4. Station Records and Climate Variability: Some Evidence

The district magistrates and collectors have been particularly interested in reporting weather conditions in detail. Though they did not provide detail meteorological data, the narratives were thick. However, as these were generally recorded as asides to social, economic and agricultural production, meteorological observations within particular areas were noticeable. The way a collector or a magistrate reported weather condition in relation to intensity of causes and damages was rich, because the information was emanated from the narrator's personal visits spent in the remote locality. This has also been evident from the records made by *chowkidar*, police and other local employees. Meteorological recording can be found in district gazetteers whilst letters and reports between collectors or magistrates were found to have correspondences with London. In the compile collection of colonial record books by Noma and Chakraborty show that corresponding letters about climate and weather describe extreme events of gale, cyclone, storm, tidal bore, other natural calamities. The climatologist Raymond S. Bradley describes the human observer as a "high pass filter, recording short-term fluctuations about an ever-changing

norm". Any form of non-systematic weather observation must, therefore, be interpreted extremely carefully.

To sidestep this challenge, some early analyses of historical climate from Noakhali District Gazetteer (1911) simply presented data with little or no systematically. For example, Gazetteers on Bengal or Districts Gazetteers in the then Pakistan presented an overview of climate, weather, people, health and the like in 1901 and 1947 respectively. Ibn Batuta and some Christian missionaries in *Noacally* recorded brief daily weather observations alongside implications notes. These were supported by district collectors and magistrates, but no analysis was undertaken.

In some cases descriptive data has been mentioned as a complement to systematic instrumental analysis. In Assam and Bengal Gazetteer, we find a qualitative observation within the weather component during 1911 that is devoted mostly to regular climate calamities. The description of weather notes was added to complement the thermometer readings. Likewise Noma and Chakraborty's compilations of colonial administrators' notes on several issues presented descriptive observations in a number of official letters from local station to London as monthly report to justify the monitoring hamlets for maximizing revenue. The weather had been further verified for future through using instrumental observations. The weather data, we got of these, include quantification of rainfall, heat, temperature, and a classification of cloudiness. This kind of information was further seen in Sub-continental station based meteorological data that were presented alongside a summary of climatic information shown simply as a table of extreme events including periods of drought, floods, heavy rainfall and cyclones. This approach was repeated by several colonial administrators in different colonies such as New Zealand, Australia, Africa and India during the early nineteenth century.

As we find descriptive climatic situation narrated by colonial collectors and magistrates, the scientific meteorological data has been initiated containing frequencies of days with observation, rainfall variability, cyclone, gale, tidal bore, heat wave and cold wave (see in Appendix- Figure 1 for climate variability). This included days of precipitation and cold/ warm days, as well as descriptions such as 'gloomy' and 'red'. A very little research has interrogated details, almost daily, records of precipitation from the records over the years. We need to know when and how long rainy days are differentiated, from days of slight to heavy rainfall. These could further be converted into estimated numerical precipitation using data at different periods, by proving that the distribution of slight to heavy rainy days had remained the same over the last hundred years or so. The reconstruction will then be able to show a general tendency of rainfall or any other calamities' intensity and variability during the colonial period, which agree or concur with documents. Only then we would be in a better position to comment that climate variability like rainfall in the last couple of centuries was generally higher or lower than that in the nineteenth or twentieth century.

2.5. Evidence of the Natural Calamities in District Gazetteers in 1911

In Gazetteers on Bengal and Assam, the diversity of weather in Noacally district meticulously recorded all the natural calamities did occur. The Gazetteer made specific mentions of weather conditions under the heading of Natural Calamities' that reads:

Thanks to the abundant and regular rainfall and the annual inundation of the rivers, the district is practically free from drought. The eastern portion between the great and little Feni River is liable to suffer from the overflow of the hill streams after heavy rain, but the water subsides rapidly and the damage caused is rarely very serious. But the islands and all the south of the mainland are exposed to the cyclones which sweep across the Bay of Bengal, driving the waters before them in great waves which sometimes overflow wide tracts of country, drowning men and cattle, destroying the crops, and often leaving behind them a residue of salt which interferes with cultivation for some time. In the year 1797 there was such a cyclone, described as the most destructive in the memory of men. (Noakhali District Gazetteers, 1911: 14).

After that the devastating cyclones of 1822, and again in 1825 and 1848 were mentioned in detail. We have been informed that when and how Hatia Island was entirely sub- merged by a storm wave, and sea-drift about four feet above the level of the country. Another devastating cyclone occurred in 31st October 1876 was ethnographically described in the document. The Gazetteer mentions,

For two days the sky had been threatening, drizzling rain falling at intervals, and clouds flying inland before an east wind. Late in the evening of the 31st the wind changed to the north and north-east, and blew with tremendous violence, uprooting some trees and breaking off others.¹¹

2.6. Evidence of the 1849-1878 in Archives

In *Noacalli*, Swndee and Hatia coastal areas faced severe cyclones causing widespread destruction. In reporting the then recent flood in the *Noacalli* district, Magistrate R. Proch wrote to the commissioner of Chittagong on 21 August 1875. The consequences of this weather uncertainty had been described by Proch in this way: As to loss of the human life it is reported that some occurred as a direct consequences of the flood. Several children and sick people were drowned in going about near their houses- but there are usual occurrences at this time of the year in this country which abounds with dangerous deep drains and watery pit falls" (Noma and Chakraborty, 1990:29).

One of the important aspects of cyclone was to produce several endemic diseases like breaking out of cholera etc. as prime consequence. In visiting one station in *Noacally*, the Magistrate Porch wrote to the Commissioner in Chittagong, "There is nothing but illness and wherever I go on my tour and there is sad distress in almost every house . During the past fortnight I have been in camp between 6-7 miles north of the station at Maizdi- population 616 of who 80 are said to have died of cholera since the cyclone- 16 having died while I was there. I opened a medical relief center there and did what i could for the sufferers (ibid, 36)."

In describing the causes of death, the Magistrate further clarifies: “The disease seems to be breaking out northwards all along those parts where the cyclone by bringing a fresh water flood (sic.) from the north at an unseasonable time has caused disturbance of the ordinary conditions of moisture in the cold season solar evaporation is much retarded (*ibid.*, 37). “The changing weather may contribute to reduce this misery mentioned by the Magistrate in this way, “Heavy rain is now falling and there is a strong northwesterly winds blowing I hope it may somehow clear away the causes of cholera and prevent any further return of the melody” (*ibid.*, 37). In a similar vein, on 24th March 1877, Mr. Proch wrote that the death by the inundation on October 31st 1876 is 45,443. On the other hand the deaths from cholera from October 31st 1876 to February 28, 1877 are 45, 450” (*ibid.*, 39).

No doubt the colonial officials faced uncomfortable weather when they were recommended to stay in Shahbajpur station. According to a Magistrate, It is beyond imagination for a foreigner to stay in this place. As a Deputy Magistrate and Deputy Collector to the collector of Noacally dated 14th August 1867 narrated,

*There are several reasons for this. For a European the vitiating and uncongenial climate--the privation of every comfort and many of the necessaries of life (table rice even cannot procured here)--the want of healthful exercise and the utter isolation of Dulut Khanare sufficient and if there be, by chance, more than one European at Dulut Khan they look on themselves as brothers in affliction. If a native officer be asked his reason for disliking the place, he will, after describing the big dangerous river emphatically sums them up by saying Nona Jal and Nona Howa (*ibid.*, 72).*

With respect to ‘cold weather tour’, similar observations are found in the narration of a District Magistrate of *Noacally* during early April in 1866. For example, Mr. Pepper visited the interior of the district during the last cold weather. He wrote in his diary that the weather was freezing cold because of the excessive rain. His predecessor Magistrate J.C. Price also visited rural interior and kept weather observations in his diary as an evidence to send to the Commissioner of Circuits at Chittagong on the 1st April, 1866. He recorded regular meteorological observations. His writings show the changing nature of climate in the district. As he narrated, “There was I believe no very great change experienced there in the weather or general health from what these have been in previous years: in the later part of 1865 the weather was very warm and unhealthy. Heavy showers of rain accompanied by storms set in during the end of April and continued up to September” (*ibid.*, 304). A causal link between warm weather and unhealthy condition was visible in Price’s narration. Predominantly this consisted of reflections on the diseases people faced irrespective of natives and Europeans”.

As Mr. Price further elaborated, “During this period I learnt that sickness was very rife, no single family was exempt from fever; the Europeans also who possess better appliances to guard against the disease did not escape; upon whole however it did not prove generally fatal. This may have been owing to

the fact that the natives have now commenced to appreciate the efficiency of European medicines, particularly quinine, and to entertain a very unfavorable opinion of the medicine administered by native quacks or *kabiraj*. At present I regret to say fever is on the increase and there have been cases of cholera in the interior" (ibid., 304).

This specific narratives tell us how much influence of the climate upon public health in the interior, and responsive to broader Western medicine narratives at the time of crisis that equated climate with health and place. Adamson and his colleague argue that the transformation of East India Company from a trading company to a territorial organization resulted in the exploration of new localities (hence new climates) and thus enabled them to stay permanently. As Adam and his colleague rightly pointed out, "This was thought to be perilous to the health of colonists, and it was also feared that the new climate would threaten their racial superiority"¹².

We have seen that the colonial administrators carried a preoccupation with the recording and classification of natural environments in coastal area in Noakhali. This has been particularly true of weather and climate. When digging out the coastal archives, we have come across evidence that during the early-mid nineteenth century the East India Company established the first systematic meteorological observatories in several territories under their control, including (in chronological order of opening) Madras, Calcutta, St Helena, Bombay and Singapore. A further investigation is needed in order to find out the legacy of recording meteorological observations extended back significantly further than this, with weather chronologies of a shorter duration available in numerous archives around the world. One of the aims of these meteorological readings was to assess the likely crop yields and their responses to droughts and floods in Bengal.

2.7. Postscript

In this paper we have tried to analyze some documents regarding weather and climate variability in a coastal setting in southern coastal part of *Noacally*. We have used some District magistrates' monthly letters and descriptions on various issues such as agriculture, weather, and climate, provide a unique set of materials within climate change research in that they provide information both on past climate variability and on the ways that people live within climate. The reports/letters, as we have seen, were based on both direct observations of the administrators and different responsible persons belonging to bureaucratic hierarchy. To do so, we have quoted some weather narratives that contained full of ethnographic data such as days with/without precipitation, the condition of grain plantation and harvest dates and consequences of various calamities in Southern part of then *Noacally*, Shabajpur, Hatia, and Swundeepl islands during colonial period. As narratives, we contend that the methodological issues are fascinating and we want more to hear. We have also argued that

most were highly based on personal experiences and narrative style of presentation was lively. In addition, we have shown that corresponding letters can therefore represent ethnographies, representing live accounts of the administrators' interactions with the weather condition and most importantly, in some cases, the ways that weather informed the complex relations with public health and agricultural productivity. Colonial Magistrates/ Collectors' narratives can therefore exemplify more nuance understandings of place, people and climate, reflective of a myriad of social, cultural, political and physical narratives of localities.¹³ The colonial narratives of climate variability can therefore provide important contributions to current debates, enabling us to see how climate is and always has been an embodied experience. We argue for digging out history to get a societal record of the local peoples' response to past climatic conditions in colonial Bengal, juxtaposing both colonialist and colonized narratives, if any.

Gergis's suggestion for seeing climate as an '*embodied experience*' in the context of colonial Australia is important for us as well. This understanding enables us to develop perspectives on how and why colonial climatic discourse enquirers into the relationships of people to particular geographic place, producing what we would term 'political climatology' in which natives responded to the environmental costs of natural calamities. We should beware of using colonial diaries and records on the meteorological data in terms of natural environment alone. We should also be cautious of investigating how weather and climatic narratives are interrelated with public health and agricultural productivity and how natives responded to that in terms of the relationships and practices that took place within them. This has not been codified in colonial climatic discourse: describing only climate variability and their devastating consequences on local livelihoods. Recommendations were made to take measures for the betterment of people and place.

We have seen that narrative as the most spontaneous historical representations has a central role in complex relations. We have argued that climatic narratives can be read from colonial archives, not as the coherent accounts, but as ambiguities and contradictions. So we have to study the politics through which climatic narratives are constructed. Ethnography in the archives makes such an effort possible. To come up with a similarly nuanced account of 'current climatic narratives' we have to attend to a similar politics of production.

Climate is thus political and social in several senses: not were local people victims of climate hazards, but they might have experienced this hazard in terms of strategies and relationships. Centrally too, why did the colonial administrators travel between remote places to observe climatic disasters? By visiting, as we have seen, different geographical spaces they were thus embodied in different political ecologies and bureaucratic hierarchies in order to govern. Obtaining meteorological data, among others, had been essential to record. It is necessary to apprehend the essence of meteorological readings which was devoted to assess the likely crop yields and their responses to drought and floods. We thus go for unveiling these teleological narratives by which colonial sustenance was made possible to continue governance for a long time.

Endnotes

- 1 Ludden, David. 1992. 'Anglo-Indian Empire', In Burton Stein. *The Making of Agrarian Policy* has described the process in respect of agricultural surveys and settlements, Nicholas Dirks, 'Castes of the Mind', *Representations* 37:56–78, for colonial Anthropology, K. Sivaramakrishnan, 1995. 'Imagining the Past in Present Politics: Colonialism and Forestry in India', *CSSHA* 37 (1): 3–40.
- 2 Prakash, Gyan. 1990. 'Writing Post Orientalist History of the Third World: Perspectives from Indian Historiography', *CSSH* 32 (2): 383–408. Chakrabarty, Dipesh. 1992. 'Postcoloniality and the Artifice of History: Who speaks for "Indian" Pasts?' *Representations* 37: 1–26.
- 3 Ecofeminists or political ecology approaches seem to be creating a 'sense of disarray' in understanding given phenomenon. (See Vandana Shiva, 1988. *Staying Alive: Women Ecology and Development* (London: Zed); Elizabeth Croll and David Parkin (ed). 1992. *Bush Base: Forest Farm: Culture, Environment and Development* (New York: Routledge).
- 4 (See Ajay Skaria, 1996. *Hybrid histories: Forests, Frontiers and Oral Traditions in Western India*. Delhi, Oxford University Press; Also see *idem* (ed.), 1989. *Subaltern Studies: Essays in the History and Society of Colonial India*, Vol. 1–6.
- 5 We use the term embodied experience here used by Adamson (2015), explaining the complex relationships between nature and society.
- 6 A fascinating discussion of this historical process as functional territorialization of state resource control can be found in Peter Vandergreest and Nancy Peluso, 1995. 'Territorilisation and State Power in Thailand', *Theory and Society*, 24: 385–426.
- 7 This has been well argued by David Arlond and Ramchandra Guha (eds). 1995. *Nature, Culture, and Imperialism: Essays on the Environmental History of South Asia* (Delhi: Oxford University Press).
- 8 In historical anthropology and cultural history such historicization is important. We find it useful to see the anthropological classics such as Marshal Sahlins (1981), notably *Historical Metaphors and Mythical Realities Structure in the Early history of the Sandwich Island Kingdom, Association of Social Anthropology in Oceania* (Ann Arbor, The university of Michigan Press. See also *idem*, 1985. *Islands of History*, Chicago: The University of Chicago Press; Jean and John Comaroff 1991. *Of Revelation and Revolution: Colonialism, Christianity and Consciousness in South Africa*, Volume 1, Chicago: The University of Chicago Press.
- 9 See K. Sivaramakrishnan, 1995. 'Situating the Subaltern History and Anthropology in the Subaltern Studies Project', *Journal of Historical Sociology*, 8(4): 395–429 and J.D.Y. Peel, 1995. 'Who Has Despised the Day of Small Things? Missionary Narratives and Historical Anthropology', *CSSH* 37(3), Marilyn Silverman and P.H. Gulliver, 1995. 'Historical Anthropology and the Ethnographic Tradition: a Personal, Historical and Intellectual Account', In Marilyn Silverman and P.H. Gulliver (eds.) *Approaching the Past*, New York: Columbia University Press.
- 10 See Zahir Ahmed, 1999. *Risk, Knowledge and Power: Indigenous Knowledge and Development Discourse in Coastal Noakhali in Bangladesh*. Unpublished PhD Thesis, Social anthropology, University of Sussex, UK. It provides interesting ethnographic instantiation of these perceptions. Ahmed's research also documented colonial narratives about Noakhali charlands on various issues.
- 11 For Narrative analysis in its historical context see: Stones, Laurence. 1979. 'The Revival of Narrative: Reflections on New Old History'. *Past and Present*, 85:3–24. White, Hayden. 'The Value of Narrativity in the Representation of History'. *Critical Inquiry*, 7: 5–25, *idem*. Norman, A.P. 1991. 'Telling it Like it Was: Historical Narratives on their Own Terms. *History and Theory* 30(2): 119–35. Commaroff, John and Jean. 1991. *Of Revelation and Revolution: Christianity, Colonialism and Consciousness in South Africa*. Vol. 1, Chicago: Chicago University Press.
- 12 The destruction had been narrated in the following way: "In Noacally, every mud or mat-walled building was leveled to the ground, and only one Deputy Collector's court remained standing. Those trees which stood against the storm were stripped of their leaves, and their branches broken and scattered. Early in the morning a tidal wave, at least six feet high, burst over Sandwip and Hatia from the south-east, and was followed very shortly by another wave six feet higher from the south-west. The waves swept across the islands lifting roofs from the houses and whirling

away the debris. On the outskirts of the island, where there were few trees and the people lived in detached houses, nearly all were drowned before they had time to escape. ... About four in the morning the wave reached the mainland and swept over it for some miles from the shore; at 7 o'clock the water in the main streets of Noacally was still 3 feet deep and running with a strong current, carrying along broken fragments of houses and shops". (Report on Cyclone and its effects, LR., Vol. 31. pp. 787-88).

- 12 See also Chris Bayly 1990. *Indian Society and the Making of the British Empire*, Cambridge University Press. 'David Washbrook, Law, State and Society in Colonial India', In C. Baker. G, Johnson and J. Gallagher, (eds.) Power, Profit and Politics, Cambridge University Press.
- 13 For our purpose environmentalism may be defined as 'ideologies and practices which inform and flow from a concern with the environment' Cecile Jackson, "Environmentalism and Gender Interests in the Third World", *Development and Change* 24(4): 649-77. See also Agnew, John. 1989. "The Devaluation of Place in Social Science", In John Angew and James Duncan, *The Power of Place: Bringing Together Geographical and Sociological Imaginations*, P-9 (Boston: Unwin Hyman).

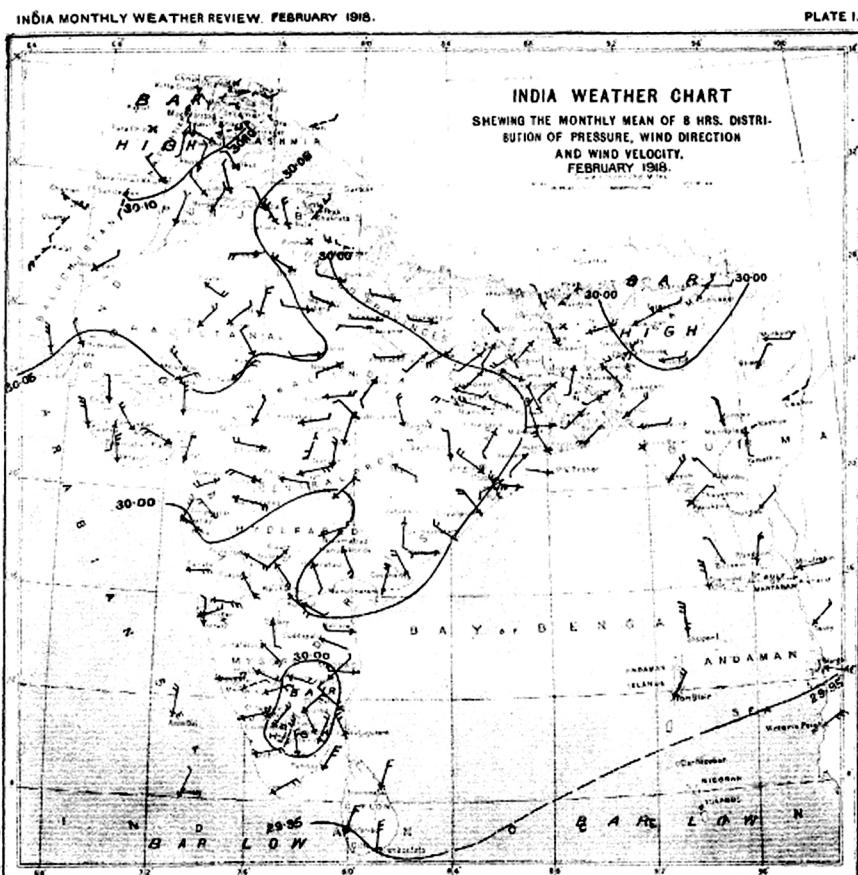
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Appendix -1

Map- 2.1: Noacally Gazetteer, 1918



The lines of the above chart represent isobars or lines of equal barometric pressure, the numbers attached indicating the barometric pressure in inches and being down for differences of pressure of .05 inch. The isobars in the Bay of Bengal are filled in by means of the shore observations, and by comparison with the normal distribution of pressure.

The mean 8 hrs. wind directions of the month are shown by means of arrows flying with the wind, and are calculated by means of Lambert's formula applied to the winds as given in Table B of the 8 hrs. observations. The mean wind directions for the hill stations are indicated by broken arrows to distinguish them from the wind arrows for the plain stations. The mean velocity of the winds during the month is shown by the following notation:-

Velocity of	0 to 2 miles per hour	... one feather added to the wind arrow.
"	2 to 5 "	... two feathers "
"	5 to 10 "	... three "
"	10 to 20 "	... four "
"	over 20 "	... five "

Wind strengths are based on factor 2.2 for the standard type of Beckley-Robinson anemograph, instead of 3.0 as used for this plate up to December 1911 inclusive.

Translating the Unthinkable in Bangla *Bratakathas*: A Study on the Cultural Dynamics of Climate Change

Santanu Banerjee

Abstract

The present paper would focus on the concept of the “Unthinkable” in the context of Bangla Bratakathas by expanding some ideas of noted social anthropologist turned novelist Amitav Ghosh. In his recent non-fiction entitled *The Great Derangement: Climate Change and the Unthinkable* Ghosh has sought to re-establish the power of fiction in its capacity of anticipating environmental catastrophes in the Anthropocene. Interestingly the roots of such fictional anticipation seem firmly embedded in certain clearly recognizable “religious discourses” of which the Bratakathas in Bangla could also be obvious examples. Being compendiums of common people’s religious views, those texts have been of marginalized position in the well accepted histories of Bangla literature. The present paper would suggest that in the regime of climate change the “climate of writing histories” of literature should also change by reconsidering the worth of those texts which tell of a so far “Unthinkable” interconnectedness of natural events. Finally, the paper would touch upon the importance of translating Bangla Bratakathas into English as a means to bring about change in our literary conventions.

Keywords: Unthinkable, Anthropocene, Bratakatha, Literary Historiography, Para-Literature, Postcolonial Studies

3.1. Bratakathas Prefiguring Literary Environmentalism

One of India’s septuagenarian poets writing in English, Aju Mukhopadhyay had published a volume of verse in 2014 entitled *Manhood, Grasshood and Birdhood* which he introduced with these words, “Though poetry is not much valued in humdrum society, real poetry prevails throughout the ages while many temporary constructions and contemporary castles crumble to ruins” (see *Manhood 3*). It has been a clue for reading the rest of the book with such

an interesting title which is probably explained towards the closing lines of the poem ‘The Grasshood’, “man lives and lives/dying to himself many times/ until one day to realize/ that grass like earth/ and wind and space/and water and fire/ and breath/ is superior/ to man/ naturally (see *Manhood* 64). The real poetry is thus not printed on pages, it is rather writ large on the face of the Earth that has been the abode of human existence alongside the place of subsistence for all other living and non-living beings. This Earth with all its poetry is undervalued by us since we rate too much beyond all other things our “temporary constructions and contemporary castles.”

An astounding similarity with what Mukhopadhyay has sought to opine through his verses could be found in an acclaimed short fiction writer in Malayalam P. Surendran. In his collection of short stories in English translation *Border*, there are two tales namely “Indoors” and “Outdoors” referring to the *Tolakappiyam* which consists of two complex words *akam* and *puram* which literally means interior and exterior respectively. But as the ancient Tamil bards were literalists of imagination they had been using the external nature symbolically to speak for specific human situations by developing imaginary landscapes, their poems bore a testimony of the world-view where human beings and nature were two parts of a whole, existing in some sort of metonymic relation with each other. Surendran’s twin-tales are actually his failures of resurrecting this glorious past in the present; his alienation is more assured and so is his desire to cope. His “Indoors” poses the problem of whether he should allow a tree to fall down in order to build a house on his own piece of land? There is no architectural design which could show how a tree could be accommodated indoors; in no way the natural world could be allowed space in the world of human affairs. Hence he finally decides to construct the house according to temple architectural design such that it could be built around a tree giving the natural world central importance (see *Border* 23-24). In “Outdoors” on the other hand what is highlighted is the desire of somehow bypassing the act of house-building itself; an attempt of embracing gypsyhood; the author writes, “Now my life has become one unending struggle not knowing whether my house is indoors or outdoors (see *Border* 25-26).

Keeping in mind those recent literary responses of different genres and in various languages of India we may proceed to understand how relevant Bangla *Bratakathas* are in the context of climate change. A tale concerning the *Bhaimi Ekadashi Brata* (see *Meyeder* 153-154) is traditionally narrated on the occasion of the celebration on the eleventh day of the lunar fortnight in the month of *Magha*. There is an unmistakable defiance of realistic narration to be found in the tale; for the *Bratakathas* are most often fantastic stories. But in this tale this defiance is not so much visible in the portrayal of human characters as in course of the depiction of nature. Taking clue from the *Mahabharata* it creates the mother and the son– Kunti and Bhima respectively, who are miniaturizations of the original characters in the epic and seem much more life-like. Kunti is an old woman seeking to perform her ritual-vow by taking a plunge in a river even in the month of *Paus*, one of the coolest months in the Hindu calendar.

Bhima is depicted as a loyal son to his aged mother who loves her so much that he could go to any extent in saving her from adversity. Kunti is almost dying of cold after bathing in the river, and her son rushes in to teach the river a good lesson by putting into it a piece of red-hot iron which makes the water boil and turn the whole atmosphere warm. That the human beings are the masters of nature is the essence of this particular narrative representation. However, the spell of this realism is immediately challenged when Varuna, the deity of the waters is described amidst the hot stream as a very insignificant creature, a small toad. It is half-burnt by the mindless action of Bhima who has paid no heed to its presence while giving comfort to his mother. Probably, this is something beyond common imagination of a reader that challenges the realistic anthropocentrism of fictional narrative by awakening him into a new plane of human existence. As the toad croaks loudly and its cry reaches heaven, none other than Vishnu listens to her pain. He immediately makes Bhima accept his crime even though it is done most unknowingly. The *Bratakatha* thus considers the utter neglect of nature on the part of the human beings as a sinful act. Bhima is asked to fast, repent, and finally perform the *Brata* himself in order to get rid of the sin. It is well known that a *Brata* is observed chiefly for human wish-fulfillment. But the tale confirms strongly, no fulfillment of human wish be allowed at the cost of the non-humans on earth.

3.2. Some Thoughts on Bangla Literary Historiography

Though Mukhopadyay's verses or Surendran's vignettes would find a precursor in the above tale, in general Bangla *Bratakathas* are not given their due acclaim as literature-proper by any literary historian of repute. Researchers in the field of postcolonial studies reiterate that the colonialists' paradigm was to treat age-old customs, beliefs, rituals and also tales related with those rituals as instances of something very primitive in the culture of the colonized, probably best suited for ethnographic rather than literary studies. The nationalist literary historians were interested in creating a glorious past which could justify their actual concern of modern literary creations in the native languages. Neither the cultural and literary pasts nor the corresponding present of the erstwhile colonized nation are to be treated by them as inferior to the colonialists'. Though the present of the nation is more important than the past, the past in nationalists' imagination is rather a means to legitimize their present which they think either superior or at least equal to the present of their erstwhile rulers. And the Marxists focused chiefly on the struggle of ordinary human beings in literature believing that they were more progressive than their nationalist counterparts. They treat the culture and worldview of olden times subservient to their typical historical – materialist interest. Probably, the *Bratakathas* for them are products of agrarian and feudalistic socio-economic structure not fit at all for the taste of the industrialized modern society. The result has thus been a relegation to the margin, this very important corpus of narratives which most often talk about sustainable relation between the human and the natural world.

The present paper seeks to focus on the climate crisis and cultural dynamics with reference to these *Bratakathas*. In a personal attempt of translating such tales into English, it is found that they are capable of evoking the ‘unthinkable’ as this particular term is used by Amitav Ghosh in his book *The Great Derangement: Climate Change and the Unthinkable* (2016). And by this, the tales may relate to the most contemporary documents like the Paris Agreement signed by the leaders of various nations across the world, and also the famous encyclical *Laudato Si’* issued by the Holy Pope at Vatican. A call for the conservation of these ritual tales is implied in the paper. It is a matter for great fortune that in Bangla literature the presence of such tales would ensure for us a culture of prolonged and sustainable habitation on this beautiful bluish-green planet.

As a noted social-anthropologist and littérateur Ghosh has pointed out that contemporary literary imagination hardly recognizes the extreme natures of today’s climate events. In the historical writings too, climate change is grossly simplified. And to top everything, in the contemporary political scenario, climate issue is considered as a matter of personal – moral and ethical choice rather than collective action. What we actually need in the Anthropocene, Ghosh rightly mentions, is an ardent search for other forms of human existence (see *Derangement* 213-217). For it is quite evident that we can no longer be satisfied with the human beings at the center of all our thoughts and actions. What Ghosh has thus been pointing out in the book most emphatically is beyond question linked with another fact that is not discussed by him in detail. Scholars seriously engaged in the field of literary studies know that there is no dearth of texts which look at human beings-nature relationship from a completely different angle where nature is not inert, it is not granted as mere resource to be exploited, and it has never been muted to human domination. The greatest failure is of literary appreciation perhaps which fails to consider the importance of such texts as those are not allowed to enter into the established literary canons. Though those texts may share a great deal in the formal features of literature-proper, as it happens in the case of the *Bratakathas*, they largely occupy a middle space between literature and non-literature. They belong to the category of Para-Literature. G N Devy remarks in this context, “... the distinction between literature and para-literature is not a distinction between two different fields, but a distinction within a single field as the one between totems and taboos within a single culture, or as between the self and the non-self within a single field of consciousness. The political dispossession of linguistic and social margin is the root cause of the creation of such categories” (see *Reader* 150).

3.3. Approaching the Unthinkable in Literature

Ghosh’s book has been referring from time to time now well-known ‘four theses’ by the famous historian Dipesh Chakrabarty. In Dipesh’s argument, one should consider the human beings as the most powerful geological and not biological factor in the history of our planet (see *Derangement* 256). Its

course of action over centuries is to be read as much more catastrophic than the sudden appearance of a meteor into the earth's atmosphere which possibly caused the extinction of the dinosaurs. Like the climate of our planet itself, Dipesh finds the climate of history predominated by the forces that essentially focus the human beings. It is a history of the, by the, and for the human species narrating their triumph over all other living beings and non-living elements. The geological reality coupled with the cultural reality have lead the human species to the ironically 'new epoch' of impending disaster, the epoch of the human beings, the Anthropocene. As people concerned with literature we must ask a question here – is literary history much dissimilar from history-proper? Literary events may differ from other historical events in that literary events do not affect the material world in the same way as the 'real' historical events do. Literary texts, both oral and written have the capacity to survive over long periods of time because every time they are encountered, they may take on a fresh life. G N Devy puts it very simply, "history deals clearly with past events, whereas literary history has to deal with events which seem to belong to the past but also belong to the present. History mediates between the readers of the narrative and the past that is narrated; but in the case of literary history this mediation is superfluous because the readers of literary history have direct personal access to the past literary events" (see *Reader* 8-9). But it is a pity that in spite of such strong dissimilarities, the anthropocentric logic of writing history proper also guides the literary historians. Devy is quite apt in pointing out, "Institutionalized study of literature turns literary history into the means of raising powerful and persuasive myths about literature, privileging some areas of creativity and repressing and concealing others. No literature, recognized as literature, escapes the fate of being represented by literary historiographers" (see *Reader* 10). Bangla literary historians Dinesh Chandra Sen, Sukumar Sen or Gopal Halder, to mention among the stalwarts, never took any serious interest in the *Bratakathas*.

If in the regime of climate change one needs to understand the desirable literary representation of the relation between the human and the non-human worlds one may easily turn towards the wealth of Bangla ritual tales. While the lesson of the Enlightenment is to read this relation in terms of a hierarchy where the essential human gift of reasoning makes the human beings superior to all other things under the sun and enjoy an unabated freedom of dominating and controlling everything, an altogether different message could be decoded from the *Bratakathas*. An example of it may be offered from the *Aranyakasti Brata* – most popularly known as the *Jamaikasti Brata* celebrated in the hot and humid month of *Jaistha*, on the sixth day of the bright fortnight (see *Meyeder* 55-57). Here the human settlement and the forests are the two different worlds where cruelty and injustice loom large in the human quarters while mercy and justice are initiated in the jungle. That the non-human world is not a passive recipient of the faults of the human world, that unthinkable consequence of human action may also occur, and that the human beings must compensate through their actions both moral and physical, the imbalance in the system they have created- is evident in the tale.

Amitav Ghosh writes in the context of his novel *Hungry Tide*, the mutual gaze between the human and the non-human worlds in the Sunderbans, which is often absent in the case of ordinary people living in the virtual safety of cities and towns, a desired correspondence in Anthropocene (see *Derangement* 38-39). It seems that similar correspondence is there in the *Jamaishasti Brata*, (see *Meyeder* 55-57) narrated much more non-seriously, and in a small scale. The youngest of all daughter-in-laws in a Brahmin household secretly craves for the delicacies prepared to celebrate *Shastipuja*. Getting the opportunity caused by the absence of her mother-in-law, she eats the dishes herself and puts the blame on the shoulder of a black cat, a pet in their house, customarily believed as the favorite vehicle of Shasti. Taken the cat as the culprit for the vanished foodstuffs, instead of the daughter-in-law who successfully saves her own public image, the mother-in-law thoroughly lashes her broom on the poor animal and drives her away. Not unlike the toad in the *Bhaimi Ekadashi Brata* her cries too are heard by the divine, in this tale Shasti, who resides deep in the forests.

In the second part of the tale the action is reversed. The daughter-in-law gives birth to more than one child but all vanish strangely. The mother-in-law now considers her son's wife as an ogress and drives her away with the same treatment she did earlier with the cat. The respective paths of the destitute daughter-in-law and the cat now cross in the forest where the animal takes the human being to Shasti for mercy. But the deity sets a challenging task for the daughter-in-law. It is worth-noting that she is to wipe clean with her tongue some foodstuff from the rotting corpse of a black cat in order to get herself restored along with the black cat into the household. She performs as directed, gets all her babies back, and in the company of the cat is finally welcomed by her in-laws. The most striking difference between this tale and the *Bhaimi Ekadashi Bratakatha* is that here the daughter in law has never been ignorant of her crime. But the human beings taking advantage of the non-humans for their own sake either knowingly or unknowingly are not spared. The message is clear - it is rather the responsibility of the human beings to ensure a peaceful co-habitation.

In each tale of this sort, the divine figures are endowed with miraculous power as usual. But it is interesting that they use their authority at some crucial time in the tale for the very purpose of re-introducing a balance into the system already disturbed by the human beings. There are many *Bratakathas* in Bangla, which directly refer to the water-bodies – their creation and conservation. Of what importance these tales could be in the present times need not be explained perhaps, since the rapid increase in the growth of human population has threatened the aquatic ecosystems either by polluting water sources or by permanently doing away by filling them up. The famous *Yama Pukur Bratkatha* narrated during the months of *Ashwin* and *Karthik* would probably explain it better, the role of the powerful in promoting an ideology of not diminishing the water-bodies rather generating and preserving them.(Meyeder 107-111)

This is an action not expected out of any personal moral or ethical choice of the individual, but as a duty towards a better future. Out of a personal animosity, the old mother-in-law frustrates the plan of her daughter-in-law time and again of worshiping Yama and digging ponds in the area surrounding their house. When she dies of an incurable disease, her soul is led to suffer in the limbo for a very long period of time. The recipe given by Yama to the old woman's daughter that her daughter-in-law, now pregnant, is to be requested to complete the vow, unless the suffering of the old woman's soul shall not end. But owing to her personal hatred, the daughter-in-law now refuses to perform the *Brata*. As a result she suffers from immense travail-pain which makes the delivery of the baby difficult. This personal difficulty is overcome by doing the social task of digging up a couple of ponds.

3.4. Why Translate the Bratakathas?

One must finally come to the issue of translation in rejuvenating interest into such narratives. It is well accepted that translation of native language texts into English is obviously a mode of writing back. But is there any justification now of doing it in the tongue of erstwhile colonizers and the present neo-colonizers the tales containing ecological messages? Going by the discourse of the discontents of globalization, the erstwhile colonizers and also the present neo-colonizers must accept their liability for taking the world so far on the path of destruction. Those who think they are not responsible for the climate crisis must go for protest, must resist, and they must always try to write back. However, the time has come to understand in greater dimensions that we have enough of politics, and should now think of a common danger we are already in, that we as human beings only are not capable of anticipating the kind of derangement waiting for us. We must come out of our anthropocentrism first, and translation of the *Bratakathas* could be a cultural means to that very end.

Both the Paris Agreement and the *Laudato Si* voice the climate crisis which is for all; though Amitav Ghosh notes a fundamental difference between these two very significant texts on climate change “The difference between the two texts is never clearer than in the manner of their ending. The Agreement concludes by conjuring itself into being through the will of the signatories and by announcing the date of its self-actualization ... The very syntax is an expression of faith in the sovereignty of Man and his ability to shape the future. The prayers with which *Laudato Si* concludes, are an appeal for help and guidance ... questioning of the idea that ‘human freedom is limitless.’”(212 -213) The translation of the *Bangla Bratakathas* shall not be so important because that could be an excellent postcolonial political move, rather it would be more meaningful because it re-emphasizes the words of *Laudato Si* “man is not only a freedom which he creates for himself He is spirit and will, but also nature.” Ghosh rests his faith on religious worldviews in the context of the culture of climate change. He writes, “religious worldviews are not subject to the limitations that have made climate change such a challenge for

our existing institutions of governance: they transcend nation states, and they also acknowledge intergenerational, long-term responsibilities; they do not partake of economist's ways of thinking and therefore capable of imagining non-linear changes – catastrophe, in other words – in ways that are perhaps closed to the forms of reason deployed by contemporary nation states" (215). For this reason probably, the *Bangla Bratakathas* should be translated, and to be taken seriously.

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Chapter Four

Cultural Perception and Engagement of Children in Climate Change Adaptation

Sumayyah Kadir and Tanjila Islam

Abstract

Climatic hazards have served to be a prominent and perpetual risk to societies and individuals throughout our time, and the subsequent vulnerability can galvanize adaptive resource management. The adaptive capacity reflects the ability of a community to act collectively to any vulnerability they face. This paper explores the social dynamics of adaptive capacity and how society perceives and responds to climate change—essentially, how society's response, and consequently their resilience, is mediated through culture. Societal perception largely involves direct personal experiences with climate change in time and space, and it includes how much cognitive presence the issue has in an individual's mind over other concerns. Moreover, sense of place and identity is a vital element of culture—in simple terms, the attachment one experiences around their settlement, and how place is a fundamental component in an individual's or community's identity and therefore their culture. The paper examines the significance of the role and engagement of children in adaptive measures, and how they being agents for change are fundamental in building resilient social-ecological systems that cope with change and crisis. Children, being the most vulnerable to the impacts of climate change, are rarely included in adaptation policies and plans. The final section of this paper will contend that including children's perspective and integrating their specific needs in a child-centered approach to climate change adaptation can greatly reduce vulnerability and increase community resilience.

Keywords: Children, Vulnerability, Adaptive Capacity, Resilience, Social Capital

4.1. Introduction

Over the last 25 years, extreme weather events, including heavy rainfall, heat waves, droughts, floods, cyclones and hurricanes, have contributed to injury, illness, impoverishment, displacement, hunger and death of hundreds

of millions of people, often with particular implications for children (Sheridan, 2008). Climate change is bringing higher temperatures, sea-level rise for all coastal cities and reductions in freshwater availability in many locations (IIED, 2008). Even if an effective international agreements are made on reducing greenhouse gas emissions sufficiently to slow and then halt global warming, much of the world's population will still face these changes over the next few decades due to the time-lag in the world's climate system. Developing countries such as Bangladesh are found to be the most susceptible to these climatic vulnerabilities, particularly in the coastal areas affected by cyclones, sea-level rise, riverbank erosion, flooding and salinity. Having said that, urban areas—specifically Dhaka—are also faced with high levels of climate-induced risks, albeit some different to those in the rural and coastal areas, but due to the continuing rapid rate of urbanization, the consequences of such risks are exacerbated by population density. Heat and cold waves as a consequence of climate change prove to be especially challenging for children and the elderly in Dhaka. There is considerable pressure on Dhaka City management authorities to meet the challenging demand of providing sufficient utilities, especially to those in slum areas (Rabbani, Rahman & Islam, 2010: 537).

Our response to climate change in preparation of risk and in reaction to their impact, gives us an insight into our adaptive capacity. Moreover, such instances reflect our ability to act collectively to tackle vulnerabilities produced through changes in climate. Adaptation can be perceived as a social process by which 'adaptation is underpinned by societal perceptions, values, and decision-making structures' (Wolf, 2011:23). Essentially, adaptation measures are influenced by society's response and capacity for resilience, which is in turn mediated by culture. Sense of place is a vital element of culture since it is a fundamental component in an individual's or community's identity. Place is a cultural asset and holds immense value, and losses to these places have a significant, often detrimental effect on a community's identity and culture. Identity and sense of belonging to place is an important factor in society's motivation to practice adaptation strategies and build resilience to climate change.

Communities across the globe, including those in Bangladesh, are already experiencing the effects of extreme weather events and unpredictable variations in seasonal weather, with poor communities, women, children and marginalized groups disproportionately affected by the impacts. The perspectives of children within the field of climate change adaptation have remained largely sidelined and yet, as this paper illustrates, children's needs, voices and capacities can and should be integrated across adaptation efforts as this leads to the establishment of longer-term and more robust community and political frameworks.

4.2. Cultural Perception and Adaptive Capacity

From an anthropological standpoint, hazards and disasters can be seen as a grand test 'of societal adaptation and sustainability' or a "natural laboratory" whereby the fundamental facets of society and culture are laid bare 'by

the reduction of priorities to basic social, cultural, and material necessities (Sahlins, 1972, in Oliver-Smith, 1996:304). Douglas and Wildavsky's Risk and Culture is a major anthropological contribution to the ideology behind perception of risk and vulnerability. They suggest that various features of social life – particularly the levels of integration and group power relations – evoke differing responses to danger or vulnerability (Douglas & Wildavsky, 1982, in Oliver-Smith, 1996:319). Societal or cultural perception of climate change largely involves direct personal experiences with its impacts in time and space, and how much cognitive presence the issue has in an individual's mind over other matters affecting their lives. Culture in this context can be described as 'the symbols that express meaning, including beliefs, rituals, art and stories that create collective outlooks and behaviors, and from which strategies to respond to problems are devised and implemented' (Adger et al, 2013: 112). With this conception of culture, if we narrow down our scope of study to the complexity of the cultural dimensions of climate change and response to risks, the way such 'outlooks and strategies' inform adaptation planning in societies can be better understood.

In most cases, when models of climate change try to incorporate adaptation, they assume a simple cause-and-effect relationship between vulnerabilities experienced and society's response to them (Adger et al, 2013: 113). However, in reality the responses rarely occur in the way presumed, and differ greatly from culture to culture, place to place. These models, generated on such assumptions, fail to explain these differences when presented with the same environmental changes. Thus, it can be said that 'adaptation is highly context-specific whereby socioeconomic characteristics, social networks, local knowledge, and non-climactic pressures all play key roles in shaping adaptation measures' (Wolf, 2011:23). How vulnerability and risk is conceptualized and perceived is what forms the basis of the attitude towards adaptation. Furthermore, there are differentiating approaches to conceptualizing dangerous climate change from culture to culture since perceptions and personal experiences shape a community's understanding of which impacts are harmful, alongside non-climatic stimuli, which in turn affect the form of response they have to adapt. Adger et al. discern that the actions of individuals and their communities 'are shaped in part by deeply-embedded (but not static) cultural and societal norms and values' (2009:344). Cultural perceptions thus affect adaptive pathways and they help explain how some societies connect with certain viewpoints or methods of adaptation and others do not. Essentially, groups of people 'with shared values and beliefs produce their own selective view of the natural environment, which influences how they interpret risk' and such perceptions may not coincide with 'responses advocated by institutions promoting adaptation' that are deemed 'rational' (Douglas and Wildavsky, 1982 in Adger et al, 2013: 113). Proactive adaptation from an individual or community depends on the perceived risk from impacts and perceived ability to adapt.

Cultural aspects and practices can successfully be used to adapt progressively to climate change. There is increasing attention given to this ideology

since ‘individuals’ and communities’ knowledge and experience of the past and recent climate...shapes their perceptions of future climate’ (Cruikshank, 2001; Huntington and Fox, 2005 in Adger et al, 2009:343). Oliver-Smith, explains that, ‘traditional adaptations to environments and indigenous technical knowledge have been suggested as sources for innovative approaches to problems of mitigation and vulnerability’ (1996:317). On the other hand, it can be suggested that certain elements of social life and culture in a community can be a barrier to adaptation, in that, there may be instances where local knowledge and practices can be ineffective in adapting to ‘rapid or nonlinear changes’ and consequently such strategies fall flat in conditions that are becoming increasingly worse.

Adger et al. give examples of climate effects and possible cultural and representational impacts in their paper Cultural Dimensions of Climate Change Impacts and Adaptation. In relation to Bangladesh, the most relevant impacts mentioned include, firstly, the projected biological and physical impacts of ‘changes to availability or range of fish stocks’, which has the cultural impact of ‘loss of symbolic value and cultural practices attached to particular species...Cultural practices may not be adaptable to changes in fish population dynamics’ (2013:113). An example of this, specific to Bangladesh, would be the changing population dynamic of the hilsa fish, which is ‘under severe stress in Bangladesh and vulnerable to over exploitation...[Results] show that increased harvesting of the adults entering the rivers and the juveniles in the rivers cause gradual decline in hilsa fish population and even may cause to disappear this valuable resource within a short period of time’ (Balaa et al., 2014:19). With this impact on hilsa fish populations in Bangladesh, the loss of its symbolic value and repercussion on culture – as it is the national fish and traditionally eaten in Bengali cuisine– would inevitably be significant. In addition to this, the cultural practice of fishing for this particular fish would be considerably affected along with its adaptive capacity. In a similar fashion, due to the climatic influences changing dynamics of fish populations in Bangladeshi waters, the traditional and historically used technique of otter fishing is being significantly threatened as the number of fisherman using this method reduce. Still practiced today in districts of Khulna and Narail, near the Sundarbans in southern Bangladesh, this method of fishing has been passed down through generations in families who breed these otters and train them into trapping fish, crab and shrimp into nets. Both examples show a loss of symbolic value in a particular species, and difficulties in adapting practices to climate-change-induced fish population changes.

Secondly, Adger et al. suggest that ‘ecosystem disturbance and plant and animal species [become] at risk from localized or global extinction’, which coincides with the cultural impact of the ‘loss of iconic and culturally significant habitats...associated with cultural expressions” and “changes to phenology and seasons...loss of experienced weather patterns...leading to dislocation from place’ (2013:113). This disturbance and loss of habitat can be associated to culturally significant areas in Bangladesh, in particular the world heritage

site of the Sundarbans – along with its iconic endangered species of animals and plants– and other major climate impacted areas of northern and coastal Bangladesh. Such changes, such as those exemplified above, leads to losses of cultural assets that communities value (Adger et al., 2013: 113). However, in some cases, climate change adaptation or mitigation policies being carried out can sometimes result in loss of cultural assets too.

4.3. The Importance of Sense of Place and Identity

Sense of place is a vital element of culture, and thus it plays a significant role in the context of adaptation. Place is the attachment one experiences around their settlement, in other words it is the ‘physical [space] that [is] given meaning by people’. There is a level of connection to this physical space to a person’s identity where there is a “sense of pride” associated with belonging to a particular space and there are friendships and social networks that exist within it (Adger et al., 2013: 112). This ideology may also be referred to as a sense of belonging. Adger et al. go on to say that this structure attests to ‘individual and community wellbeing and quality of life’ (2013:113). As mentioned previously, places of settlement hold cultural value, and losses to these have a significant, often detrimental effect on culture, so when people are displaced from places they value, there is strong evidence that their cultures become endangered (Adger et al., 2013: 113). In most circumstances, there is little or no compensation for these losses. Losses that are indirect and physical – such as these places of attachment – are more likely to be invisible in environmental decision-making, and if caused by climate change impacts, it ‘will influence the ways in which individuals interact with the natural and social environments’ (Adger et al. 2009:348). These impacts are unlikely to be addressed in adaptation framework and are systematically undervalued.

Over the years, there has been a great deal of migration from rural to urban areas due to pull factors – such as better employment opportunities – and push factors, which in Bangladesh, commonly includes climate change impacts on livelihoods and places of settlement, which forces people to settle elsewhere. Those with a strong attachment to a place and their community may be too reluctant to migrate to maintain their livelihoods and adapt to a new place and social structure. Such relocation has substantially negative psychological effects and an impact on an individual’s emotional wellbeing. Adger et al. explains this phenomenon of place attachment by referring to popular thought in social science, whereby continuity of place can be an important aspect in reinforcing identity, and discontinuity is associated with strong social impacts reflecting sense of loss (2013:113). Communities are bound up in local places, and physical changes to their place of attachment will have ‘profound cultural and symbolic impacts’ (Adger et al, 2009:347). Furthermore, any economic opportunities and benefits brought by migrating can be diminished ‘by increasing financial and emotional stress and weakening social structures in both source and destination communities’ (2013:113). In addition to these stresses faced

by migrants, the new areas in which they move to are also at risk, including a new set of vulnerabilities caused by climate change and various other urban related risks. The loss of their local adaptive knowledge makes them susceptible to unfamiliar climate change impacts in their new surroundings. The migrants' identity and sense of belonging is an important factor in their motivation to practice adaptation strategies in these new destinations, thus hardships and loss of identity incurred when relocating could hamper such initiatives. Place attachment then, plays an important part in defining adaptive responses. Mishra et al. have observed that those with high levels of place attachment are more likely to make preparations for climate change related risks, and be motivated enough to do so because of 'social and economic investments' in their area of settlement (Mishra et al., 2010, in Adger et al., 2013:114). In turn, place attachment may then mean a higher probability of people inspired to participate in the climate change adaptation planning process.

4.4. The Role of Social Capital in Climate Change Adaptation

Social capital is a crucial resource and component for shaping the adaptive capacity of societies to climate change. In order to build capacity, enhance resilience and to aid communities to self-organize, the right resources and assets must exist in a society. The concept of social capital has become a noteworthy concept among social scientists in the last twenty-five years, and one of the key creators of the concept defines it as 'features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives' (Pelling and High, 2005:310). Adger (2003) claims that empirical evidence 'suggests that the ability of societies to adapt is determined, in part, but the ability to act collectively (in Wolf, 2011:26). The theory of social capital, at its core, gives reasoning for 'how individuals use their relationships to other actors in societies for their own and for the collective good' (Adger, 2003:389). Emerging as a bottom-up approach in relation to adaptive capacity, the concept can be highly useful in policymaking and may be viewed as an intangible resource in relation to climate change adaptation. However, there may be limits to adaptation using social capital as a resource for the reason that societies have become increasingly complex, with more and more intricate forms of governance (Adger et al., 2009:340).

Social capital has the ability to provide the necessary power not only for the management of property and resources, but also 'to build an adaptive capacity to better tolerate climate variability as well as climatic hazards and extreme events' (Kiithia, 2010, in Berberyan, 2012:4). As Bangladesh is prone to these hazards and climate-induced disasters, it is imperative to give social capital a higher platform in order to produce effective adaptive measures, thus building adaptive capacity. Even though the country may not possess sufficient enough resources to build the required infrastructure to mitigate climate change impacts, and reduce vulnerabilities faced by its urban population in particular, it may however, demonstrate the presence and capabilities of social

capital. Rural communities have proven to have a strong level of collaboration between themselves and with other stakeholders, but this cooperative system may be less evident in urban areas of the country. In order to use social capital as an effective resource, it must be mobilized and ‘strong social relationships’ must be formed, ‘reinforced by trust and reciprocity’ (Berberyan, 2012:5).

4.5. Understanding the Impacts of Climate Change on Children

Climate-related disasters often have disproportionate impacts on children, with serious implications for securing their human rights. Despite children’s right to participate in decisions that affect them, they are often excluded from the decision making process. In the next few decades, it will be these children and their own families who will be affected by the decisions made today (Brendan, 2013). By supporting children now to explore the issue of climate change, they will be better placed to face the challenge in the future. Children are key to winning the climate argument.

Detrimental health effects that climate change produces include increased incidence of malnutrition and infectious disease, physical and psychological trauma from extreme weather-related disasters, respiratory disease, reproductive and developmental disorders and cancer. The developing fetus and child are more biologically and psychologically vulnerable to the many direct and indirect affects of climate change and fossil fuel combustion. Subsequently, early impairment and disease can affect the physical and psychological health and wellbeing of children over their entire life-course.

Children will bear the brunt of the impact of climate change because of their increased risk of health problems, malnutrition and migration. Families without adequate incomes and assets, protective infrastructure and housing, access to basic services, and inadequate nutrition and clean water, face the greatest risk in a changing climate. UNICEF in 2013, estimated that 25 million more children will suffer undernourishment due to climate change, with a further 100 million suffering food insecurity. Children are among the 150-200 million people estimated to have to flee their homes and will suffer more than adults because of their relative lack of resources and higher vulnerability to disease. Heat waves are likely to grow more intense and frequent under climate change, where babies and small children are more likely to die or suffer heatstroke as they find it more difficult to regulate their body heat (UNICEF, 2013).

To be effective, prevention and adaptation strategies to climate change must be centered on the needs of our children—present and future. Fifth Assessment Reports, 2008 by the IPCC, McKinsey and researchers at Stanford University indicate that the cost of acting broadly to reduce emissions from power generation and transport, make buildings and appliances more efficient, and investing in alternative fuels and technologies is modest compared with the benefits to our children and their future.

The most affected by climate changed induced impacts are children and the elderly. Children are at greater risk of injuries, death, displacement, loss of caregivers and post-traumatic stress due to these impacts. Moreover, children's development is threatened through the decreased access to food, water, health care and education; increased exposure to abuse and violence; and increased prevalence of vector-borne diseases and acute respiratory infections.

Only looking at how climate change affects children, without substantial dialogue on preventative measures and actually taking action, adaptation and security for children will not materialize effectively. The challenge is clear – the world is running out of time to reduce its greenhouse gas emissions and transition to a low-emission, climate resilient global society. In the face of unavoidable impacts for the next generation, child-centered adaptation is a necessary aspect of global response. Priority attention should be given to understanding how disasters, risks and environmental changes are affecting them at present, the social dynamics within their communities, how policymaking can be influenced and tailoring activities that need to be implemented in order to stimulate positive change for the future. With adequate support and protection, children can also be extraordinarily resilient in the face of stresses and shocks. There is ample documentation, moreover, showing the benefits of having youth active, informed and involved in responding to challenges in their lives, not only for their own learning and development, but for the energy, resourcefulness and knowledge that they can bring to local issues.

4.6. Engaging Children in CCA: A Child-Centered Approach

Historically, the voices of children have largely been omitted from discussions that relate to community planning and activities. It has been widely assumed the voices of adults have comprehensively addressed the needs of the community as a whole thus sidelining the views of children who are often portrayed as passive victims of disaster events and climate change impacts (Save the Children & Plan International, 2015). In recent times, children have proven to be developing the confidence and self-esteem to act as leaders and pioneers of change in their community. There have already been significant changes at the community level. Opportunities for communities and children to learn about and build their capacity around climate change adaptation and disaster risk reduction are multiplying. Children and young people understand what is at stake for this generation and future generations not just in their community, but also for their country and region as a whole.

Children's vulnerability to climate change can be understood as an intersection of three axes (B. Mauger; A. Minujin; S. Cocco-Klein, 2016). The first is exposure; the extent to which children live in a physical location that is vulnerable to drought, floods, extreme weather events and sea level rise. The second axis is socio-economic, with vulnerability to hazards due to a lack of resources, poverty and marginalization. The third axis is time. Today's children and future generations will bear the brunt of environmental impacts, creating

an inter-generational injustice without precedent (B. Mauger; A. Minujin; S. Cocco-Klein, 2016). All children fall somewhere along these three axes, but it is the children who live in greatest poverty and in the most exposed places that face the greatest risks. More than just passive victims, these young people, often with the support of their caregivers and communities, also represent agents of change and have consistently demonstrated the capacity to devise local solutions, participate in global conversations and contribute to a safe and sustainable future. Recent estimates by UNICEF indicate that 160 million children live in drought-prone areas, and half a billion more live in zones at risk to high floods and severe storms (UNICEF, 2014).

One of the most effective means of reducing children's vulnerability to the impact of global climate change is to build their capacity to adapt to the range of changes it may bring in their lifetime (Mitchell, 2016). Building children's capacity is likely to be one of the most effective strategies to enhance the resilience of the whole community over time. Children are extremely efficient in creating a strong, personal connection to the issue of climate change and can encourage behavioral change in the lives of the adults who care for them in a way that others cannot. Child Centered Climate Change Adaptation initiatives highlight that children are able to challenge the mindsets of adults in their communities and are great communicators of climate change. Children are also particularly good at raising awareness among their peers. Having youth climate change advocates speaking at the local, national and international level can be a powerful educational and outreach tool. The child centered approach to building adaptive capacity is not only about strengthening the wellbeing of children – it is equally about working with children, young people, households, communities, local and national governments, and international organizations, to reduce or mitigate the risks that directly impact children's lives.

There are two aspects of child resilience: resilience for children, where the capacity of caregivers to focus on children's needs and capacities is enhanced; and resilience with children, where children are centrally involved in the decision-making, planning and implementation of adaptation at all levels (Children in a Changing Climate Coalition, 2015). A child-centered approach to adaptation and disaster risk reduction targets activities that can help to reduce the vulnerability of children to climate change, and can include a wide range of activities, such as structural measures that protect children from disasters, training and evacuation planning for children, or insecticide treated mosquito nets to prevent the spread of malaria. The child-centered approach to development is based on child rights, and places children at the heart of efforts to secure these rights and fulfill their development aspirations. It works to target children directly – particularly the most vulnerable, excluded and marginalized – and works to overcome the disadvantages children face, by helping them understand and combat layers of discrimination.

This approach is to make children's participation more effective and sustaining, there is a need to allow children to provide their inputs in determining

objectives, approaches and processes of the intervention. It requires greater flexibility in the process of project planning as well its implementation to allow review and adaptation at any stage of the intervention. This approach can be categorized into two types: programs that focus specifically on children's needs – referred to as "child targeted" policy and programming – and programs that involve children in the design and delivery, referred to as "child led" adaptation (UNICEF & Plan International, 2010). To identify and promote appropriate climate change adaptation measures in the community, it is essential to investigate and explore local problems and link it with accumulated global knowledge on climate change adaptation, which then children are capable to investigate and explore local problems and it immensely enhances value of children's participation. A child-centered approach to adaptation targets activities that help to reduce the vulnerability of children to climate change. It is also important to note that a child-focused approach does not necessarily have to occur at a community level. It is apparent that many activities take place within the community, such as school initiatives focused on disaster risk reduction, training, and first aid. However, child focused approaches can also occur at a national level in terms of strengthening policy and legislation, and at an international level through integrating children's voices into negotiations on climate change, for instance.

Moreover, to enhance community resilience, it requires addressing children's specific concerns associated with climate change. Community awareness raising programs must include children's concerns associated with climate change e.g. loss of education, recreation and protection and exposure to child labor and early marriage. To ensure children's contribution in communities' climate change adaptation, children's risk assessment must be linked with communities' planning and implementation process. It requires children to analyze communities' current adaptation plan and process, and engage with the key stakeholders to reach an agreement with the community on children's role and activities for climate change adaptation processes. Interventions that seek children's contribution in any communities' planning process must have liaison with children to reach such a negotiated agreement.

Children's participation in climate change adaptation is a noteworthy initiative because children comprise of about half of the population, they can bring in their unique perspective and contribute to the communities' climate change adaptation planning process. Promoting children's participation should apply an ethical approach. It should give children opportunity to express their views and involve them in decision-making. To achieve that, it requires applying practice standards for children's participation. Planning process for designing project intervention should include consultation with children and project plan and allow degree of flexibility for children to review and adapt objectives, approaches and processes of interventions. Children's activities – awareness raising, risk assessment and participation in communities' planning, must include children's specific issues and benefit both children and community.

Project interventions that involve children in climate change adaptation should apply child friendly tools and processes; otherwise the exercise becomes hugely challenging and may fail to produce the desired results.

4.7. Adaptation to Climate Change and the Road to Resilience

The impacts of climate change are already being felt. Learning how to live with these impacts is a priority for human development. In this context, it is too easy to perceive adaptation as a narrowly defensive task – protecting core assets or functions from the risks of climate change. A more profound engagement, which sees climate change risks as a product and driver of social as well as natural systems, and their interaction, is called for.

Adaptation to climate change argues that, without care, adaptive actions can deny the deeper political and cultural roots that call for significant change in social and political relations if human vulnerability to climate change associated risk is to be reduced. Furthermore, adaptation efforts should focus on the most vulnerable groups, including children. Actions should be based on meaningful, gender-sensitive and inclusive consultations and participatory design processes that result in programs that fully address the needs of the most vulnerable. Adaptation funding allocations should be based on need, with more funding flowing to local level actions in particularly vulnerable communities and high-risk areas. There are many ways of characterizing adaptation, which as an intellectual construct cannot be directly observed. Here, a key distinction is made between adaptations that are forward or backward looking. As a backward looking attribute, adaptation is revealed by capacity to cope during moments of stress or shock.

Child-centered approaches to adaptation should be included prominently in local and national climate change and development planning processes. Existing adaptation policies, guidelines and strategies should be reviewed to ensure that children are visible, that their rights are being respected, and that the root causes of girls' and boys' vulnerability are addressed. Newly developed plans, including national adaptation plans, should include child-centered approaches and ensure that children's rights are integrated into policy implementation. Children as active agents are an important component in climate change adaptation and disaster risk reduction processes. Despite children's disproportionate vulnerability on many fronts, it is an oversimplification to think of them only as victims in the face of climate change (Sheridan, 2008).

One primary component of resilience simply relates to the level of adequate and timely knowledge that children, communities and government institutions are made aware of (Save the Children & Plan International, 2015). However, this acquisition of knowledge is not sufficient; communities must also be given skills through which they can apply this knowledge. In addition, institutional frameworks must be supported so that resilience activities can be sustained. Mechanisms such as insurance, social funds and the diversification

of livelihood options are just some of the activities that are implemented. Communities are provided with the necessary training and support (ongoing technical support from NGOs and government institutions) to carry out locally relevant climate change adaptation activities. Resilience is context specific and will change over time as children, communities and institutions evolve.

4.8. Conclusion

Place and sense of belonging is a crucial component in an individual's and community's identity. The loss of these physical and ecological places tends to be irreversible, 'with associated environmental, cultural, and social implications' (Adger et al., 2009:349). Sense of place and identity is thus a vital element of culture, and plays a significant role in the context of adaptation since cultural aspects and practices can successfully be used to adapt progressively to climate change. 'Adaptation is highly context-specific whereby socioeconomic characteristics, social networks, local knowledge, and non-climactic pressures all play key roles in shaping adaptation measures' (Wolf, 2011:23). The process of conceptualizing vulnerability and risks forms the basis of the attitude towards adaptation. Adaptation policies and decision-making processes should take into account these cultural aspects and differing perceptions in order to produce successful adaptation measures. Social capital is a key resource for shaping the adaptive capacity of communities to climate change, and those societies that use this capital effectively 'become more sustainable, effective and resilient than those with adaptation mechanisms designed and imposed by external entities' (Berberyan, 2012: 1). The voices of children – who are the most vulnerable to the impacts of climate change – have largely been omitted from discussions that relate to community planning and activities. Children's participation in climate change adaptation is a noteworthy initiative because children comprise of half of the population in Bangladesh, they can bring in their unique perspectives and contribute to the communities' climate change adaptation planning process. Child-centered approaches to adaptation should be included prominently in local and national climate change and development planning processes. Children as active agents are an important component in climate change adaptation and disaster risk reduction processes, and existing adaptation policies, guidelines and strategies in Bangladesh should be continuously reviewed to ensure that children are visible, that their rights are being respected, and that the root causes of girls' and boys' vulnerability are being addressed.

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Local Interpretations of Climate Change: A Study in Selected Coastal Areas of Bangladesh

S. M. Arif Mahmud and Md. Borhan Uddin

Abstract

The paper aims to understand local perceptions of climate change with anthropological insight. This also includes local beliefs, values and practices associated with their adaptation strategies. Perception about climate change varies from region to region and with skeptical belief as well. Most of the elderly peoples of the locality have a belief that past days were full of happiness when they used to practice different rituals to make God happy for ensuring good weather during six seasons. But climate started to change and they interpreted this change as God's punishment for committing wrong deeds and transgressions by humans. However, gradual climate changes are seen in different regions through frequent river bank erosion due to climate induced river-siltation (resulting in inundation and salinity intrusion), erratic rainfall, nor'wester and thunderstorm. Therefore, local knowledge, beliefs, and perceptions of people about climate change are significant to address the challenges of climate change.

Keywords: Climate Change, Environment, Perception, Sustainable, Weather

5.1. Introduction

Climate change is one of the major problems of the world and its impacts significantly vary from country to country because of different geo-ecological conditions. IPCC (2013) reported that no country of the world is protected from the adverse impacts of climate change. Thus, coastal and island communities of equatorial and tropical regions are said to be more vulnerable to climate change and Bangladesh is considered as one of the most climate vulnerable countries of the world due to its deltaic situation and downward socio-economic capacity. MoEF (2009) assumed that climate change will adversely affect lives and livelihoods of approximately 70 million people of Bangladesh

in near future. Notably, impacts of climate change would not be the same in every region of Bangladesh and coastal communities are more likely to be affected by rigid climate induced frequent hazards and disasters than rest of the country (MoEF 2014).

Most of the researchers have reported the effects of global climate change on the lives and livelihoods of local people of Bangladesh, the outcome of which includes – decrease in seasonal diversity, changes in precipitation (i.e. excessive/ inadequate/ heavy rainfall in shorter period of time, unseasonal rainfall), gradual increase in the frequency and intensity of cold wave, flood, drought, cyclone, and tidal surge, changes in the feature and amount of water, salinity intrusion in coastal belt, and unusual fluctuation of temperature (Huq 2004; Ahmed 2005; Khan 2006; Alam and Rahman 2008; Ali and Sircar 2010; Baten 2010; BCAS 2012). Climate change is not only restricted to its effects but also elaborated by the perception of local people about its nature, cause, and intensity in Bangladesh. Thus, it is important to explore people's perception about climate change¹. Global climate change and its impacts on the people of Bangladesh were explored several times, but their knowledge, belief and perception regarding climatic change were less explored and are crucial for greater understanding of climate change impact analysis and sustainable adaptive strategies².

This study is encouraged by several writings of Crate on the nature and motives of climate ethnography. Emphasizing on documenting local perception of climate change through anthropological insights, Crate (2008:574) argued that considering the cultural implications of global climate change, one approach to a research agenda incorporating applied and advocacy approaches begins with understanding how our research partners perceive the change that is occurring. And cultural ecology holds that environment affects culture so that cultural beliefs and practices are shaped by environment (Haenn and Wilk 2006; Milton 2006). This is evident in the drought prone zone of Bangladesh where great concerns over rainfall patterns are central to everyday life. This concern might not be found in societies where precipitation rate is satisfactory. So local cultural teaching of adaptation is an outcome of human-environment interaction. Eco-feminism, greatly concerned with different dimensions of climate change, refers to the way in which gender affects human environmental perceptions and studies have shown that women react differently to environmental risk than men (Stallen and Thomas 1988; Pilisuk and Acredolo 1998). Therefore, perception of climate change varies in terms of gender differences and also differences in their experiences. Thus, it is significant to include gender based perception and interpretation of climate change.

In Bangladesh most of the elderly peoples of rural areas possess in-depth knowledge about weather, climate and environment. These are very potential resources for climate change study and should be explored to account for the effects of global climate change on local lives and livelihoods in Bangladesh. Therefore, one of the major objectives of this study was to make a comparative

study in two different ecological locations of Bangladesh to understand the local interpretation and perception of climate change and the way people develop their knowledge regarding this.

Place, People and Objectives

Designed with emic and cross cultural model of climate ethnography, one of the major aspects of this study was to listen, share, and accommodate people's ways of knowing, observing, and perceiving the effects of global climate change. For this a number of methods were used. Along with observation, oral history and case study, focus group discussion and key informant interview were used to map out collective cultural perception about the nature, cause and intensity of climate change in Bangladesh. Here sources of data were of two categories— primary (collected from field in two phases in March and July 2016) and secondary (collected from available literatures, reports, and articles on climate change). Collected data were analyzed through qualitative and interpretive ethnographic tradition with special references to cases.

This study was conducted in two coastal districts of Bangladesh— Pratapnagar and Khazra unions of Satkhira, a South Western coastal district of Bangladesh, for the frequent incidents of salinity intrusion, river-siltation and many other erratic climatic factors; and Charhajri and Charparvoti unions of Noakhali, a South Eastern coastal belt of Bangladesh, for its familiarity of struggle to several climate changes induced hazards and disasters. However, the prime objective of this study was to find out local people's perception regarding climate change in these unions. The specific objectives were to explore— peoples' realization of climatic changes from different form of human-environment interactions, functional ways of observing erratic changes in climatic condition, local causation behind changes in climate, and its impacts.

5.2. Human-Environment Interactions in Climate Change Regime

Intimate relationship grows up between human and environment due to inhabiting in an environment for longer period of time. This relationship produces deeper understanding and knowledge about weather and climate including seasonality and variability. For instance, following local proverb from Pratapnagar union of Satkhira district demonstrates the importance of this interactive relationship with environment and climate change—

“Kings become beggar if it showers in Agrahayan, production gets worse if it showers in Poush, and kings become successful with enshrined granary if it showers at the end of Magh (In Bengali: zodi borshe agone raja jai magone, zodi borshe pushe kori hoy tushe, zodi borshe magher shesh, dhonyo rajha punyo desh).”

In both the study areas people interact with environment in climate change regime for three major purposes: adaptation, intervention and dependency. And many occupational groups depend on nature and environment for their daily subsistence. Hence, adaptation to environmental change takes place when intervention is either impossible or non-beneficial.

A good numbers of inhabitants of the study areas occupy subsistence directly from the nature. Lives and livelihood in Pratapnagar and Khajra unions are intensively connected with saline ecosystem that best illustrates the nature and scope of human-environment interactions. In this area, shrimp productivity is a primary means of subsistence, which is ultimately dependent upon nature and climatic condition. In addition, riverine ecosystem not only provides essentials for subsistence but also make human-environment relations difficult to some extent. For instance, sudden erosion of embankment produces multidimensional vulnerability. According to a community member of Khajra union-

"We always prepare ourselves to run out of our home to safer places in fear of devastating water due to embankment erosion. Last year (2015), we were sleeping and during midnight people shouted 'Run! Run! River water is coming!' Even when we go to sleep at night, we have to make full preparation to escape from the danger of increasing river water."

Charhajari and Charparvoti unions are also enclosed by riverine ecosystem. Environment molds lifestyle and worldviews of this area in many respects. Agriculture is the major source of livelihood for the community with close interactions with environment. Happiness and sufferings of the inhabitants of this area are closely connected with the river. Therefore, in-depth intimacy with environment shapes perception of climate change in this area. According to a peasant of Charhajari union-

"We have been cultivating lands for many years. Agriculture is our traditional profession. Our forefather also did this. During childhood, we observed perfect seasonal variations in association with particular weather conditions. We heard our forefathers to say- 'tigers shiver in the month of Magh, and peasants buy blanket in exchange of bullock during heavy cold of this Month'. Nowadays, seasonal variations are not operating as did in the past and it is difficult to predict the weather condition."

5.3. Local People's Perceptions and Predictions

Most of the people of the study areas argued that climate is changing gradually. In this regard one of the most popular local proverbs is that- "running days (present) are good, but coming days (future) will be worse". These are forecasts about gradual change in climatic conditions and human is going to face the severe challenges of climate regrettably. Local people's testimonies about climate change vary on the basis of the way they observe, understand, and perceive how climate is changing with reference to their interaction with nature and environment.

Although in recent times lots of debates are there regarding climate change, but to observe this change requires a vast passage of time. For instance, elderly people of the study areas were more likely to report climatic change and its related factors, while many younger people were not very much concerned about climate change. Macchi, Gurung, and Hoerman (2015) argued that elderly people in India and Nepal can easily report climate change and some informants were not sure whether climate is changing or not. People's knowledge

and perception regarding climate change varies on the basis of differences in environmental culture. BDRC (2015:105) showed that 55.27% households of all seven divisions feel long term climatic change, where the percentage for knowledge and perception about climate change is 21.36% for Dhaka division followed by Barisal (18.76%), Khulna (15.34%), Rajshahi (14.07%), Rangpur (11.20%), Chittagong (9.87%), and Sylhet (9.40%) respectively. Among the occupational groups, peasants of the study areas firmly reported that climate is changing and essential amount of precipitation, cold, and heat for agricultural production is either increasing or decreasing day by day. However, following table-1 shows that people of Satkhira and Noakhali districts follow several perceptions about climate change (for different ecological sites).

According to the people of these areas, perception about climate change is relative and sensitivity and feelings to climate change vary on ground of age. People identify their bygone days as better than the present regarding weather and climatic conditions. Like many other changes, climate change is viewed as necessary. Most of the informants argued that due to changes in climatic conditions (i.e. irregularity and abnormality of weather conditions) gradual changes are seen in the agricultural practices of the locality. This is highly connected with the intensity of heavy or less rainfall, extreme cold or lack of cold, and intrusion of saline water in cultivable lands among others. Again local peasants used to cultivate traditional species of paddy such as

Table– 5.1: Perceptions about Climate Change

Study Areas	Perceptions about Climate Change
Pratapnagar and Khasra unions, Satkhira District	<ul style="list-style-type: none"> ○ Hazards and disasters hit community frequently, which were not severe in the past. ○ After the 1980s there is an increase of saline water intrusion in cultivable lands. ○ Increased intensity of river bank erosion. ○ Excessive rainfall is creating water logging in new areas. ○ Scarce precipitation is troubling the production of paddy and paddy culture is replaced by shrimp cultivation. ○ Intolerable temperature and humidity. Natural calamities like storm (Kal Boishakh), thunderstorm, and hailstorm are taking place recurrently during the months Chaitra, Boishakh, Joishtho, Ashar, and Sraban.
Charhajari and Charparvoti unions, Noakhali District	<ul style="list-style-type: none"> ○ Abnormality in seasonal cycle observed, which was not seen 20 years ago. ○ Change in the sequential appearance of weather. ○ Lack of rainfall during the months from late Jaishtha to middle of Ashar, and excessive or heavy rainfall after the month Bhadra. ○ Scarcity of water in the paddy field during the month Baishakh (in the past paddy fields were inundated by knee-high rain water). ○ Due to an increase in temperature heat wave is now a frequent incident and summer season prevails for as long as seven months of a year. ○ Climate change induced diseases have been increased since 1980s. ○ Inadequate cold weather prevails during the months of Poush and first half of Magh, but excessive cold weather exists after the months Magh to second half of Falgun.

Kajol Haile, Hariya, Bajal, etc. According to their experiences, these species failed to stand still in heavy wind caused by climate change. But things started to change where high yield crop production has become a common practice which includes paddy species such as BR10, BR11, and BR22 among others. Two major aspects for the change in the species of paddy were to make them flood and wind tolerant and make them capable of massive production. Yet again some people considered climate change as a sign of 'Dooms Day' or '*Keyamot*'³ with the belief that climate will change naturally and this change will destroy the universe.

5.4. Impacts of Climate Change: Local Experiences

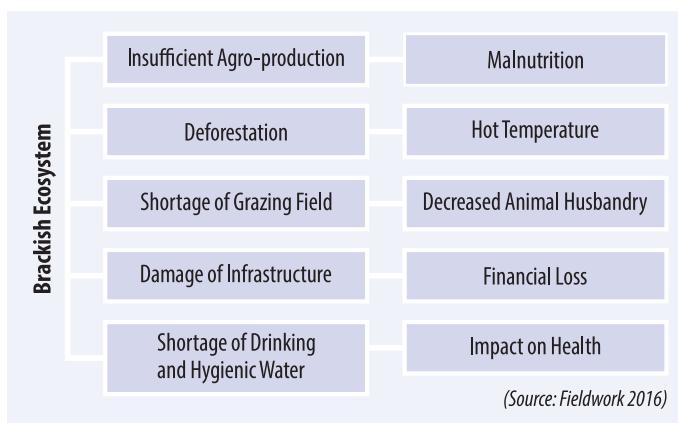
Peasants from Pratapnagar and Khajra unions argued that harvesting of Aush Paddy has declined due to inadequate precipitation during late *Baishakh* to early *Jaishtha* months. This declination of paddy production encouraged people of Pratapnagar and Khajra unions to intentionally enter saline water into agricultural lands in order to cultivate shrimp, and to give up Aush production. According to a peasant from Charparvoti union,

"Regular precipitation during Baisakh month does not occur as we used to see during our childhood. And inadequate precipitation in the first month of rainy season (Ashar) delays the harvesting time for Aush which ultimately changes harvesting seasonality for Amon and monsoon vegetables. Thus belated productions bring low price in the market. Absence of precipitation for longer period of time requires costly irrigation for production. Therefore, this abnormality of precipitation has direct impact on the production of crops and costs for irrigation."

One of the major impacts of climate change has been the shift in labor processes of the local people. Many land owners of Pratapnagar and Khajra unions have replaced their agricultural production with shrimp cultivation causing unemployment of many agricultural laborers. Because shrimp cultivation requires less labor than agriculture. According to a day laborer⁴ from Khajra union,

"We used to work in agricultural lands. But many of us have become unemployed due to the practice of shrimp cultivation in the area. I have seen many to migrate to other districts (such as Barishal) for doing agricultural work. My brother has migrated to Khulna and now works in a factory. Some agricultural laborers are working in brick-field and shrimp-girdle or pull van. There has been a dramatic change in the practice of day labor and I think this is because of the changes in land based economy from agriculture to shrimp cultivation. And our land is no more productive for agricultural production due to the increase in salinity of water and intrusion of saline water in the land. I think this is also connected with the change in environment."

Thus, those land owners shifting from agriculture to shrimp cultivation have started to play monopoly in earning money from shrimp-girdle creating both wealth and class gaps among the village people. As a result they are shifting their residence from rural area to Satkhira city and maintaining infrequent interaction with their village people. One of the shrimp laborers from Pratapnagar union illustrated the issue more clearly as:



"I used to cultivate my 1 Bigha (33 decimal) agricultural lands. During cyclone Aila of 2009, saline water entered into my agricultural plot and I forcibly shifted to shrimp cultivation. There is a big plot beside mine. I had to enter saline water into my girdle through this big girdle. But the owner of big girdle did not allow me to enter saline water into my plot crossing through his plot. So I had to lease out my plot to this owner for a contract of yearly eighteen thousands taka. Now I am working in other's girdle as a day laborer."

Thus, intrusion of saline water in the agricultural lands not only hampers agricultural productions but also causes severe problems. Following Figure– 5.1 shows the impacts of saline ecosystem in these unions of Satkhira district.

Strong heat wave, desert like weather, and salinity induced deforestation are affecting human mental health⁵. Erratic precipitation caused by climate change has already destroyed various kinds of indigenous fish which was available in paddy fields during rainy season a few decades ago. Along with these in these areas substring of agricultural productions has been worsening with an increase of unknown insect attacks. These have become very common aspects in these days and, therefore, the situations like insufficient agro-production, deforestation, shortage of grazing field, damage of infrastructure, and shortage of drinking and hygienic water are affecting peoples' livelihood options and adaptive strategies.

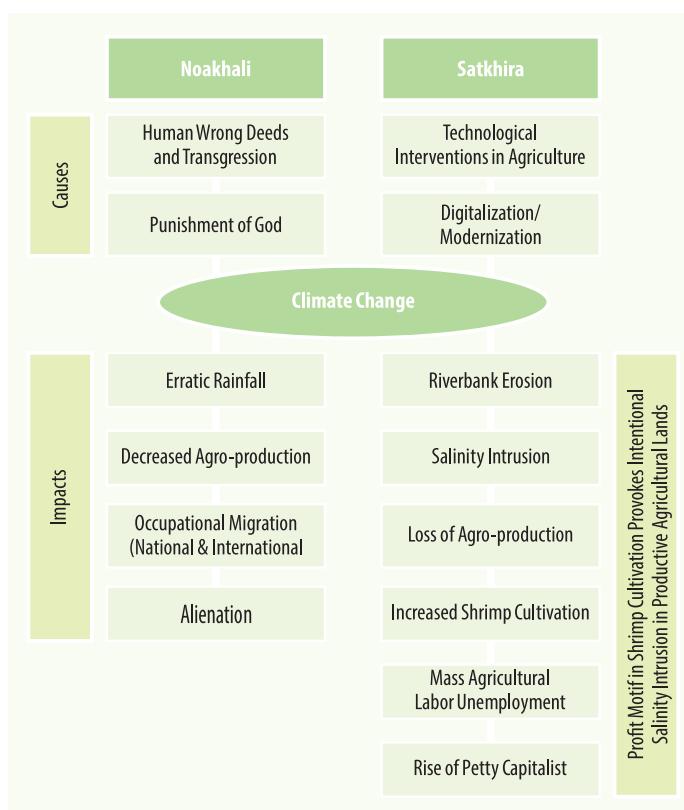
5.5. Local Beliefs, Values, and Ways Forward

Local people have recognized several issues for climate change. They have different types of perceptions and interpretations about the changes taking place in weather and ultimately directing climate change induced disasters and vulnerabilities. People in these regions, closely connected with nature for their subsistence, have identified technological intervention in agriculture as a sole reason for erratic behavior of weather. Additionally, they believe that intervention of modern technology in every step of agricultural activities has

increased production, but natural productivity of land has decreased⁶. The Figure– 5.2 shows the climate change perceptions of local people.

Thus most of the people of these regions think that humans are playing crucial roles in changing climate through misdeeds and immoral tasks that agitate God⁷. People are more likely to view the reasons for climate change in terms of violating social norms, customs and ethics related to nature and environment. Women of Noakhali region argued that television and satellite culture have endangered not only social norms and values but also their bondage with nature and environment. This has further endangered peace, social security, and environmental security leading to threats for climate.

Different religious groups in these regions have different perspectives and perceptions about climate change. Perception of Muslims about climate change is somewhat homogenous in a sense that they view stability and normal condition of climate as a Neayamot (gift and blessings) of Allah and climate change as a *gojob* (curse) of Allah. According to them, Allah provided essential weather for specific season when Muslims strictly abided by Islamic rules and regulations. But Allah is changing climate because Muslims do not follow Islamic



Figure– 5.2: Climate Change Perceptions

rules and regulation anymore⁸. According to a Muslim religious practitioner from Noakhali-

"Allah is the creator of this universe. He sent us here for his worship. Allah promised to provide two things for human: Neayamot (gift and blessings) for good deeds and Gojob (curse) for immoral and sinful tasks. When humans indulge in committing sins such as violation of Purdah custom, telling lie, making premarital and extramarital sexual relations (termed as Zena), and denying of justice among others Allah sends down various types of punishment upon them. Thus, climate change is one of those curse and punishment."

Hindu people, on the other hand, are divided into two segments regarding perception about climate change. One group thinks that *Esshbar* (God) is changing climate because of human indifference to worship (*Puza*) and the other group thinks that climate change is the consequences of over exploitation of land and environment. According to one of the Hindu peasants,

"I owned ten Bighas of agricultural land. During the late Pakistan and earlier Bangladesh period, we used to cultivate these lands by plough with organic fertilizer such as cow-dung, ashes, etc. But nowadays tractor, chemical fertilizers and insecticides are used for cultivation. We used to produce paddy two times in a year. We cultivated our lands only for subsistence, but today over exploitation of lands is a common practice with the use of modern technologies. This is causing harm to the nature and ultimately responsible for climate change."

Some rituals are thought to be deeply connected with climate change⁹. These rituals express human-environment interdependency and intimidating of God who is believed as the controller of nature and climate. There is a belief observed in Noakhali that God ensures pleasurable weather for six seasons which they termed as 'the gift of God'. They strongly believe that during any environmental crisis they practice *Quran Khotom*, *Milad Mahfil*¹⁰ and many other religious rituals to satisfy Allah which ultimately save them and their belongings. Therefore, traditionally people of these four unions of Noakhali and Satkhira districts have different beliefs and values regarding nature and environment. Because they are dependent on them and believe that their activities are the root cause for any change in the environment leading to climate change.

5.6. Conclusion

This study mainly emphasizes on local beliefs, values and perceptions about climate change in Bangladesh. It draws attention to a broad epistemological exploration of these perceptions to understand the causes and consequences of climate change and the challenges faced by the people for their survival. It seems crucial that if climate change transforms people's environment related occupation to other profession, then it may bring different socio-economic problems. Social unrest may take place for conflict of interest among big owner

of shrimp-girdle, landless, laborers, and destitute groups. Many of the peasants and agricultural laborers of Pratapnagar, Khajra, Charhazari and Charparvoti unions have gone abroad for a better earning due to decreased agriculture production. This has kept them away from their kith and kin and weakening social ties. Therefore, it is important to justify local people's perceptions about climate change for sustainable development.

Endnotes

- 1 Lorenzoni and Hulme (2009) argued that comparative studies help link perceptions at local and global scales, given the pervasive character of climate change, for mitigation at global and local levels (Crona et al 2013:2).
- 2 In this regard Byg and Salick (2009) argued that knowledge of local perceptions is fundamental for gaining a better understanding of the impact of climate change; but along with this, comparative studies across sites are important for building generalized theory around why and how people understand and interpret climate change and its associated risks (Crona et al 2013).
- 3 Muslims believe that Allah has created this universe and 'Dooms Day' or Keyamot is the day when He will destroy the whole universe.
- 4 Day laboring is designated as "Jone" in Protapnagar and Khajra unions.
- 5 Exploring the impacts of climate change on the mental health of the Sakha community, Crate (2008) cited that 'people's attitudes will get worse and things will go crazy, and the way people are so violent these days is connected to the change in the air and climate'.
- 6 In this regard an example can be drawn from Kullu Valey of Himachal Pradesh, India. Here the perception of local people is that technological changes are driving life from 'natural to artificial' and this transition not only limited to climate regime rather encompasses human-environment relations (Vedwan 2006:11).
- 7 In this regard, Salick and Byg (2009) explored that people of northwestern India have traditionally inferred adverse weather condition as punishment for human transgression.
- 8 This incidence coincides with the perception of some Indians and Nepalese where they regard climate change as punishment and believe that the gods are angry (Macchi et al 2015).
- 9 In this regard Paerragaard (2013) argued that in Peruvian society changes in the ritual practices may intimately be connected with environmental change including climate change.
- 10 A type of Islamic ritual prevails in the sub-continent.

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Spatial Variations of Land Surface Temperature over Urban Environments: An Assessment of Kandy City in Sri Lanka

R.M.S.S. Sanjeeewani and L. Manawadu

Abstract

Urban sprawling pattern of most of the cities in Sri Lanka has encountered numerous socio-economic and environmental issues like increased land surface temperature over urban areas. This study identifies the spatial trends of land surface temperature (LST) over Kandy city, Sri Lanka from 1988 to 2015 and determines the anthropogenic factors contributing to increased LST variation including the impact of built-up areas, traffic count and population density. Thermal bands of Landsat TM 5, Landsat ETM+ and Landsat 8 OLI/TRIS data are used in this study to measure land surface temperature. Accordingly higher temperature more than 30°C in Kandy city is concentrated into a certain part of the Municipal Council (MC) area that is followed by the road structure of the area. Furthermore, there is a significant positive relationship between NDBI and LST in Kandy MC and the relationship is strong. Higher level of population density and traffic count have profound impact on increased LST levels.

Keywords: NDBI, Land Surface Temperature, Landsat, Population Density, Thermal Bands, Traffic Count

6.1. Background and Context

Sri Lanka is experiencing a messy urbanization pattern, which is characterized by urban sprawl and ribbon development along transport corridors as recorded by World Bank, 2015. These urbanization patterns have impacted numerous socio-economic and environmental issues. Most of the researches find that the anthropogenic causes like concentration of secondary and tertiary economic activities, expansion of built-up areas and depletion of vegetation cover, large number of vehicle population and fuel consumption lead to increased land surface temperature causing micro-climate warming in

urban environments. These heat-trapping sources are associated with higher land surface temperature than the surrounding environment. This generates a number of issues like heat stress, air pollution and many other health problems.

Air temperature in Sri Lanka has increased in a trend of 0.14°C per decade and upto by 0.64°C over the past 40 years and 0.97°C over the last 72 years. Recent researches suggest an increasing rate of 0.2°C per decade (Sector Vulnerability Profile, 2016). As recorded by the Department of Meteorology, Sri Lanka, 2016, there is a considerable increase in average annual surface temperatures across the country in recent times showing a similar trend with the global rise of temperature in the last century. Rapid urbanization that has been taken place during the recent past and the increasing of greenhouse effect are responsible for this warming trend.

Many studies have focused on land surface variations in urban regions in Colombo district. In Colombo, very high temperature in highly urbanized areas of the Western part of the Metropolitan Region and a declining spatial pattern towards the periphery of the area have been identified (Manawadu, 2012). Moreover, Colombo harbor and surrounding areas were identified as the most critical area and the impact of built up areas on temperature change has been recognized (Senanayake, et al, 2013). LSTs of the Kasbewa urban council has increased during 2001-2014 due to human activities and land use and land cover changes (Manawadu, 2014). This outcome motivates to investigate LST variations in other urban regions too. Kandy city in Sri Lanka is focused in this study to identify the spatial trends of LST variation in urban environments and causal factors.

Kandy MC (Map– 6.1) is located in Kandy district of the Central Province of Sri Lanka. Kandy city is the second largest city in Sri Lanka and it is the urban center in central Sri Lanka. This city is one of the highly urbanized cities in the Island. Its area is 773 ha of land and the population in year 2012 was 102,459 while the daily migrant population was approximately 150,000 (Kandy City Waste Water Management Project, 2016). Nearly 55% of Kandy MC Boundary is demarcated by Mahaweli River in West, North and East of the area and this city is located in a valley surrounded by hilly areas limiting the expansion of the city.

Map– 6.1: Kandy Municipal Council Area

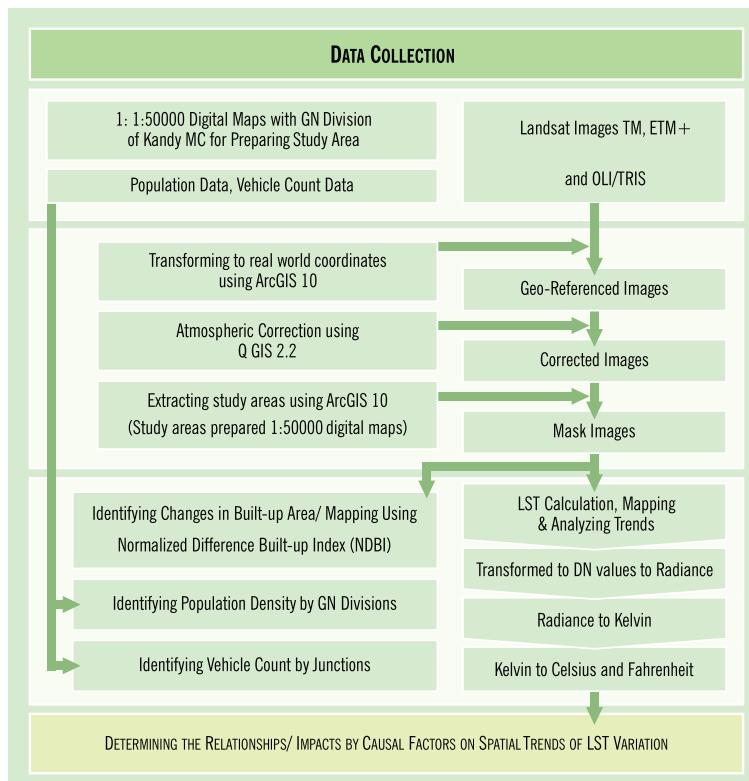


The main objective of this study is to identify the anthropogenic causal factors determining spatial trends of land surface temperature (LST) variation in Kandy Municipal Council in Sri Lanka. The specific objectives of this study are to: (1) detect spatial trends of LST variation over Kandy city from 1988 to 2015; (2) identify vulnerable regions exposed to higher urban temperature levels; and (3) determine the anthropogenic causal factors contributing to LST variation over Kandy city. Having these objectives, this study tries to determine the spatial trends of LST variation over Kandy city using thermal remote sensing technology to identify most exposed regions to higher temperature and to determine the anthropogenic causes on increased land surface temperature levels over the city from 1988 to 2015.

6.2. Research Methodology

Methodology adopted in this study contains materials and methods used for data collection, data processing, analyzing and displaying data throughout the study. The research design outlines different stages and methods carried out to identify spatial trends of LST over Kandy city (Figure– 6.1).

Figure– 6.1: Research Design



Data Collection

This study is performed based on remote sensing techniques. Landsat satellite images are used to measure LST. Most of the researchers use Landsat images for calculating LST. According to Ahmed et al., 2013, little is known, to-date, about land cover dynamics and their impacts on land surface temperature (LST uses Landsat images of 1989, 1999 and 2009 for simulating land cover changes and their impacts on land surface temperature in Dhaka, Bangladesh. Buyadi et al., 2013 also uses Landsat images of 1991 and 2001 to assess the impact of land use changes on the surface temperature distribution of area surrounding the National Botanic Garden. The relationship between land cover changes and spatial-temporal dynamics of land surface temperature in Isfahan is determined by Falahatkar S. et al., 2011, which used Landsat thermal images in 1990 and 2001. Manawadu L, 2012 uses Landsat images for measuring temperature in Colombo. Accordingly this research also uses landsat images covering entire study area for measuring LST as well for calculating Normalized Difference Built-up Index (NDBI). Landsat data utilized in this study have been given in the Table– 6.1. and these images were freely downloaded from USGS explorer site, USA.

Table– 6.1: List of Satellite Images Collected for the Study

Area	Satellite	Sensor	Date	Path/ Row
Kandy	Landsat 5	TM	1988.12.15	141/55
	Landsat 5	TM	1997.01.22	
	Landsat 7	ETM+	2000.01.23	
	Landsat 5	TM	2010.01.26	
	Landsat 8	OLI/TIRS	2015.01.08	

Source: Based on <http://glovis.USGS.gov>, 2016.

Digitized maps of Sri Lanka were obtained from the Department of Survey, Sri Lanka for the purpose of demarcating Kandy Municipal Council Boundary. Population data was collected from Department of Census and Statistics, Sri Lanka for 2012. Vehicle count data was collected by the project, Strategic City Development Plan: Kandy City conducted by DIMTS & Uni Consultancy Services, University of Moratuwa.

Data Processing

Data processing consists of few steps including gross check, extracting the study area from the satellite image, Atmospheric Corrections, LST Calculation, NDBI Calculation & mapping built-up area, Mapping Population Density, Mapping Vehicle population. Gross check was done manually to find out the images without cloud covering in the selected urban region. Entire study area (Kandy Municipal Council Area) was extracted by all the images mentioned in the Table– 6.1 using ArcGIS. Atmospheric

correction was done using Semi-Automatic Classification plugin in QGIS 2.2 version (Semi-Automatic Classification Plugin, 2016). When calculating LST from the images similar method is applied to derive LST values from Landsat 7 ETM+ and Landsat 5. Different algorithm is used to extract temperature from Landsat 8 images. There are two thermal bands in Landsat 8. Hence LST is calculated using both bands and mean is considered as final LST. Thermal bands of each satellite image are used to calculate LST. Band information is indicated in Table– 6.2.

Table– 6.2: Band Characteristics of Different Sensors

Satellite	Sensor	Band	Wavelength
Landsat 5	TM 5	6	10.4 – 12.5
Landsat 7	ETM +	6	10.31-12.36
Landsat 8	OLI/TIRS	10	10.60-11.19
		11	11.50-12.51

Source: Landsat Handbook 7, Landsat Handbook 8

Estimation of the surface temperature consists of several steps: (1) Conversion of Digital Numbers (DN) to Radiance ($L\lambda$); (2) Conversion of Radiance to Temperature; (3) Conversion of Radiance to Kinetic Temperature; (4) Conversion of Kelvin to Celsius and Fahrenheit Scales; (5) Emissivity calculation; and (6) Land Surface Temperature Calculation.

The linear equation model is used to convert the DN into radiance temperatures. Similar equation is used to convert digital numbers to spectral radiance from Landsat 5 and Landsat 7 (equation 1) and another equation is utilized for Landsat 8 (equation 2).

$$CV_R = G (CV_{DN}) + B \quad \text{[Equation 1]}$$

Where: CV_R is the cell value as radiance

CV_{DN} is the cell value digital number

G is the gain

B is the bias (or offset)

This formula can be simplified as:

$$\text{Radiance} = \text{Gain} * \text{DN} + \text{Offset}$$

This can be expressed as given in equation 2.

$$\text{Radiance} = ((L_{MAX} - L_{MIN}) / (QCAL_{MAX} - QCAL_{MIN})) * (QCAL - QCAL_{MIN}) + L_{MIN} \quad \text{[Equation 2]}$$

Where: L_{MAX} is the Spectral Radiance Range or high gain for specific band at digital numbers 0 or 1 and 255

L_{MIN} is the Spectral Radiance Range or low gain for specific band at digital numbers 0 or 1 and 255

$QCAL_{MIN}$ is the value, which can be the lowest among DNs

$QCAL_{MAX}$ is the value, which can be the highest among DNs

$QCAL$ is the Digital Numbers

(These values can be obtained from the MLT file downloaded along with the Landsat images)

For converting the raw bands of Landsat 8 into Top of Atmosphere Radiance (TOA_r) equation 3 is used

$$y = mx + b$$

{Equation 3}

Where, y is TOA_r (Similar as CVR in equation 1) m is the Radiance Multiplier

x is the raw band

b is the Radiance Add

These values can be obtained from the MLT file downloaded along with the Landsat images. Spectral Radiance values were converted to a brightness temperature value using the equation 4. It is common for all three sensors.

$$T_s = \frac{K2}{In\left(\frac{K1}{CV_R} + 1\right)}$$

{Equation 4}

Where: T_s is surface temperature in Kelvin

K1 and K2 are calibration constants chosen to optimize the approximation for the band pass of the sensor.

K1 and K2 are calibration constants, which can be obtained from MLT files.

Emissivity is an important factor in calculating LST. Up to the above process, only brightness temperature is calculated. Land surface emissivity is used to convert brightness temperature to land surface temperature. Q_GIS provides guidelines to calculate emissivity raster (Estimation of Land Surface Temperature with Landsat and Aster, 2016). First land cover classification is done using Q_GIS 2.2 using the categories as vegetation, built-up, bare soil and water. Secondly, emissivity values are assigned into each category as indicated in Table– 6.3 reclassifying the raster. To calculate actual LST from Satellite temperature, equation 5 is used.

Table– 6.3: Emissivity Values Used in Different Land Surfaces

Land surface	Emissivity ϵ
Bare Soil	0.93
Vegetation	0.98
Built-up	0.94
Water	0.98

Table– 6.4: Bands Used to Calculate NDBI According to the Sensor

Sensor	Near Infrared	Red
OLI/TRIS	Band 6	Band 5
ETM+	Band 5	Band 4
TM	Band 5	Band 4

b

$$\{1 + (10.8 * b / 14380) * ln(a)\}$$

{Equation 5}

Where; b is the brightness temperature raster

a is the emissivity raster

Then Land surface Temperature raster is retrieved in Kelvin scale. To convert Kelvin scale into Celsius, 273.15 is subtracted from the above raster data set generating a raster file of LST in Celsius. ArcGIS 10 was used to identify spatial trends and patterns of LST and this study uses zonal statistics to determine mean LST by GN Divisions and to detect the vulnerable GN Divisions of higher temperature levels. Furthermore, spatial autocorrelation is used to analyze spatial pattern of LST.

Normalized Difference Built-up Index (NDBI) is also used to identify the built-up cover and determine the relationship of LST and Built-up area. Equation 6 is used to calculate NDBI. Relationship between LST and NDBI was tested using Polynomial regression model in MINITAB 16.

$$\text{NDBI} = \frac{\text{Medium IR - Near IR Band}}{\text{Near IR Band + Medium IR}} \quad \text{[Equation 6]}$$

Index values range from -1.0 to 1.0, higher index values are associated with built-up areas. Bands used to calculate NDBI according to the sensor is indicated in Table– 6.4.

Population density is calculated using equation 7,

$$\text{Population Density} = \frac{\text{Population of Particular GN Division}}{\text{Area of the GN in km}^2} \quad \text{[Equation 7]}$$

Calculated values are mapped to identify the spatial pattern of Population Density. Vehicle count derived from a 12 hour survey in 2015 for the project Strategic city development plan: Kandy city conducted by DIMTS & Uni Consultancy Services, University of Moratuwa was used in this section and visualized by entry corridors using ArcGIS 10 version.

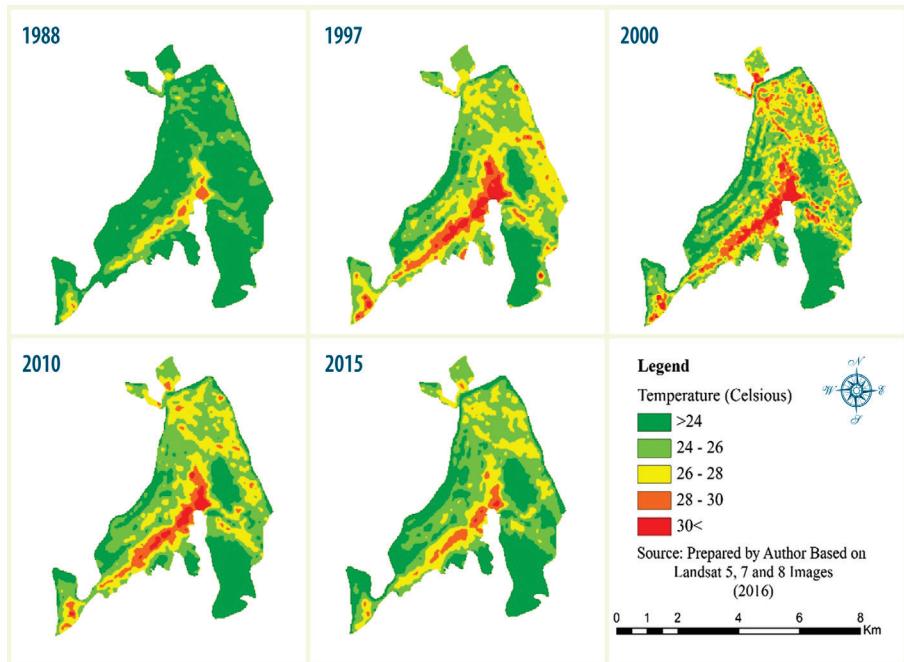
6.3. Analyzing Data

Calculated LST, NDBI values and population density were reclassified into a common class limits to calculate and compare the areas. In addition, they were mapped to identify spatial trends and patterns. Zonal statistics is a proper method to identify the mean LST of the area according to a given field (Manawadu, 2012). Accordingly, this study uses this method to determine mean LST of GN Divisions and to detect the vulnerable GN Divisions of higher temperature levels in Kandy MC. Basic statistical analysis including mean, minimum and maximum was used in the study. In addition, Regression and Pearson Correlation analysis were used in this study to identify relationships.

6.4. Distribution of LST in Kandy MC and Variations

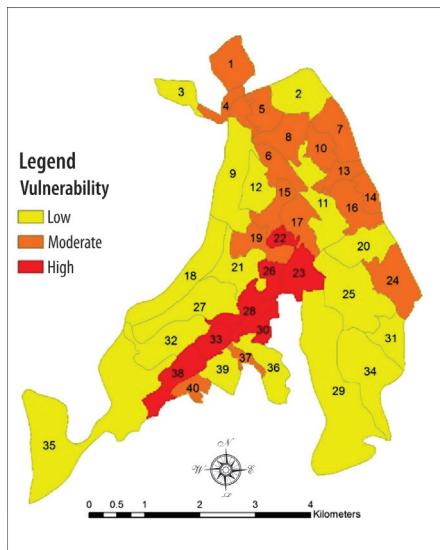
Mapping LST values as indicated in the Map– 6.2 generates a clear idea about the spatial variation of the LST in the study area. Color ranges from Red (Higher LST) to Green (Lower LST) visualize spatial patterns of LST. It is clear that higher temperature is concentrated in to a certain part of the

Map– 6.2: Land Surface Temperature Variation in Kandy MC Area from 1988 to 2015



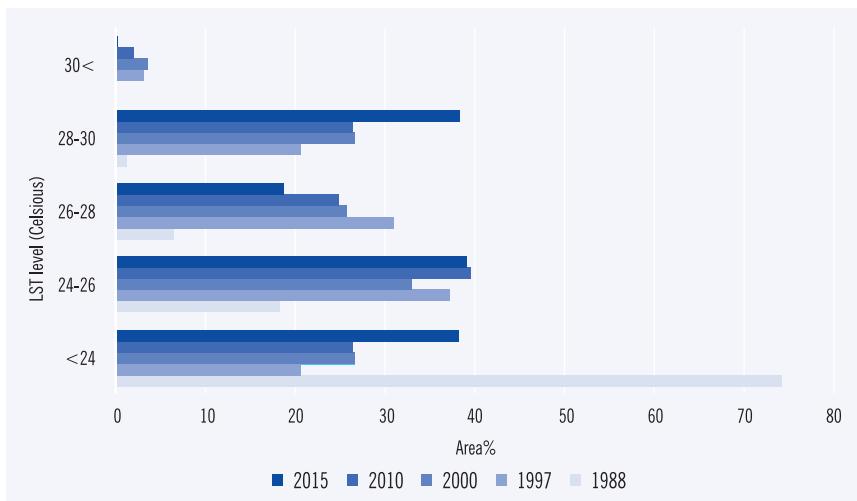
study area. Higher temperature more than 28°C is concentrated into the inner city area of the MC that it seems to be followed by the road structure of the area. This higher temperature can be seen along and beside Sirimavo Bandaranayaka Mawatha, William Gopallawa mawatha and around the Center of Kandy city.

Map– 6.3: Vulnerability to LST in Kandy



This study does not focus on the temporal trends of the LST distribution over the city. Yet few years were considered in this study to identify spatial trends. Accordingly, even in 1988 comparatively higher LST level can be seen along the above-mentioned corridors when compared with the other parts of the study area. Other than these, considerable extent of western part of the MC area is also vulnerable to higher temperature. In most of the years, there are records of LST levels between $24^{\circ}\text{C} - 26^{\circ}\text{C}$ in many parts of the area and the LST levels below 24°C are prominent as indicated in

Graph– 6.1: Percentage of Area Covered by Different LST Levels



Graph– 6.1. The area with temperature above 30°C is very low. Here, it is clear that the proximity to city areas correlates with temperature measures.

Determining different vulnerability levels to LST is also aimed in this study. Identifying different vulnerability levels by local level administrative units is ideal in order to suggest mitigation and adaptation strategies in the local level. Grama Niladhari Zones are the smallest administrative zones in Sri Lanka. Zonal statistics in Arc GIS 10 provides an easy approach in determining the zonal level mean temperature values. Accordingly, mean LST variation in Kandy MC is clearly indicated in Map– 6.3. This map summarizes the vulnerability to temperature in different levels considering the distribution of mean LST by GN Divisions in all these years. Accordingly Mahanuwara, Poorna Watta West, Ihala Katukelle, Katukelle, Deiyanneewela, Katukelle West and Welata GN divisions are vulnerable to higher temperature. Moderate vulnerability can be expected in the GN Divisions including Galewatta, Senkadagala, Siyambalagasthenna, Pitakanda Gama, Mahaweli Uyana, Nittawela, Watapuluwa, Watapuluwa South, Aruppala East, Poorna Watta East, Aruppala West, Mulgampala, Thalwatta, Suduhumpala East, Mahaiyawa and Asgiriya whereas rest of the GN divisions are not highly affected by higher LST levels.

6.5. Anthropogenic Causal Factors Impacting LST Levels

Determining anthropogenic causal factors was also one of the specific objectives of this study. Anthropogenic causes including built-up areas, population density and vehicle population were considered.

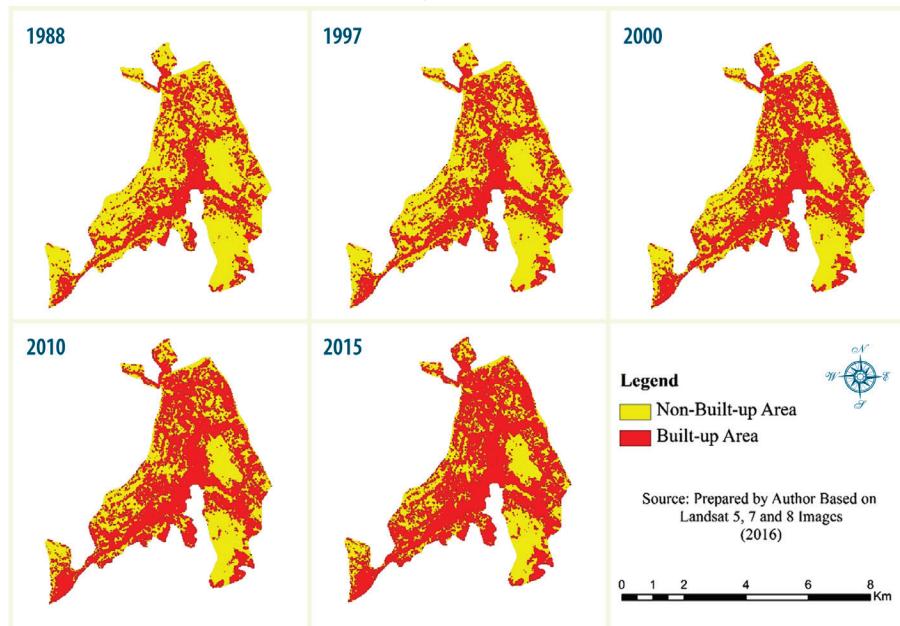
Impact of Built-up Areas on Land Surface Temperature Variations

Built-up areas is one of the major anthropogenic causal factors for the increased temperature. Temperature of the built-up areas is also higher in value. Increase of built-up areas in Kandy MC Area from 1988 to 2015 is apparent in Map– 6.4. Since the beginning, road sides which connect Gannoruwa and Kandy city seem congested with buildings and with the passage of time built-up area is expanded. When comparing the LST distribution and built-up areas it is vivid that both spatial patterns are almost overlaid. With the time factor, built-up areas have gone up extending spatial distribution of LST also. Accordingly there was a build-up area of 37% by 1988 where it gradually increases and reaches up to 66% by 2015 (Map– 6.4). Expansion of the built-up area can be witnessed towards westward, eastward and upward where the most part of the MC is highly congested.

Relationship of built-up areas (using NDBI) and LST is tested using Pearson Correlation statistics and regression analysis. Minitab 16, Cubic regression method has been used to identify the best relationship between LST and NDBI in Kandy after testing all regression models. The summary of the analysis with corresponding statistical indicators is presented in Table– 6.5.

According to the statistics derived from the regression analysis in each year the correlation between the LST and NDBI is considerably higher indicating a significant positive relationship with a confidence level of 95%. In each year it is more than 0.65. Relationship between these two variables is very strong in

Map– 6.4: Distribution of Built-up Area in Kandy MC Area from 1988 to 2015



Table– 6.5: Correlation and Regression Statistics of Kandy MC

Year	Pearson Correlation	P-value	R square	Anova P-value	Cubic Regression Model
1988	0.673	0.000	47.8%	0.000	$LST = 23.84 + 7.502 NDBI + 11.68 NDBI^2 + 27.65 NDBI^3$
1997	0.723	0.000	52.3%	0.000	$LST = 26.10 + 10.48 NDBI + 2.150 NDBI^2 - 5.44 NDBI^3$
2000	0.827	0.000	68.7%	0.000	$LST = 25.50 + 13.88 NDBI - 7.180 NDBI^2 + 49.25 NDBI^3$
2010	0.731	0.000	53.6%	0.000	$LST = 25.36 + 10.79 NDBI - 1.193 NDBI^2 + 30.67 NDBI^3$
2015	0.758	0.000	57.9%	0.000	$LST = 26.79 + 24.68 NDBI + 59.67 NDBI^2 + 138.2 NDBI^3$

the year 2000 possessing a value of 0.827. When considering R-square value of these two variables, relationship is stronger in each year having recorded R-square value greater than 50% after 1997. Year 2000 shows the strongest positive relationship between LST and NDBI.

6.6. Impact of Population Density on LST Variations

Population is one of the important factors leading to high temperature in urban areas. Higher population density generates higher LST levels in urban regions contributing to emit more heat trapping gases by various means (Manawadu, 2012). Polynomial regression is the best model fitted for describing the relationship between population density and Mean LST values. Accordingly there is a significant positive relationship between population density and mean LST levels in Kandy MC ($R^2= 0.6846$) with a significant level of 95% (Graph– 6.2).

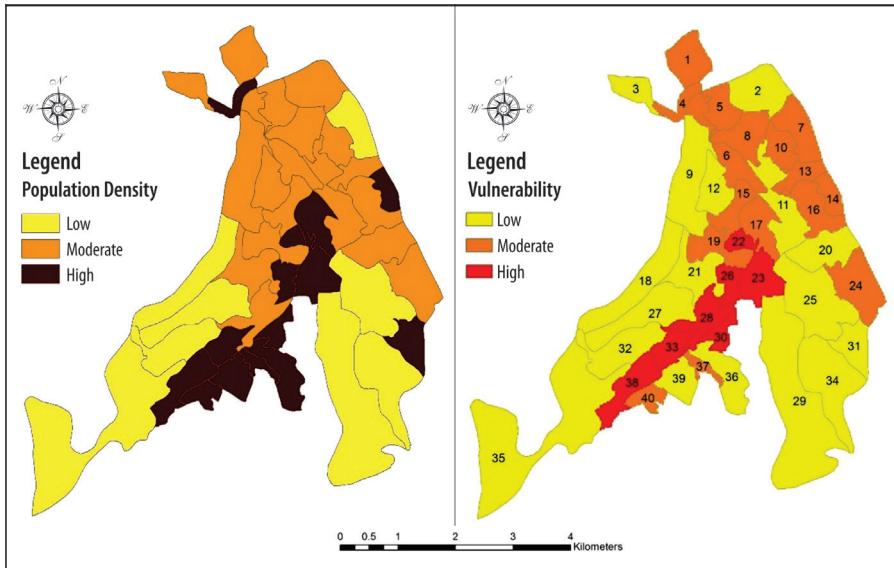
The GN divisions showing a very high density of population is almost similar to the area which shows higher LST levels (Map– 6.5). It implies that the levels

Graph– 6.2: Relationship between LST and Population Density



of vulnerability to LST is highly coincided with three population density categories. Mahanuwara, Poorna Wattaw West, Ihala Katukelle, Deiyannevela, Katukelle West and Welata GN are among the GN divisions overlapped with both higher population density and higher vulnerability to LST.

Map– 6.5: Population Density in 2012 (left) and Vulnerability Levels to LST (right)



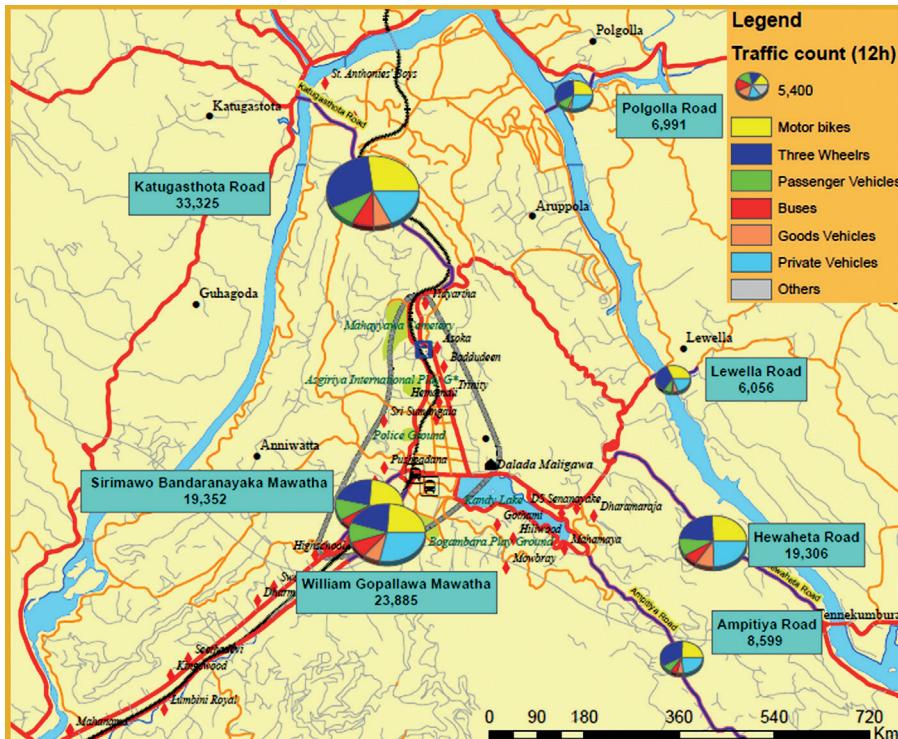
6.7. Impact of Vehicle Population on LST Variation

Vehicle population is also another important factor, which causes increased surface temperature levels. They emit greenhouse gases generating high level of micro climate warming in urban regions. When identifying the spatial trends of LST in Kandy MC, the study finds that increased LST can be seen clustered along and beside major transport corridors in MC. Accordingly, Map– 6.6 shows vehicle count by entry corridors in 2015 derived from 12 hour survey for the project Strategic city development plan: Kandy City, conducted by DIMTS and Uni-consultancies, University of Moratuwa. Higher vehicle count can be identified along Sirimawo Bandaranayaka Mawatha, Williyam Gopallawa Mawatha and Katugastota road which is aligned with areas identified as critically vulnerable for higher LST levels. In addition to that, the number of private vehicles is also higher. This creates more congestion on roads.

6.8. Conclusion

Kandy MC Area in Sri Lanka is also experiencing a messy urbanization pattern which is characterized by urban sprawl and ribbon development along transport corridors. These urbanization patterns seem to be associated with environmental issues like increased urban temperature according to the results of this study. Accordingly, higher temperature is concentrated into a certain part of the MC area that it seems followed by the road structure of the area, proving the association of sprawling city. This higher temperature can be seen along and beside Sirimavo Bandaranayaka Mawatha, William Gopallawa

Map– 6.6: Vehicle Count by Entry Corridors in Kandy MC (2015-12 hours)



Mawatha and in and around the Center of Kandy city. Considerable extent of western part of the MC area is also vulnerable to higher temperature. Mahanuwara, Poorna Watta West, Ihala Katukelle, Katukelle, Deiyannewela, Katukelle West and Welata GN divisions are vulnerable to higher temperature.

This study identifies some of the anthropogenic factors that lead to higher LST levels in the MC area. There is a significant positive relationship between NDBI and LST in Kandy MC and the relationship is considerably strong. As well there is a strong relationship between population density and Mean LST in MC area. Another causal factor contribute to increased LST levels is vehicle population (See Map– 6.6). These anthropogenic heat trapping sources are critically associated with higher land surface temperature in the city than in the surrounding environment.

It is clear that the spatial distribution of higher level of land surface temperature is associated with the road network of the area. Most of the built-up areas are also located besides those transport corridors. Besides, population density is also higher in the highly vulnerable areas of Kandy city. A few anthropogenic factors have been researched in this study. Further studies can be initiated to identify more anthropogenic sources as well as the impacts caused by increased land surface temperature in the area. And if the influence of these factors

increases in the current trend, this critical environmental issue will be worsened creating many adverse impacts on all people in this area making the city an unpleasant place for living. Hence the urban authorities and responsible institutes should pay their attention to address this issue in the city beforehand. Kandy city is the second largest city in the country. The authority should pay their attention on the identified critically vulnerable areas and prioritize them in mitigating and adopting increasing land surface temperature levels. Planning the city in order to minimize urban sprawl is needed to mitigate this issue. In addition, some strategies like green roofs can be implemented to minimize the temperature levels since built-up areas is also one of the prominent factor in higher land surface temperature levels. Sustainable transport measures should be implemented to minimize the impact from vehicular factors in case of increased LST levels. In this way it is clear that this study is a policy merited and these outputs can be taken into consideration by urban planners, designers and administrators so as to create a pleasant urban environment for every one including the residents and daily commuters.

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Chapter Seven

Changes in Rainfall Patterns and Paddy Abandonment in Panadura DS Division of Sri Lanka

RMB Madhuwanthi, RUK Piyadasa and SMAT de S Nandaseela

Abstract

Paddy cultivation in Asia has evolved through generations with more than 2500 years old history. It was the main agricultural activity in many parts of this continent including Sri Lanka, which is known as the “Eastern granary”. Rice in the country is harvested from an area of approximately 158 million hectares producing more than 700 million tons annually (470 million tons of milled rice). Rain fed lowland rice is grown in river deltas and coastal areas, using abandoned fields that are flooded with rainwater for at least part of the cropping season and in the rain fed upland environment rice is grown in valleys and mountains which is known as terraced cultivation. Upland environments are highly heterogeneous, with climates ranging from humid to sub humid, soils from relatively fertile to highly infertile, and topography from flat to steeply sloping. Rice is being cultivated in all agro-ecological zones for two seasons, which is called Yala and Maha. Paddy farming has spread over 34% of whole area in Sri Lanka. During the gap Between Yala and Maha seasons, paddy lands become abandoned (Kijne et al., 2003). Abandonment results from sea water intrusion, water logging, soil related problems, flood hazards, use of poor salinity irrigation water, poor maintenance of irrigation and drainage systems, water stagnation as a result of infrastructure development and also due to lands not being cultivated for a longer period of time. This study explored the spatial distribution of abandonment of paddy lands, and identifies the factors contributing to the abandonment in Panadura DS Division in Western Province of Sri Lanka.

Keyword: Rainfall Patterns, Climate Change, Paddy Abandonment, Seasonality

7.1. Introduction

Paddy cultivation in Asia has evolved through generations over more than 2500 years old history. It was the main agricultural activity in many parts of Asia and it is equally important today since most people in Asia are still

engaged in paddy cultivation. Over the centuries, most of our occupations are related to agriculture. That is why Sri Lanka is called as “Eastern granary”. Paddy is the main crop in wet areas like river deltas and paddy farming has taken 1st priority crop in Sri Lanka (Maclean, 1997). “Rice is grown in more than a hundred countries, with a total harvested area of approximately 158 million hectares, producing more than 700 million tons annually (470 million tons of milled rice). Nearly 640 million tons of rice produced in Asia, representing 90% of global production. Sub-Saharan Africa produces about 19 million tons and the Latin America produces some 25 million tons. In Asia and sub-Saharan Africa, almost all rice is grown on small farms of 0.5–3ha” (Ricepedia, 2017).

Paddy is cultivated in twenty five districts in Sri Lanka; Rain fed lowland rice is grown in river deltas and coastal areas, using abandoned fields that are flooded with rainwater for at least part of the cropping season and in the rain fed upland environment rice is grown in valleys and mountains which is known as terraced cultivation. Upland environments are highly heterogeneous, with climates ranging from humid to sub humid, soils from relatively fertile to highly infertile, and topography from flat to steeply sloping. Paddy rice or ‘rough rice’ is produced to varying extents in all twenty-five districts of the nine provinces in Sri Lanka during both ‘*Yala*’ and ‘*Maha*’ cultivation seasons (Kijne, Barker, & Molden, 2003).

In Sri Lanka, paddy cultivation took deep root, transforming the lifeblood of the islanders and setting the pace for a national culture embellished with elaborate rituals centered on preparation of the fields and the harvesting of the grain. Paddy cultivation was a communal collaboration involving both the land-owning farmers and the tenant farmers or “*Anda Goviya*”, who worked

Table– 7.1: The Two Main Cultivation Seasons in Sri Lanka

Season	Planting	Harvesting	Total Percentage	Dependent Monsoon
Yala (Minor)	Apr-May	Aug-Sept	30%	Southwest
Maha (Major)	Oct-Nov	Feb-Mar	70%	Northeast

Source: www.nipunarice.com

Table– 7.2: Available Paddy Species in Sri Lanka

Indigenous Rice Varieties	Wild Rice	Cultivated Species
KaluHeenati	Oryza nivara	Oryza sativa
Murungakayan	Oryza rufipogon	
Kuruwee	Oryza risomatics	
Gonabaru	Oryza echinigari	
Dikwee		
Suwadal		

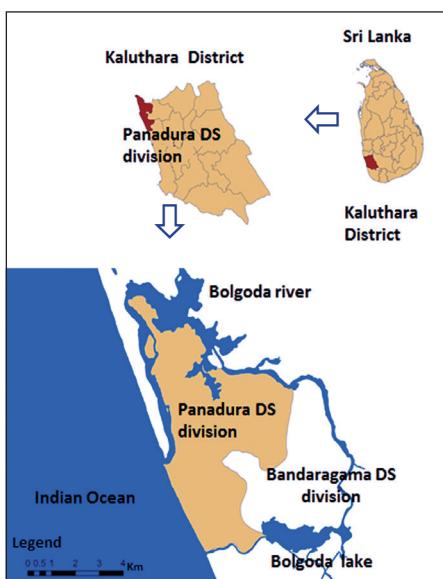
Source: (Bambaradeniya et al., 2004; Maclean, 1997)

individually and collectively, from the seeding to the harvesting, under the guidance of wise seniors (Bambaradeniya et al., 2004). The cultivation cycle was a high point of their social life.

Rice is the single most important crop occupying 50 per cent (0.73 million ha) of the total cultivated area in Sri Lanka (Kendaragama & Bandara, 2000). On average 560,000ha are cultivated during *Maha* and 310,000 ha during *Yala* making the average annual extent sown with rice to about 870,000 ha (ibid). About 1.8 million farm families are engaged in paddy cultivation island-wide. Sri Lanka currently produces 2.7 million ton of rough rice annually and satisfies around 95 percent of the domestic requirement. Rice provides 45% total calorie and 40% total protein requirement of an average Sri Lankan. The per capita consumption of rice fluctuates around 100 kg per year depending on the price of rice, bread and wheat flour (Kendaragama & Bandara, 2000).

Rice is being cultivated in all agro-ecological zones in two seasons, which is called *Yala* and *Maha*. Paddy farming has spread 34% of whole area in Sri Lanka. During the gap Between *Yala* and *Maha* seasons, paddy lands become abandoned (Kijne et al., 2003). There are two types of abandonment of paddy lands such as short-term fallowing and long-term fallowing. The short-term fallowing can be mostly seen in between the seasons— *Yala* and *Maha*, While the long-term fallowing is driven by many factors.

Other reasons for abandonment of paddy lands are: sea water intrusion, water logging, soil related problems, flood hazards, use of poor salinity irrigation water, poor maintenance of irrigation and drainage systems, water stagnation as a result of infrastructure development and also due to lands not being



Map– 7.1: Panadura Divisional Secretariat Division

Source: Prepared by the Author based on Secondary Data Provided by the Survey Department, Sri Lanka

cultivated for a longer period of time. Abandonment is mainly confined to the wet zone (Kendaragama & Bandara, 2000). Socio-economic, technological and institutional matters, prevailing unsettled conditions in the north east, natural disasters, damages caused by wild animals have been among main problems that are working against the growth in paddy cultivation (Kendaragama & Bandara, 2000). Anomalies in land ownership and poor soil conditions have been identified as hindrances to increasing productivity. Of the total cultivation expenditure, over 50% is labor cost. Use of high- tech machinery could have been a likely solution to high labor costs but the facilities are yet to be available. This could be attributed to farmers in the wet zone keeping away from paddy cultivation. Poor relationship between the farmers and relevant institutions cause institutional problem (Seo, Mendelsohn, & Munasinghe, 2005).

This study is based on Panadura Divisional Secretariat Division in Western Province of Sri Lanka (see Map- 7.1). Abandonment of paddy lands is a huge problem in the study area and because of the abandonment there is no productivity of the lands. Panadura area is a semi urbanized area and it is densely populated. Therefore, this research will help identify the causes that are changing paddy land to fallow land. This research examines the spatial distribution of abandonment of paddy lands and identify the factors causing abandonment. Another objective of this research is to identify the changes of rainfall patterns during *yala* and *Maha* harvesting seasons.

7.2. Methodology

Methodology of this study can be segmented into three phases: data collection, data analysis and data visualization. The data collection methods include semi-structured interviews (SSI), observations and review of secondary sources. Both primary and secondary sources were used to collect data for this study. Panadura Divisional Secretariat (DS) Division has 72 Grama Niladhari (GN) Divisions and only 38 GN divisions have paddy cultivated lands. Abandoned paddy lands can be identified only in 29 GN divisions. Therefore, the semi-structured questionnaire survey was conducted representing all the GN divisions which have abandoned paddy lands and random sampling method was used to select the sample. Therefore, 87 farmers who have abandoned paddy cultivation were selected representing three farmers from each GN Division. Selected farmers and government officials like Grama Niladhari, Agricultural Officers and other government officials who are linked to paddy cultivation in the area were interviewed. Primary observations were conducted in the area to assess the current situation of the abandoned paddy lands of the region. Finally, secondary data were obtained from the DS office of Panadura regarding paddy lands and rainfall data were obtained from the Department of Meteorology, Sri Lanka for further analysis.

For semi-structured interviews, both quantitative and qualitative analysis methods were used. Measures of central tendency and dispersion were used

as statistical methods. Secondary data obtained by the Divisional Secretariat Office and the Department of Meteorology were also analyzed using above statistical methods. Quantitative data analysis softwares, for instance, MS Excel and Statistical Package for Social Sciences (SPSS) have been used as well. Statistical analysis refers to a collection of methods used to process large amounts of data and report overall trends. Statistical analysis is particularly useful when dealing with quantitative data. For mapping the spatial distribution, Geographical Information System (GIS) software—Arc GIS 10.1 is used as the tool. A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. Observation is the active acquisition of information from a primary source (Sugirtharan, Delina, & Amuthenie, 2013). Observations provide accurate data on a particular situation. Analyzing observation data means simply get a clear picture about the situation. A contextual analysis is simply an analysis of a text in whatever medium, including multi-media that help us to assess that text within the context of its historical and cultural setting, but also in terms of its textuality or the qualities that characterize the text as a text.

Data representation is also known as data visualization. Data visualization is the study of the visual representation of data. It presents the abstracted information in schematic form and includes attributes or variables for the units of information. Descriptive statistics enable us to understand data through summary values and graphical presentations. Summary values not only include the average, but also the spread, median, mode, range, and standard deviation. It is important to look at summary statistics along with the data set to understand the entire picture, as the same summary statistics may describe very different data sets. Descriptive statistics can be illustrated in an understandable fashion by presenting them graphically using statistical and data presentation tools. Different types of data require different kinds of statistical tools. Mostly we have used graphical methods and tabulation for data presentation.

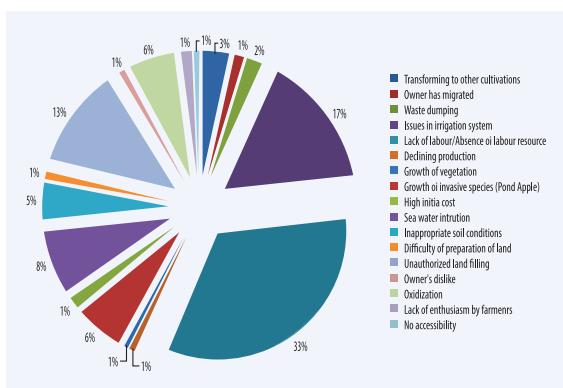
7.3. Results and Discussion

According to the analysis, it is found that the total extent of paddy lands in study area are 849.08 hectares of which approximately 393.87 hectares or 46.38 % of the total cultivable paddy lands are found to be abandoned or fallow fields. Reasons for the paddy abandonment in Panadura DS division as identified by the respondents are represented in the Graph—7.1. Main reason for the abandonment of paddy lands in Panadura Divisional Secretariat Division is the lack of labor to be engaged in the process of cultivation. Paddy in Sri Lanka is a labor intensive production and most of the young generation does not want to engage in farming since there are more job opportunities in the secondary sector and they don't want being called as 'farmer' because of low status in social hierarchy and existing social stigma. Since Panadura consists of urban and semi-urban areas, people tend to migrate to urban parts to find jobs.

Therefore, many paddy lands are abandoned due to the unavailability or absence of labor. Owners do not have the financial capacity to hire labor from outside since it would enhance investment cost of paddy cultivation resulting lower return to investment. Most of the farmers apply for loans although investing on wage labor seems to be not financially viable or cost-effective for them.

17 % of the abandoned paddy lands are due to issues in the prevailing system of irrigation. Prevailing irrigation system has not been maintained for long time and most of the paddy lands are not getting proper access to water. 13% of the abandoned paddy is due to unauthorized land filling. Since this is an urban and semi-urban area, demand for the land is comparatively high. Therefore, paddy lands are now being filled and used as residential sites. Boundary of the Panadura DS Division is bounded by the Bolgoda River in north and Thalpitiya canal in the south and it is located in the coastal region of the country. Therefore, sea water intrusion is another reason for the abandonment of paddy in the study area. Due to climate change, the sea water intrusion has been intensified in the dry season and more paddy lands are being affected by the sea water. It will affect soil conditions of the paddy lands and the crop cycle.

Waste dumping has increased with the urbanization and abandoned paddy lands are used as waste dumping locations by many people (Image– 7.1). Mostly it can be seen along the roadsides. This will indirectly create many health risks like polluting ground water and breeding of mosquitoes. Image– 7.2 indicates that there are invasive pond apple plants in the abandoned paddy lands in Panadura DS division. Most of the paddy lands are located adjacent to the main roads and almost all the abandoned paddy lands have pond apple plant. Since these paddy lands have been abandoned for long period of time, the pond apple population has also increased in numbers. Image– 7.3 indicates the paddy lands are used to cultivate plants like Ipomoea aquatic, Alternanthera sessilis, Centella asiatica which represent by the local names of “Kankun”, “Mukunuwenna” and “Gotukola”. Map– 7.2 indicates the spatial distribution of paddy lands in Panadura DS Division. It clearly illustrates that the paddy lands are located towards inlands from the coasts and they are



Graph– 7.1: Reasons for Paddy

Abandonment

(Source: Questionnaire Survey 2016)

Image– 7.1: Waste Dumping in Abandon Paddy Lands



Source: Field Survey -2016

Image– 7.2: Invasive Pond Apple Plants in Abandon Paddy Lands

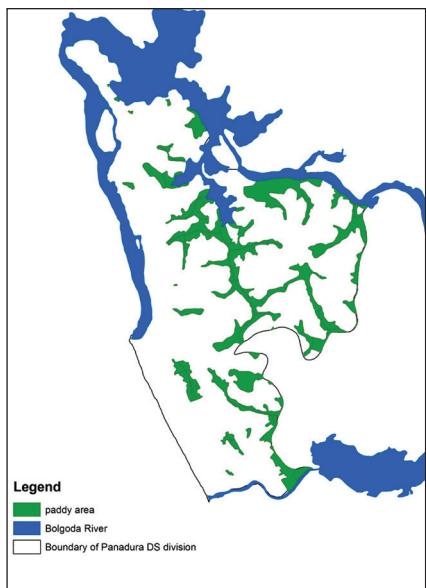


Source: Field Survey -2016

Image– 7.3: Other Cultivation in Abandon Paddy Lands



Source: Field Survey -2016

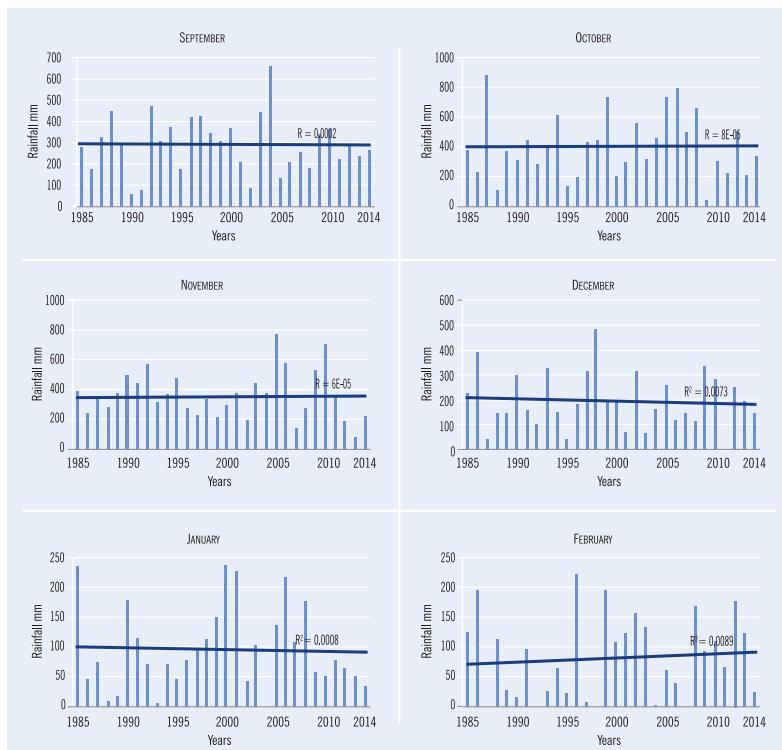


semi-urbanized parts of the study area. Most of the paddy lands are located adjacent to the Bolgoda River and Thalpitiya canal. Most of these lands are now abandoned and transformed into residential areas and, in some cases, used for other cultivations.

Paddy is cultivated in Sri Lanka in two harvesting seasons, namely *Yala* and *Maha*, ranging from March to August and September to February respectively. Graph– 7.2 and Graph– 7.3 indicate the changes in rainfall patterns in the given period of time. It is clear that there are many fluctuations

Map– 7.2: Spatial Distribution of Paddy Lands in Panadura DS Division

Graph– 7.2: Rainfall Distribution in Maha Season from 1985 to 2014

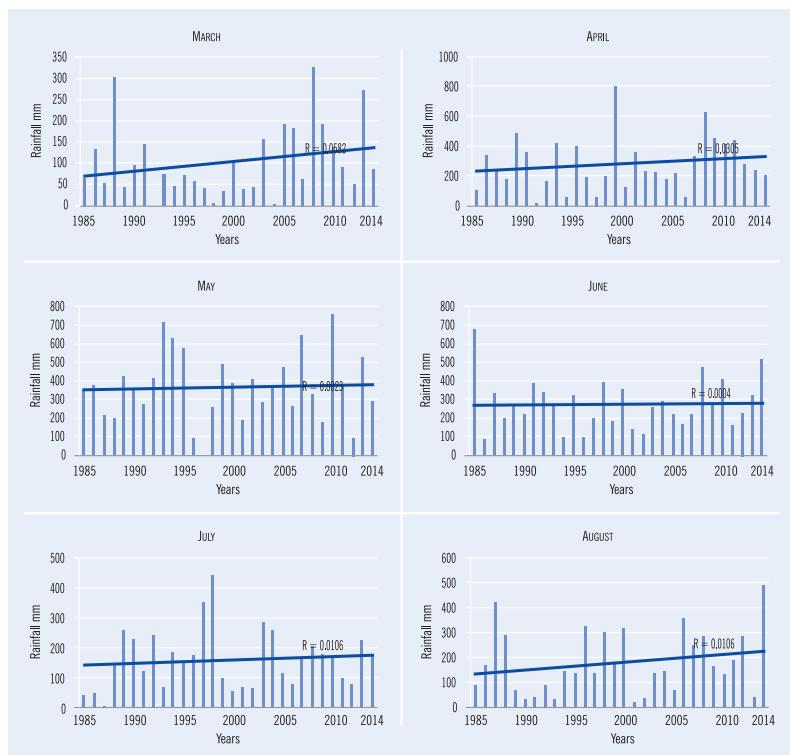


Source: - Department of Meteorology

in the rainfall during the past three decades where some years have lowest rainfall values and some have the highest in the same month. Maximum monthly rainfall recorded exceeds 800mm and highest rainfall can be seen in the months of September, October and November. During this period the south west monsoon is activated in the first half of the season where crop water requirement is high in paddy fields.

In *Yala* season, the amount of rainfall is less compared to *Maha* season. But the trend in rainfall indicates slight increase. Panadura DS Division belongs to the wet zone of Sri Lanka under climatic zones. The prominent rainfall type in wet zone is the south west monsoon and it affects during the months from May to September. During the rest of the month, the prominent rainfall type is convectional. Therefore, these are paddy lands which are cultivated based on irrigation and also by rain water. The cultivation in the study area is segmented into three basing on water accessibility as major irrigated land, minor irrigated and rain fed land. According to the available secondary data, total extension of major irrigated paddy lands are 44.29%, minor irrigated paddy lands are 21.12%, while rain fed paddy lands are 31.59% in the study area for *Yala* season. During *Maha* season, the extent of paddy lands remains

Graph– 7.3: Rainfall Distribution in Yala Season from 1985 to 2014



Source: - Department of Meteorology

the same for all three categories. The production of paddy in Yala season is 3 metric tons per hectare and 3.4 metric tons per hectare during Maha season.

7.4. Conclusion

It is evident that many paddy lands are abandoned due to various reasons of which the main is the unavailability of labor. To avoid paddy lands being abandoned there are suggestions which can be introduced. One main important fact is to identify the real owners of the paddy lands according to the land registry. Since most of the paddy lands are abandoned it is important to find the owners to re-cultivate them. Another important fact is to rehabilitate the existing irrigation schemes in the DS Division. Only one rainy season has the capacity of providing sufficient rainfall where south west monsoon is prominent. And there are many paddy lands which are cultivated through irrigation. Therefore, maintenance and proper functionality of the prevailing irrigation system are highly important to avoid the abandonment of paddy cultivation (Landreth & Saito, 2014; Sandika, 2012).

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Chapter Eight

Spatio-Temporal Distribution and Social Vulnerability of Dengue Fever in Sri Lanka

RM Bhagya Maahewanthis, DRP Sendanayake and MAD Samanmali

Abstract

Dengue is a mosquito-borne viral disease, which has rapidly spread in all regions over the world. The global incidence of dengue has grown dramatically in recent decades. About half of the world's population is now at-risk, especially people living in tropical and sub-tropical climates. According to the world health organization, an estimated 390 million dengue infections occur worldwide each year, with about 96 million resulting in illness. In recent years, dengue has become a major international public health distress. According to the Intergovernmental Panel on Climate Change (IPCC) report, dengue is primarily an urban disease. According to the epidemiology unit records of Sri Lanka, from 2010 to 2015, the recorded total episodes of dengue illness (dengue cases) of Sri Lanka are 29777, 47502, 32063, 44461, 28473, and 34188 respectively. This paper mainly focuses on spatial and temporal (seasonal) distribution of dengue cases of Sri Lanka from 2010 to 2016. This study is based on secondary data collected from epidemiology unit and the Ministry of Health Sri Lanka. According to the results of spatial distribution of dengue disease, Colombo, Gampaha, Rathnapura and Batticaloa were recorded high value of dengue patients from 2010 to 2016. Especially 34,773 dengue patients were recorded January to mid of August in 2016. The papers makes the point that spatial and temporal changes of dengue cases correlate with climate change and short-term weather streams.

Keywords: Dengue, Mosquito-borne Disease, Climate Change, Seasonality

8.1. Introduction

Dengue is a mosquito-borne viral disease which has rapidly spread in all regions over the world. The dengue infection causes flu-like illness, and occasionally develops into a potentially lethal complication called severe dengue (WHO, 2016). The global incidence of dengue has grown dramatically in

recent decades. About half of the world's population is now at a risk. Specially, dengue is found in tropical and sub-tropical climates worldwide. There is no specific treatment for dengue, but early detection and access to proper medical treatments reduces the fatality rates below 1%.

According to the world health organization, an estimated 390 million dengue infections occur worldwide each year, with about 96 million resulting in illness. Most of them occur in tropical areas of the world, with the greatest risk to the life of people. Also WHO reports showed that in the first five months of last year in Sri Lanka more than 6,500 patients were treated for dengue fever and 80 succumbed to the disease. The disease is spread by the bite of two species of mosquitoes *Aedes aegypti* and *Aedes albopictus* which are female mosquitoes. Presently dengue is largely spread throughout the world, Specially, in tropical areas and climatic components like rainfall, temperature and also anthropogenic activities like unplanned rapid urbanization is caused to spread dengue heavily. Dengue Hemorrhagic Fever was first recognized in the 1950s during dengue epidemics in the Philippines and Thailand.

There are three types of dengue fever as: (1) Dengue Fever (DF); (2) Dengue Hemorrhagic Fever (DHF); and (3) Dengue Shock Syndrome (DSS). Dengue Hemorrhagic Fever is a mosquito-borne viral infection endemic in the tropical and sub-tropical regions. The female mosquito *Aea-aegypti* most in semi domesticated, preferring to lay its eggs in man-made water containers, resting indoors and feeding in early morning or late afternoon. Dengue is a major problem, particularly in urban areas in Sri Lanka. It affects all human beings. Dengue has now evolved from a public health problem to a social problem. It's a problem for everyone, including infants to adults.

In recent years, dengue has become a major international public health distress. According to the Intergovernmental Panel on Climate Change (IPCC) report, dengue is primarily an urban disease. In addition, the tropical areas of the world, dengue transmission occurs year-round but has a seasonal peak in most countries during months with high rainfall and humidity. Sri Lanka is one of the tropical climatic country and the majority of people live in urban areas. Urban population of Colombo, for example, Gampaha districts is higher than the other districts of country. In Sri Lanka, it is also an important concern as several dengue outbreaks were reported during past decade. It has become a major public health issue with a high morbidity and mortality (Sirisena, et al 2014).

Multiple dengue viruses are transmitted throughout the Sri Lanka and Since 2000, the magnitude of dengue epidemics has increased and the viruses started to spread from urban to semi-urban and rural settings. Cases were reported from all districts in the island from 2009–2013, Sri Lanka experienced an exponential increase in dengue exposure, with an average of 35,000 episodes of dengue per year and an incidence of 175/ 100,000 population reported nationally (Source: denguevaccines.org). However, Sri Lanka has reached the

lowest-ever case fatality rate of 0.2% (47,258 cases with 97 deaths) in 2014 from a high 5% and 1% in 1996 and 2009 respectively, despite the increase in the proportion of DHF to 10-15%. According to data from epidemiology unit of Sri Lanka, the most affected district is Kandy, while Colombo, Gampaha and Kaluthara districts are also susceptible because of high rate of recorded infection and deaths. During the last 7 month of the year 2016, 26,690 suspected dengue cases have been reported to the Epidemiology Unit from all over the island.

Dengue usually occurs as epidemics in Sri Lanka following monsoon seasons, such as: (a) 1st inter Monsoon rains (March to April); (b) South western monsoon rains (1st seasonal epidemic period - May to September), (c) 2nd Inter Monsoon rains (October to November); and (3) North- Eastern monsoon rains (2nd seasonal epidemic period – December to February). This study mainly focuses on distribution of dengue patients of Sri Lanka. Sri Lanka was located in Indian Ocean close to India. In additionally it has 25 districts as a main administrative boundary (see Map– 8.1).

Major objective of this study is to investigate spatial and temporal (seasonal) distribution of dengue cases of Sri Lanka from 2010 to 2016. The spatial distribution of dengue patients in Sri Lanka was studied by using Geographical Information System (GIS) for the period of 2010 to 2016. This study also examines the variations of dengue patients according to the rainy seasons of Sri Lanka. Finally, the study identifies the most affected areas and represents different levels of risk of dengue exposure in terms of regional population variation in Sri Lanka.

Map– 8.1: Map of Study Area

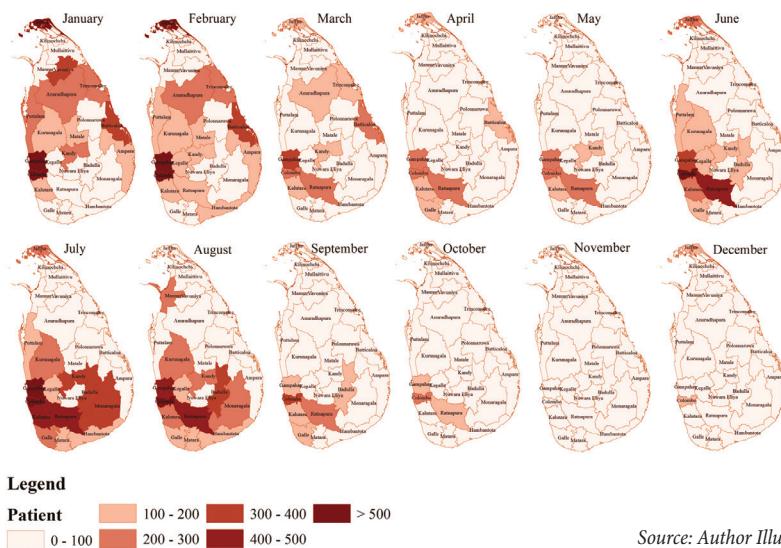


Source: Author Illustrated

8.2. Methodology and Data Analysis

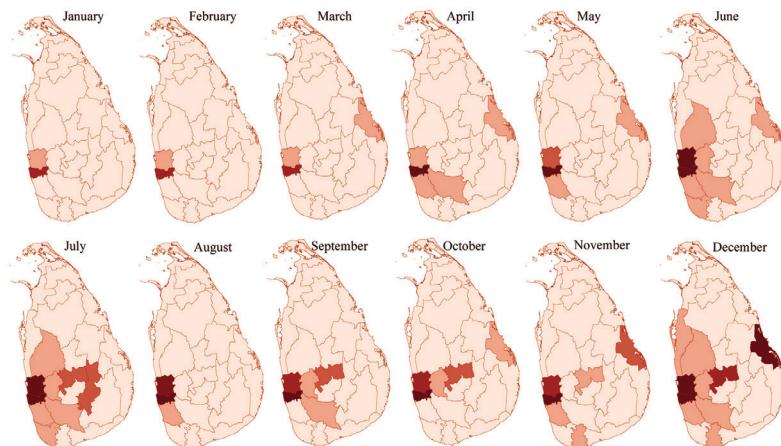
Methodology of the study can be segmented into three parts: data collection, data analysis and data presentation. This study is based on secondary data, which is collected from epidemiology unit of the Ministry of Health, Sri Lanka. These data were analyzed by using Spatial Analysis tool in ArcGIS 10.1 platform and Microsoft Excel 2013 version. According to this study, analysis

Map– 8.2: Monthly Distribution of Dengue Patients in Year 2010



Source: Author Illustrated

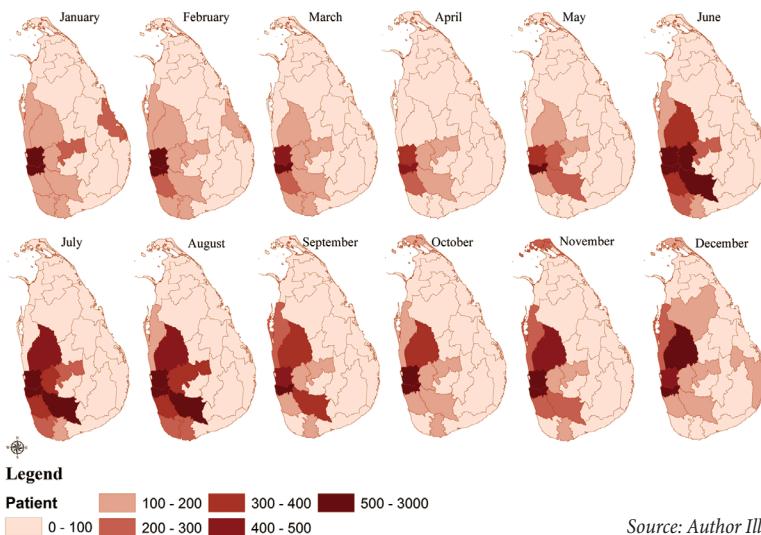
Map– 8.3: Monthly Distribution of Dengue Patients in Year 2011



Source: Author Illustrated

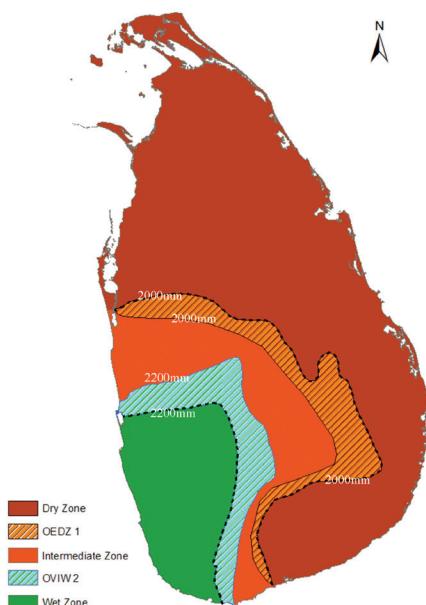
process is mainly based on spatial analysis methods. The Inverse Distance Weighted method (IDW method) in Geographical Information System (GIS) is used to identify the spatial variations and seasonal changes of dengue patients in Sri Lanka.

Map– 8.4: Monthly Distribution of Dengue Patients in Year 2012



Source: Author Illustrated

Map– 8.5: Climatic Zones of Sri Lanka



Note: OEDZ: Observed expansion area of dry zone (fluctuating); OVIW: Observed vulnerable area of intermediate zone and wet zone (fluctuating). Source: Withanachchi, et al. 2014

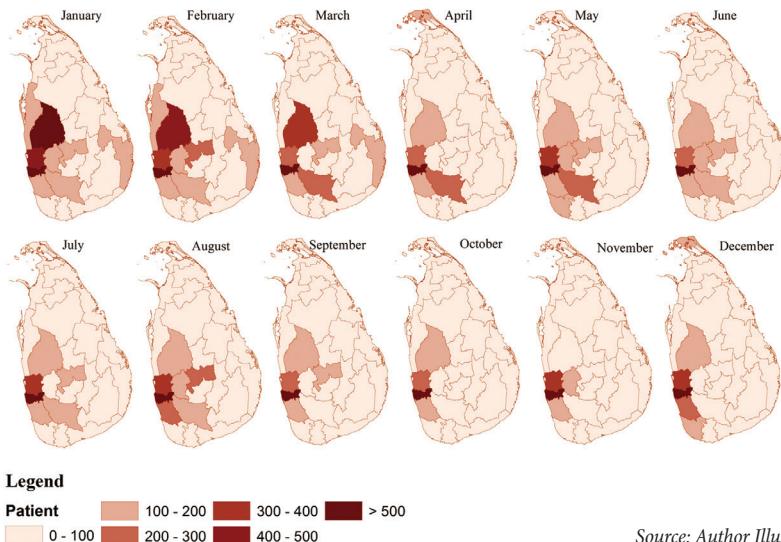
8.3. Results and Discussion

This study has shown that there are certain issues regarding the spatio-temporal distribution and social vulnerability of dengue fever in Sri Lanka. According to the study, highest number of dengue patients was recorded from June to August in the western part of the Sri Lanka 2010, mainly Colombo, Gampaha and Kaluthara district in Sri Lanka. The Map– 8.2 projects monthly spatial distribution of dengue patients in Sri Lanka in 2010. The map also helps to identify the highest concentration of dengue patients recorded between January to February, while Colombo, Gampaha and Jaffna districts had highest number of dengue patients in 2010 during the northeast monsoon period.

And also during the southwest monsoon period, the highest number

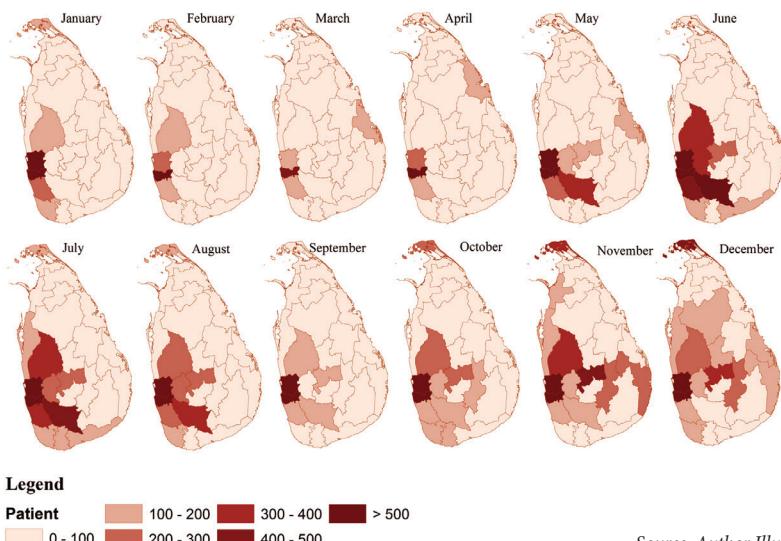
of dengue patients in June, July and August month mainly in Colombo, Gampaha, Rathnapura, Galle districts. Then during the 2nd inter monsoon period, there were no significant variations in recorded dengue patients in year 2010. However, during the month of October, November and December, fewer patients were identified in comparison with other months in 2010.

Map–8.6: Monthly Distribution of Dengue Patients in Year 2013



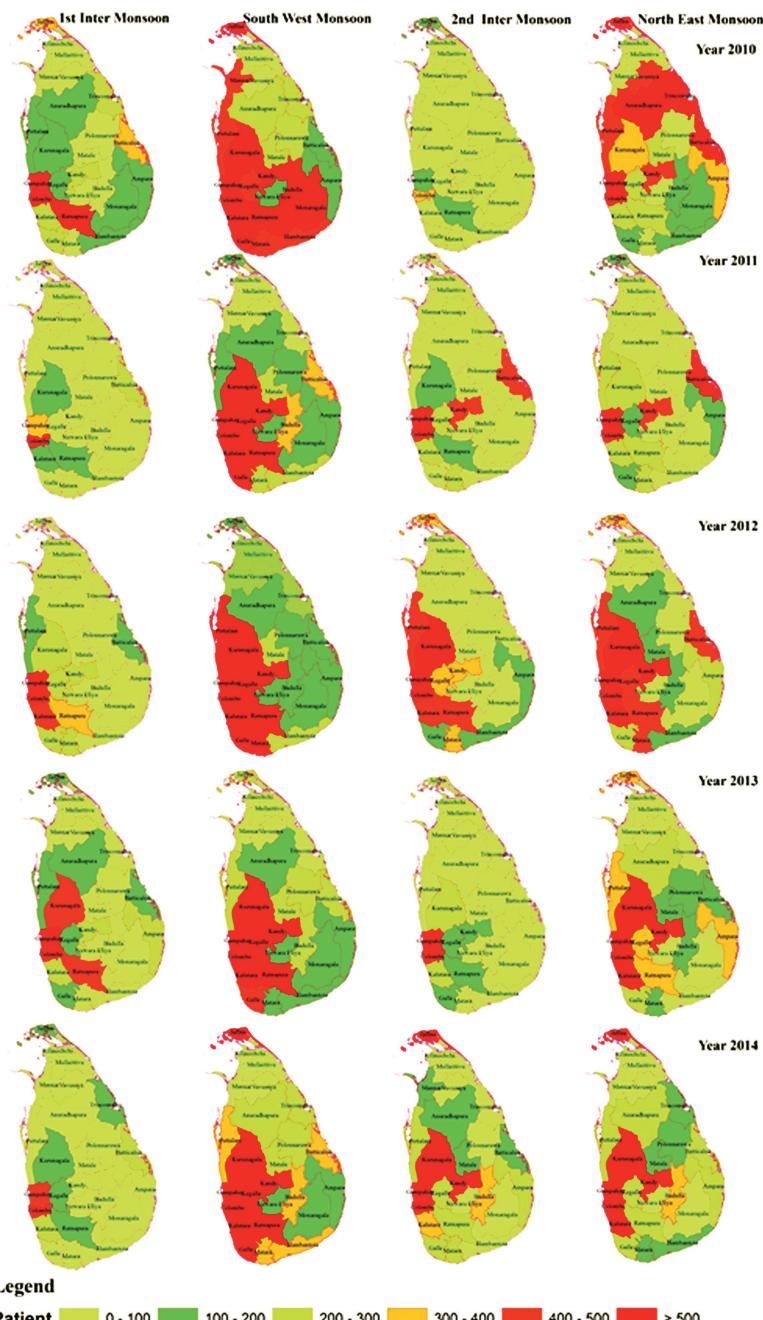
Source: Author Illustrated

Map–8.7: Monthly Distribution of Dengue Patients in Year 2014



Source: Author Illustrated

Map– 8.8: Distribution of Dengue Patients between 2010 to 2014 by Monsoon Seasons



Source: Author Illustrated

According to the Map– 8.3, in year 2011, during the north eastern monsoon period, very few dengue patients were identified. But, the Colombo and Gampaha districts were recorded as having high number of dengue patients throughout the year. Colombo and Gampaha are densely populated districts with high degrees of urbanization. This can be one reason for high dengue concentration in Colombo and Gampaha districts.

The Map– 8.4 indicates monthly distribution of dengue patients in 2012. From that, we can identify Colombo district as having the highest number of dengue patients in Sri Lanka. When we compared this map with climatic zones map of Sri Lanka (Map– 8.5), the districts belonging to wet zone, while intermediate zones were recorded as having the highest concentration of dengue patients in Sri Lanka in 2012. Wet zone received 2500 mm annual rainfall throughout the year and intermediate zone received 1750 mm to 2500 mm annual rainfall. Rainfall is the one of reason for spreading dengue fever.

The Map– 8.6 shows the monthly distribution of dengue patients in 2013. There was highest number of dengue patients recorded in January in Kurunagala district. Apart from that, Colombo district was also recorded as having the highest number of dengue patients in every months of 2013. The Map– 8.7 indicates the monthly distribution of dengue patients in 2014. It can be clearly identified that Colombo and Gampaha districts are the most vulnerable districts for dengue fever in 2014. And also during the period of south western monsoon rains, from May to September, we can see the highest number of dengue patients recorded in Colombo, Gampaha and Rathnapura districts. This period also called as 1st seasonal epidemic period.

Map– 8.8 shows the seasonal distribution of dengue patients in Sri Lanka from 2010 to 2014 in relation to the monsoon season of Sri Lanka. According to this study, dengue patients were highly recorded in the South West Monsoon period in the country. It means the first epidemic period of Sri Lanka. As the special case, Batticaloa district was identified as the highest vulnerable district as well as west and south-western part of Sri Lanka. The reason behind is, Batticaloa district and the west and south-western part of Sri Lanka are densely populated areas.

8.4. Conclusions

The above maps, analyzed in this study, illustrate the spatial distribution of the dengue fever from year 2010 to 2014 in the country. According to the results of spatial distribution of dengue disease, Colombo, Gampaha, Rathnapura and Battcaloa were recorded as having the highest number of dengue patients from 2010 to 2016. Especially 34,773 dengue patients were recorded from January to mid of August in 2016. 50% of the cases was recorded in the western province during last eight months. However, above mentioned districts are highly populated areas and temporary slum houses are built around the urban areas in these districts. According to the epidemiology unit records

of Sri Lanka, from 2010 to 2015, total affected population (dengue exposure) of Sri Lanka in order from 2010 to 2015 is as follows: 29777, 47502, 32063, 44461, 28473, and 34188. The relationship between these districts' total population and dengue patients is analyzed for the year 2015. Positive correlation was found with 0.56 as R square value at 0.05% significance level.

Additionally, collected data was analyzed for temporal pattern and correlation with climatic data, such as rainfall, temperature and humidity of the country. According to the results, bulk density of dengue cases was recorded in the South West and North East Monsoon period. The monthly variation of Dengue cases was very high in May to September and these five months recorded to have the highest rainfall in the Western part of the Sri Lanka. However, positive correlation was recorded between the number of dengue cases and number of rainy and wet days with average humidity.

Finally, spatial and temporal changes of dengue cases indicate that climate change has direct bearing on the prevalence and incidence rates of dengue exposures. In addition, majority of the populated areas are highly vulnerable to the climate change impacts in the context of dengue occurrence. The research findings clearly indicate that highly populated districts in Sri Lanka are highly vulnerable to dengue exposure and spatial distribution of dengue patients is also high in those districts.

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Chapter Nine

Decline in Cloud Cover in Last 50 Years from Satellite Pictures

Shahriar Khan and Asma Khatun

Abstract

While global warming, sea level rise, and ozone layer depletion are well documented, the issue of cloud cover has seldom been addressed. The study of cloud cover from Earth stations is complicated by the difficulty in quantification of cloud cover and the variation throughout the day. Unlike observation from meteorological stations, cloud cover is much more visible in satellite images from space. This study compiles satellite pictures from the earliest space flights, from around 1967, permitting the documentation of 50 years of cloud cover. A very visible and dramatic decline in cloud cover is observed, that has been hardly ever been acknowledged, let alone investigated for causes. Preliminary inspection suggests that the cloud cover has declined from about 33 % to about 5 % in the last 50 years. Also relevant is the decline in volume of clouds, that can be found from the simple geometry or $V \propto A^{1.5}$, implying a decline of 95% by volume. The thickness of the clouds has declined to about 38 % in the last 50 years. The reason for the decline in clouds is likely to be the same as the man made changes of global warming, ozone layer depletion, and deforestation. Extrapolation beyond 1967, it is likely the decline in cloud cover has been continuing for centuries or even thousands of years. This supports that today's deserts such as the Sahara, must have once partially been fertile land covered with clouds. It is argued that the greater clouds of thousands of years ago might have contributed to the ice age.

Keywords: Cloud Cover, Satellite Image, Global Warming, Climate Change

9.1. Introduction

The study of climate change has confirmed the realities of global warming, ozone hole depletion and sea level rise. Global warming is acknowledged to have been occurring not just for decades, but for hundreds or even thousands of years. At Glacier National Park, of the 150 glaciers in the late 19th

century, only 26 remain today (The Guardian 2017). The polar ice sheets are disappearing at a rapid rate, lessening the habitat of wildlife like the polar bear.

As rainfall has declined over the last 50 years, dams such as Hoover dam have less rainfall, and less power generation (E&E News 2014). Other issues in climate change such as frequency and severity of storms more within a gray area, as these changes are less easily quantifiable. The issue of cloud cover has almost always been sidelined, perhaps because of the difficulty in quantification, and as it may generate more pessimism to compound global warming. Thus we fail to be draw attention to the increased exposure to sunlight, increase in harmful ultra violet radiation, and incidence of skin cancers and other diseases.

Although the older generation may be heard describing how the world was more cloudy in past decades, there have been few documentations of this decline. In the past, there have been reports of slight variations of cloud cover over several years (NCAR 1988; Hahn, C. et al. 1995; Warren, S. et al. 1986; Albert, Arking and Childs, Jeffrey D. 1985; Kaufman, Yoram J. and Koren, Ilan 2006; Vautard, et al. 2009; Norris & Wild, 2009). Some correlation has been shown between cloud cover and solar activity (Svensmark & Friis-Christensen, 1997). It is suggested here that cosmic ray flux has a relationship with cloud cover and climate which has not be recognized. This decline in cloud cover was documented by the author in 2015 (Khan, S. 2015). The exact reasons for the decline are not well understood, but anthropogenic causes, included global warming, usage of aerosols and CFCs are likely to be major causes.

9.2. Ultraviolet Light and Genetic Programming

Decreasing cloud cover implies more intense and longer periods of exposure to sunlight and to harmful ultra-violet radiation. It is well known that exposure to even half an hour of direct sunlight can lead to tiredness. Exposure of a few hours can even lead to onset of fever and tiredness which continues the following day. The required vitamin D from the sun can be obtained by only about 5 minutes of direct exposure for very light skins to 30 min for darker skins (GB Health Watch 2017). The increasing sunlight is known to cause mutations in our DNA leading possibly to cancer and other diseases. Treatment should include staying away from the sun.

The explanation for the harm caused by increased sunlight is as follows. Over thousands (and millions) of years, the human body has adapted to prevailing environmental conditions through selective survival and evolution. The human body is hardly adapted to today's excessive sunlight arising from decreased cloud cover. Evolutionarily, the human body has had insufficient time to respond to these changes.

9.3. Methodology

Observations from meteorological stations may have been the only way to analyze cloud cover before the advent of satellites in the 1960s. Cloud cover is hard to quantify and varies through the day, meaning that accurate quantification of clouds was not possible before the age of satellite photography around 1967.

This study takes into consideration published and publicly available satellite pictures from the earliest satellites in about 1967. Satellite pictures were taken in Sept. 1967 by the Department of Defense Gravity Experiment (DODGE) satellite of NASA, launched from Cape Canaveral. High definition color television images of the Earth as a disk were first obtained by the U.S. Applications Technology Satellite, on November 18, 1967. In 1968, clear pictures were taken by the three astronauts of Apollo 8.

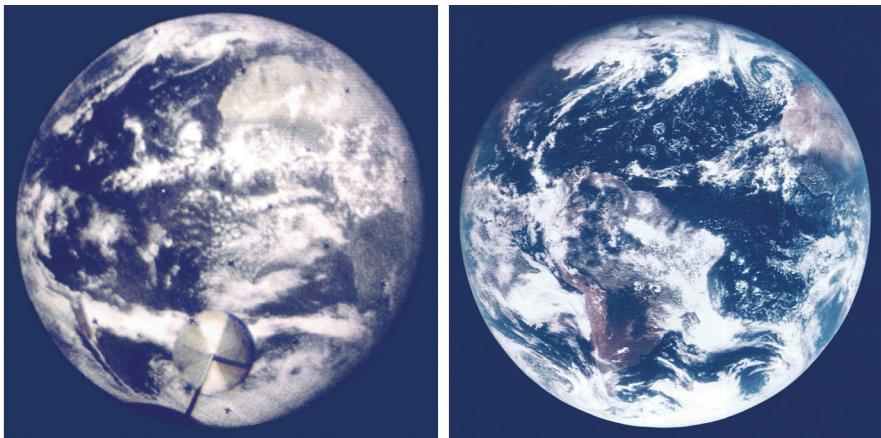
While preliminary inspection of the satellite imagery quickly shows dramatic changes in the cloud cover, a more accurate analysis would require more detailed means for measurement of cloud area. In this study, a comparison of the clouded areas is made by visual estimation. Such estimates of the area was only problematic in the first few low resolution satellite pictures. Here, both land and cloud boundaries were poorly defined. Modern pictures and even other pictures from 1967 have better resolution and visual estimation is much better.

Besides the decline in area of cloud cover, the volume and thickness are of interest, as they determine degree of blockage of the sun. While clouds have visibly decreased in area, we make the assumption that there has been corresponding decrease in thickness and volume, that leaves the fundamental shape of the clouds unchanged. This allows usage of formulas arising from area being proportional to square of length and volume being proportional to cube of length. As the starting point of this study is the area, the thickness would be proportional to the square root of the area, and the volume would be proportional to the 1.5 of the area.

Satellite pictures from 50 years ago are rare, which is why most publicly available pictures have been included in this study. On the other hand, today's numerous satellite pictures show about the same area of cloud cover. A single representative satellite picture has been shown in this paper.

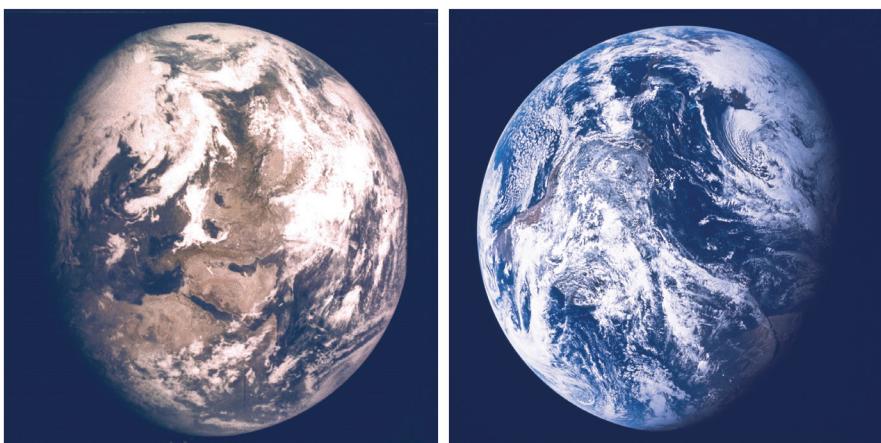
9.4. Observations

The four publicly available pictures from 1967-68 (when pictures were rare) show much contrast with the single picture from 2014. Upon preliminary visual inspection, cloud cover over the globe seems to be hardly affected by seasons and there is little variation between the Northern and Southern hemispheres and the time of the year that the picture was taken.



Image– 9.1: The Earth is Covered in Clouds and the Continents are Barely Distinguishable

Above Left– Image Taken by DODGE Satellite on September 1967 (Source: www.cosmic-watch.com). Above Right– High Definition Color Images Taken by the U.S. AT Satellite on November 18, 1967 (Source: Google Image).



Image– 9.2: The Earth is Covered in Clouds. Although the Arabian Peninsula is Visible in Above Left but Other Regions not Distinguishable

Above Left– Image Taken by Zond 7 at about 70,000 km. on August 8, 1969, while on its way to the Moon (Source: Google Image). Above Right– Image Taken by the Apollo 8 in 1968 (Source: www.airandspace.si.edu).

The Earth is closest to the Sun at Perihelion in January at 147 million miles and furthest at Epihelion in July at 152.1 million miles. The difference in the distances is so small that it is unlikely to cause a major seasonal variation in the cloud cover. Also, an inspection in today's numerous satellite pictures does not indicate any major seasonal variation in cloud cover.

Of the four pictures from the 1960s, only the first is significantly blur (Image– 9.1). The others show clearly identifiable land boundaries in color, and allow



Image– 9.3: A Recent Satellite Image of the Earth Showing a Decline in Cloud Cover Compared to Earlier Images Taken almost 50 Years Ago

(Image Source: CIRCA 2014).

distinction of clouded areas. Upon inspection, it is clear that the cloud cover around the globe has decreased dramatically in the last 50 years. At the very least, it has become much easier to recognize continents, countries and their borders. The easier recognition can be partly attributed to the higher definition pictures of today, but the decline in cloud cover is by far the main reason.

A quantitative estimate of the decline in cloud cover can be made by comparing the areas of the world covered by clouds. According to satellite pictures above, the cloud cover was about a third of the world's surface in 1967, compared to about 5% today. Taking the ratio of the two values, gives a decline to about 15%, in terms of area.

$$\text{Decline in Area of Cloud Cover} = \frac{A_{\text{Today}}}{A_{50}}^{0.5} = \frac{0.05}{0.33} = 15\%$$

Here A_{50} and A_{today} are the percentages of cloud cover over the Earth 50 years ago and today.

9.5. Volume and Thickness

Quantification of clouds may consider not only the area, but as a volume also. More voluminous clouds are thicker, meaning they stop sunlight more. Further analysis is possible with the assumption that a change in area is

accompanied by a corresponding change in volume and thickness, that leaves the fundamental shapes of the cloud unchanged, regardless of decrease in size. From geometry, area is proportional to the square of the length, whereas volume is proportional to the cube of length. A measure of the volumes of clouds can be found by taking the root of the area and then taking the cube. This corresponds to taking raising the ratio of the areas to the power of 1.5.

$$\text{Decline in Volume of Clouds} = \left(\frac{A_{\text{Today}}}{A_{50}} \right)^{1.5} = (0.15)^{1.5} = 0.058$$

Substituting values of 33 % and 5 %, the cloud cover has decreased to 5.8 % of its volume from 50 years ago. This corresponds to both a decrease in the surface area and the thickness of clouds. The thickness of clouds is also relevant as it indicates the extent of blocking of the sunlight. Once again, we make the above assumption that the decreasing cloud area results in corresponding lowering of thickness and volume, such that fundamentally the cloud becomes smaller, but the cloud shape remains unchanged. The area is now proportional to the square of the length, which gives the following formula.

$$\text{Decline in Thickness of Clouds} = \left(\frac{A_{\text{Today}}}{A_{50}} \right)^{0.5} = 0.387$$

This means the thickness of clouds has decreased to about 38.7 % of what it was 50 years ago. Calculation of the sunlight increase is interesting as it is not very different from calculating half life of radioactive materials.

9.6. Causes for Decline in Cloud Cover

Now that the decline in cloud cover is established, the question arises as to the cause of the decline. Global warming is mainly caused by greenhouse gases such as carbon dioxide, and deforestation. The change in cloud cover is likely to be just a part of the climatic changes caused by human interference. The same man-made (anthropogenic) causes of global warming are also likely to be causes of cloud cover decrease. Just as global warming, ozone depletion, and sea water rise are man made (anthropogenic), the decline in cloud cover is likely to be man-made and due to the same reasons. It is likely that the burning of fossil fuel, deforestation, and increased greenhouse gases are responsible. While the internal combustion engine has been around for just a century or two, coal and wood have been burned for heat for thousands of years. These, coupled with deforestation, must have contributed not only to global warming, but to decline in cloud cover.

9.7. Extrapolating to Centuries and Thousands of Years Ago

Now that the dramatic decrease in cloud cover has been established over the last 50 years, the question arises as to how much decline there has been in the last hundreds or even thousands of years. Extrapolating beyond 1967, when satellite pictures were not available, the implication is clear that the decline in cloud cover has been happening well before 1967, perhaps for hundreds or even thousands of years.

The primitive world just hundreds of years ago, must have had great cloud cover. Thousands of years ago, there may have even been very little opening in the clouds. Today's Sahara desert may have been cloud covered, with more lush greenery. The sun god Ra of Egypt may have been inspired by fewer opportunities to see the Sun amidst the clouds. Stonehenge, which is at least partly inspired by the Sun, may have been made under conditions of less frequent or very infrequent direct sunlight.

Could the increased cloud cover and decreased sunlight have been among the main reasons for the ice age thousands of years ago? There is very little agreement on the cause for the ice age (Vautard, et al. 2009). Some have argued that it is the position of the continents while others say it is due to the feedback caused by ice reflecting back sunlight into space. The Ruddiman hypothesis states that anthropogenic activities such as farming, deforestation, and forest fires may have led to global warming. Such man-made climate changes are likely to have also caused decrease in cloud cover for thousands of years. This leads to the amazing conclusion that the decrease in cloud cover may have been a major reason for the ice age.

9.8. Conclusion and Further Research

Over the last 50 years, not only has there been global warming, ozone layer depletion, and sea water rise, there has been a dramatic decline in cloud cover. This change in the cloud cover has been rarely acknowledged, let alone investigated for causes. One reason could be that established powers of the world could be less inclined to report pessimistic outlooks reflecting 'doom and gloom'.

This paper has identified and to some extent quantified the decline in cloud cover over the world by looking only at satellite pictures from 50 years ago. Quantitatively the cloud cover has decreased from about 33 % of the globe from 50 years ago to about 5 % today. This corresponds to drastic declines to 15 % in terms of area and 5 % in terms of volume. Both the lessened area and volume of clouds imply longer exposure to direct sunlight and harmful ultraviolet rays. Today, spending too much time outdoors may result not only in sunburn, but in tiredness or even fever. The excessive sunlight and ultraviolet rays are likely the reasons for skin disorders, including cancers deep within the body. Man's evolution has barely kept up with the rapidly increasing exposure

to direct sunlight. Extrapolating the decline in cloud cover, the decline in sunlight must have been continuing for centuries at least during the popularization of fossil fuel. Decline in cloud cover must have continued for thousands of years because of deforestation, and the burning of coal and wood for cooking and bodily warmth.

A more comprehensive look at satellite pictures from more recent decades is left for a later study. There may be consideration of satellite pictures spread out over the last 50 years, showing variations within the last half century. In addition, there should be research into the causes of the decline. There should be research into the effect of the increased sunlight on the human body, including finding the extent of association of sunlight with cancers and other diseases. The association between direct sunlight and skin cancer is established, but there should be research on whether the heightened sunlight has also worsened other types of cancer and diseases.

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Response to Cyclone Early Warning in a Coastal Island of the Southern Bangladesh

*N. M. Rabiul Awal Chowdhury, Mohammad Ainul Haque,
Israt Jahan Lipa and Fazle Sharior*

Abstract

Coastal people's early warning system for weather forecasting is required to provide accurate information in-time, as well as, it incorporates with the experience of local people to prepare themselves for natural disasters. This study aims to understand community people's access, local interpretations and responsive actions towards early forecasting and the dissemination of early warnings. Using qualitative tools: Group Discussion, Key Informant Interview and Semi-Structured Interview, this study was conducted in Hatiya, Bangladesh. The results of this study indicate people's perceptions, explanations, their own interpretations about the probability of disaster and their respective responsive actions, along with local people's preferences regarding effective forecast system. These issues were analyzed by the paradigm of mental model of communication. Study result revealed that, when people strongly believe something, their respective response reflects those belief, because human actions and practices first come in their thoughts. Inhabitants prefer to be alive not only for their lives but also for their livings. These concerns were evolved through the exploration of existing disaster weather forecast system communication and motivation of its particular preparedness and responsive actions among the coastal people of Hatiya.

Keywords: Early Warning System, Local Interpretation, Response Action

10.1. Introduction

Natural disasters have severe impacts, especially in coastal areas, on the life and livelihoods of people. The severity of impacts, however, depend on the capacity of local people and how they are going to face it by preparing themselves. Therefore, efforts to reduce disaster risk have been focused, in part, on developing early warning systems to provide timely and effective information that enables local people and communities to respond when a disaster occurs.

Early warning systems are increasingly considered to be an integral component of disaster preparedness and involve a broad spectrum of actors. Early warning systems are combinations of tools and processes embedded within institutional structures, coordinated by international- and sometimes national- agencies. Whether they focus on one particular natural calamity/ disaster or many, these systems are composed of four elements: knowledge of the risk, a technical monitoring and warning service, dissemination of meaningful warnings to at-risk people, and public awareness and preparedness to act (UNISDR, 2006). Warning services remain at the core of these systems, and how they can operate that depends upon having a sound scientific basis for predicting and forecasting.

Meteorologists working for the state government in Bangladesh claim that the kinds of forecasts they can currently produce are not useful for local people, who lack resources to act on forecast-based decisions (Paul and Rahman, 2006). It was argued that scientific predictions do have meaning and consequences in rural communities. Official forecasts inform policies that affect local people. Therefore, local people hold government accountable for early warnings, even if this forecast system does not directly influence their own decision-making process regarding strategies to cope with adverse weather conditions. Analyzing local interpretation of weather forecast takes research on climate-society interactions in a new direction. It pushes us beyond simplistic knowledge-transfer approaches that assume a receptive target population and questions how meteorological science (particularly as a product of government) fits into the local cultural context.

Emphasizing on the above issue, this investigation takes the discussion beyond notions of scientifically developed early warning system which should be based on the context of the forecast system rather than the only text of the early warning dissemination. Cyclone early warnings were chosen as the focus of this study as it is imperative to have accurate early warnings to decrease the vulnerability of local coastal villagers. Early warnings are the first step in evacuating people to a safe location before a cyclone storm to reduce the loss of lives and properties. However, the government has acknowledged that risk reduction and hazard mitigation are not feasible without the input of the local government and has begun to work together with community-level organizations to improve early warning systems. These systems are not effective yet in reducing vulnerability because of mistrust among those people who are receiving the warnings. Attempted investigating issues were like; right to use, own explanation, trust in weather information received, tendency to ignore weather information, readiness and planning for severe weather, influence of weather information on the responsive action while comparing and assessing people's attitude and behavior between previous and recent ways of weather forecast communication. The study has identified some behavioral issues related to early warning system and has outlined recommendations to make them more responsive and effective in life-loss prevention.

According to UNISDR Platform for the Promotion of Early Warning (2006), four components should be considered as compulsory to ensure people-centered early warning system to mitigate losses caused by natural disasters. First one is to ascertain risk knowledge among community people and to assess risks. By this, community people's risk knowledge can be explored to prevent risks during a disaster (Table– 10.1). The second and third elements are centered on warning process. These propositions of early warning system tend to prevent damage to properties and losses of lives from a disaster. They are considered as important elements of people-centered warning system as the first and foremost fact for community preparedness based on early warning. And finally, there comes the issue of responsive action to communicate with this warning system. It emphasizes on the community responsive capability and factors, as well as, elements related to this response. With the help of these four elements, an effective people focused early warning system can be developed to mitigate loses of natural calamities. However, the problem is, making community people act upon early warning system, or is this early warning system disseminated effectively among those people who would communicate with this early warning system. This paper tends to focus on this important issue of effective early warning development, emphasizing community people's preparedness and responses to an effective early warning system to mitigate problems. It is focused on the inquiries that do these four components proposed by UNISDR work successfully in calamity inclined regions like Hatiya in relation to correspondence?

Table– 10.1: Four Elements of People-Centered Early Warning Systems

Elements	Activities
Risk Knowledge	Undertake Risk Assessment
Monitoring and Warning Services	Develop Hazard Monitoring and Early Warning Services
Dissemination and Communication	Communicate Risk Information and Early Warnings
Response Capability	Build National and Community Response Capabilities

Source: From UNISDR Platform for the Promotion of Early Warning 2006

10.2. Means and Methods

Maxwell (2005) suggests that a researcher does not have to adopt one single research paradigm, and encourages the researcher to find a paradigm or theory that fits with the conceptual framework, research questions and methods, which should also be compatible with the researcher's pragmatic stance. This research has followed the critical anthropological research paradigm. The critical anthropological paradigm explores the social world, criticizes it, and seeks to empower the individual to overcome problems in the social world. This paradigm seeks to critique and transform historical insights (Guba and Lincoln, 1994). The anthropological research paradigm enables researchers to understand how society functions, while incorporating participatory research and empowerment for the local level people (Neill, 2006).

A qualitative approach was chosen for this study and some qualitative tools and techniques were used to collect data. Latent content analysis, which measures unobservable and uncountable concepts, was used to analyze collected data. Content analysis has attempted to measure all variables as they naturally and normally occur. Study participants were selected purposively to have the opinion from the right and involved individual concerning the study topic. The critical anthropological paradigm requires a “dialogue between the investigator and the subjects” (Guba and Lincoln 1994); therefore this study was executed through a qualitative research study of early warning system and the local-level community responses as well as their interpretation from their inner perspective. Guba and Lincoln (1994) argue that knowledge in the critical anthropology paradigm “grows and changes through a dialectical process of historical revision that continuously erodes ignorance and misapprehension and enlarges more informed insights”. This study aimed to use a dialogue between the researcher and the persons at risk in order to address current issues and create new insight that will address current misapprehensions regarding early warning systems. This study conducted open-ended interviews and discussions at all three levels data collections tools. They were Key Informant Interview, Semi-Structured Interview and Group Discussion (see Table- 10.2). Existing relevant documents were reviewed to gain understanding on this issue.

Content analysis was used to refer to any qualitative data reduction effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings (Patton, 2002) and is performed by searching test for recurring words or themes. These may be patterns within the local-level responses and it may identify a need to alter current early warning messages. Content analysis was important for this study as it examined data, in this case, current early warning systems, in order to understand what they mean to people, what they enable or prevent, and what the information conveyed by them does. Here content analysis provided insight into relationships between human thought and communication use.

Table– 10.2: Methodological Matrix of the Study

Method	Participants	No
Key Informant Interview (KII)	Community People (with Experience of Disaster)	04
	Personnel from Local Organizations	04
Semi-Structured Interview	Community People (Male Member)	05
	Community People (Female Member)	05
Group Discussion	Respective Local Disaster Management Organization Personnel	03
	Local Government Personnel Who Are In Charge Of Disaster Management Department	02
Group Discussion	Community People (Male Member)	05
	Community People (Male and Female)	02
	Community People and Staff from Local Organization	01

10.3. Literature Review

A review of the existing literature shows that, although a number of studies have been carried out in Bangladesh looking at different aspects of flooding, cyclone and storm surge but a systematic documentation of the causes of human ignorance of cyclone warning, reluctance to seek refuge, and the natural signs of cyclone and storm surge, are lacking. This paper aims to fill this gap by showing human behavioral responses to cyclone warnings and identifying people's own interpretation on natural warning signs of cyclones and storm surges. This essay also provides some policy measures to integrate local interpretation in modern cyclone forecasting system of Bangladesh. The practical significance of these findings may help policymakers, planners and practitioners to advise on interventions for enhancing the effectiveness of current cyclone forecasting systems, with a broader goal of building a disaster-resilient coastal community.

Adaptive capacity is seen as a key component of the concept of vulnerability (Adger, 2000). One method adapting to cyclone-prone areas involves changing human attitudes and behaviors toward nature. This approach attempts to modify human vulnerability, and reduce hazard loss, by integrating technological means and human elements (Haque, 1997). It proposes that warning systems are designed to enable people to take precautionary measures to minimize loss and to insist on the evacuation of an area in advance of an approaching hazard.

The cyclone bulletins issued by the Bangladesh Meteorological Department include information on the location of the cyclone, the direction of its movement, the maximum sustained wind speeds generated by the cyclone and the radius of maximum winds (Manirussaman et al., 2001). The success of the warning depends on the reactions and responses of people (Haque, 1997). Responses to warnings tend to be quite varied and often warnings will be ignored because of fatalistic attitudes, disbelief in the warnings or fear of losing household assets, indecision, insecurity of cyclone centers, as well as a love of domestic animals (Haque, 1997 and Paul and Rahman, 2006). Disbelief of warnings because of previous false warnings is a major factor causing inaction against warnings (Haque, 1997). Prior to the 1991 cyclone, the reliability of cyclone warning signals was under question, with residents failing to react to them because frequently no cyclone followed (Paul, Rahman and Mahbub, 2002).

The value of a forecast is measured by more than just its accuracy (Meinke and Stone 2005). Forecasting is linguistic acts that test the limits of people's knowledge, their judgment and their faith. By analyzing the communicative practices of meteorologists, and tying these to historical, social, environmental, economic and epistemological contexts (Pennesi, 2005), we can integrate theoretical dimensions of linguistic and ecological anthropology. This ethnographic and discourse-based research brings to the heart of communication issues that

emerge where a global knowledge system like meteorological science intersects with local cultural knowledge and individual experience. This study helped to formulate general ideas regarding the impact of local belief and cultural knowledge on local interpretation of weather forecasting. It also developed a theoretical model of this study which focuses on a mental model of interpreting local prediction and interpretation of early warning system. After reviewing these literature, this study aimed to make early warning systems more effective targeting those community people living at highest risk as well as creating suitable, understandable and trusted warning messages.

10.4. Mental Model: Response to Early Warning System

Addressing weather forecasting issues, there are various theoretical assumptions concerning the role of knowledge and respective behavioral responses. Interpretations and responses are meaning-making endeavors—not just of ecological and atmospheric processes. Depends on who the people are and how they live (Pennesi, 2005). Drawing on mental model theories of performance and responsive activity, this study analyzed the strategic language used within a cultural model framework, the emotions and motivations associated with experiences of living in a particular environment (both natural and material), and how these are crucial to understanding the meanings of local prediction regarding weather forecast (Bauman, 1992). In this study, it was examined how the connections between cultural models of ‘prediction’ and ‘local interpretation’ explain and how traditional predictions motivate local people and build solidarity in opposition to exclusionary systems of government and science.

In this mental model theories of performance and responsive activity, knowledge is often believed to be a background factor that influences a person’s attitude toward a certain behavior (Ajzen, 1991) and given the known association between attitude and behavior (Armitage and Connor, 2001), knowledge is then assumed to influence behavior through a mediating variable. The idea behind the attitude and behavior relationship is that the more people know about and understand the connections between their own behavior and a range of environmental threats, the more likely it is for a person to adjust their behavior accordingly. While knowledge of climate change impacts has also been implicated in eliciting behavioral change (Nillson and Kuller, 2000), Truelove (2009) found that knowledge of appropriate response behavior was the strongest predictor of mitigating intentions. A mental model is a psychological term which refers to the mental illustrations that explain a person’s thoughts and behaviors. The concept first appeared in the book ‘the nature of exploration’ by Kenneth Craik in 1943. In his book, he mentioned that the mind develops mental models or illustrations which serve as reference and explanation and for taking the decision in various events of life. It defines how individuals approach and solve problems and perhaps most important they help formulate actions and behavior (Carey, 1986; Morgan et al., 2002). The

majority of research on mental models and individual knowledge has identified several fundamental gaps in the public knowledge and understanding of climate change.

As the mental model is the representation of human mind's thought process, in this research in terms of weather forecast communication, this thinking paradigm is used as a lens of view to interpret human behavioral process and responsive attitude. On the other hand, it is considered as an internal approach for a human being for evaluation and taking decisions. So it is much more relevant to internalize its point of view for analyzing communication process of people during a natural disaster. In this study, this approach of the mental model helps to illustrate the fact of how individual formulates his decision regarding his responses to early forecast system. Furthermore, this theoretical conjecture of mental model is asserted in this study to investigate communication process in relation to local people's interpretation of weather which ultimately denotes their way of decision-making and communicating process. And as this paradigm emphasizes on understanding local people's knowledge and behavioral attitude for better communication process, it helps to develop some ideas from local people for an effective communication regarding forecast dissemination system as well.

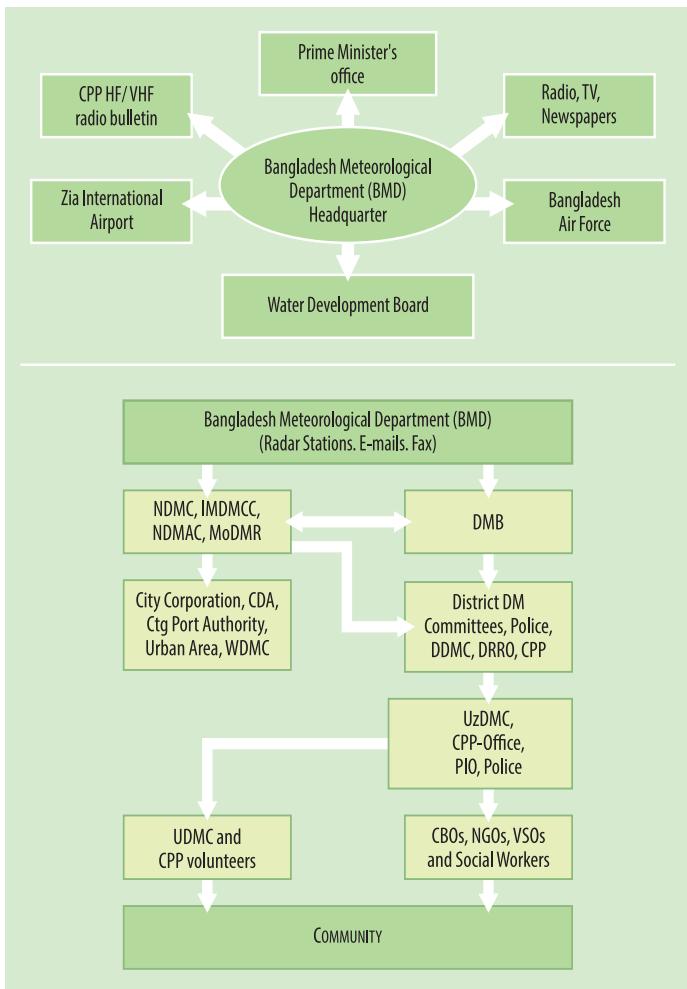
10.5. Local Interpretations of Disaster Warning and Signal Systems

Bangladesh Meteorological Department (BMD) is responsible for all kinds of weather forecasting. Cyclone warning system is the only one and well-known warning system used in Bangladesh. As the main purpose of this study was to investigate people's responses to weather forecast system, it was important to narrate about existing forms of weather warning system. However, the early warning system from national level to local level is illustrated in Figure– 10.1. It describes how warning forecast of natural disaster is disseminated from divisional level to local village level and which organizations and administrative units are involved with this warning regulatory process.

There are 11 numbers of signals for maritime ports and 4 numbers of signals for river ports to indicate the severity of weather conditions ((Table– 10.3). These signals reveal the meanings of the signal numbers for maritime ports and river ports respectively. However, the meanings of these signals, which are developed for the port system, have been ambiguous to the local community.

While discussing signals of early warning to reduce complexities during a natural disaster, most of the respondents asserted that they just know the numbers of signals rather knowing about the meaning and effective risk communication interpreted by these signals. It was evident from this study that the number of signals meant a lot for community people as they interpret the risks of hazards only by the number of signals. They reported like when signal no. 8 is announced, they assumed that the possibilities of danger might be more than that condition of signal no. 6. As such respondents mentioned

Figure– 10.1: Early Warning System in Bangladesh



that they measured the severity of risks only by the numbers of signals not by the meaning of signals. Because most of them do not know the actual meaning and responsibilities ended for each signal. Some of others told that till the signal number 5, they do not take these signals as severe or disastrous like they feel severity when it comes to signal no. 7 or signal no.9. However, this scenario of the gap between warning and heeding was explored as a common issue among almost every people when it comes to response effectively to ensuring safe communication process in the eve of natural calamities. As one of the study participants said,

"We do not know the meaning or explanation put by officials for warning signal. We just hear the signal no. and then we decide what to do by observing the natural sign of weather. We just know that if the number of signals increases like from 6 to 8 then

Table– 10.3: Interpretations and Meaning of Early Forecast Signal

Signal		Interpretations and Meanings
Description	Number	
Distant Cautionary Signal	01	There is a region of Squally weather in the distant sea where a storm may form
Distant Warning Signal	02	A storm has formed in the Distant area
Local cautionary Signal	03	The port is threatened by squally weather
Local Warning Signal	04	The port is threatened by a storm but it does not appear that the danger is as yet sufficiently great to justify extreme precautionary measures
Danger Signal	05	The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the south of Chittagong or Cox Bazaar and to the east of the port of Mongla.
	06	The port will experience severe weather from a storm of slight or moderate intensity that is expected to cross the coast to the north of the port of Chittagong or Cox Bazaar and to the west of the port of Mongla
	07	The port will experience severe weather from a storm of light or moderate intensity that is expected to cross over or near the port.
Great Danger Signal	08	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port of Chittagong or Cox Bazaar and to the east of the port of Mongla.
	09	The port will experience severe weather from a storm of great intensity that is expected to cross the coast to the south of the port of Chittagong or Cox Bazaar and to the east of the port of Mongla.
	10	The port will experience severe weather from a storm of great intensity that is expected to cross over or near the port.
Failure of Communication	11	Communication with the Meteorological Warning Center have broken down and considered as devastating cyclone

the severity might be increased due to a natural condition. But we respond according to our own interpretation. It matters the most.”

This quote noted that in study area signals according to the realization of community people just serve the message of severity of the forthcoming disaster. People do not act according to the inner message of signals which are meant to reduce losses of lives and properties. As such there found a huge gap between the interpretation of each forecast signal by community people and its scientific message which is developed from the national level to reduce vulnerabilities caused by the disaster. This gap denotes the idea that rather than improving the effectiveness of early warning systems in itself, emphasis should be given to community people's responsive attitude as early warning does little good unless it is followed by early action conveyed by forecast signal.

Past and Present Forms of Warning Communication

Mass media, broadcast media, local organization and local publicity through the announcement of disaster warning signals were found as the most effective sources of primary information for warning dissemination in the study area (Table– 10.4). The finding of the present study suggests radio was an important broadcast media for disseminating cyclone forecasting in remote rural coastal areas of Hatiya in the earlier period. The present study finds that most of the respondents relied on radio for receiving weather forecast in previous time. The majority of respondents were detached from modern warning facilities and vulnerable to impending natural disasters due to not having a radio or any other means of modern communication. This study explores the fact that some of them rarely listened to cyclone forecasting information in earlier times. But at present, they receive forecast news from local organizations, voluntary members and also sometimes through text over the mobile phone along with radio or television. Almost every respondent agreed that the system of disseminating forecast has been improved better than earlier. But it was also reported as a fact, although the process of receiving early warning has been improved, till now they mostly relied on their local interpretation of weather and individual decision rather than official information.

Table– 10.4: Medium of Communication

Previous Sources	Present Sources
Transistor	Community Radio
Signal from Office	Television
Peers, Relatives, Neighbors	Local NGO
	SMS
	Peers, Relatives, Neighbors
	CPP (Bangladesh Red Crescent Society Volunteers)

10.6. Reception and Responses to Cyclone Early Warnings

The present study finds that a majority of respondents in the coastal region of Hatiya did not have any idea about the implications of cyclone signals. Most of the respondents in the island village did not understand official cyclone signals. Respondents and their family members understood cyclone signals superficially, without having a clear idea about the implications of signals. Only a few respondents understood some signals in the shoreline village. In contrast, very few, mostly those who were involved with voluntary organization serve to disseminate warning forecast were found as having some understanding of all the signals implicated by the Metrological Department of Bangladesh.

Another concern was also raised while discussing ‘false’ warning which was mentioned by the respondents. According to them, ‘false’ warning meant like when signal no. 6 is conveyed to community people through government or

non-government organization, but such severity of disaster was not felt, then people thought that signal was not true. And for that, respondents indicated that most of them were not willing to leave their houses, no matter whether they felt if there would be a storm or not. Limited tendency to keep faith in early warning and past experience of individuals, families and communities as a whole act as motivation to communicate. The present study finds that most of the surveyed respondents received a warning prior to natural hazards. However, though community people received an early warning prior to the natural disaster, they did not act upon according to the instruction of early warning system. Such findings reveal weaker dissemination of cyclone warning and responsive communication in the coastal areas of Hatiya. The study also urges to focus on regional variation in the dissemination of cyclone warning for effective responses. Such disparities in cyclone warning dissemination were closely associated with different levels of severity at different locations.

Previous Experience of Early Warning and Disaster

People living in low-lying coastal areas of Hatiya tend to have a heightened sense of personal risk. This study noted that past flooding experiences are significantly related to expanded readiness. As indicated by them, past experience on catastrophic event demonstrated them the method for confronting such calamities. They also reported that previous experience helps them to formulate strategies to cope up with upcoming natural disaster. Along with individual experience, they likewise told that sometimes they took the case of others who had broad experience in a catastrophic event. Here, they specified that they picked up learning from senior's understanding about what to amid natural disasters and how they can best adjust with dangers. In particular, it was evident from primary findings that past flooding experiences and perceived local vulnerability turn to increased individual preparedness. Another issue is that even if direct experience matters, there found a disassociation among cognitive information which is originated from their local interpretation based on early experience of disasters.

Economic Fact

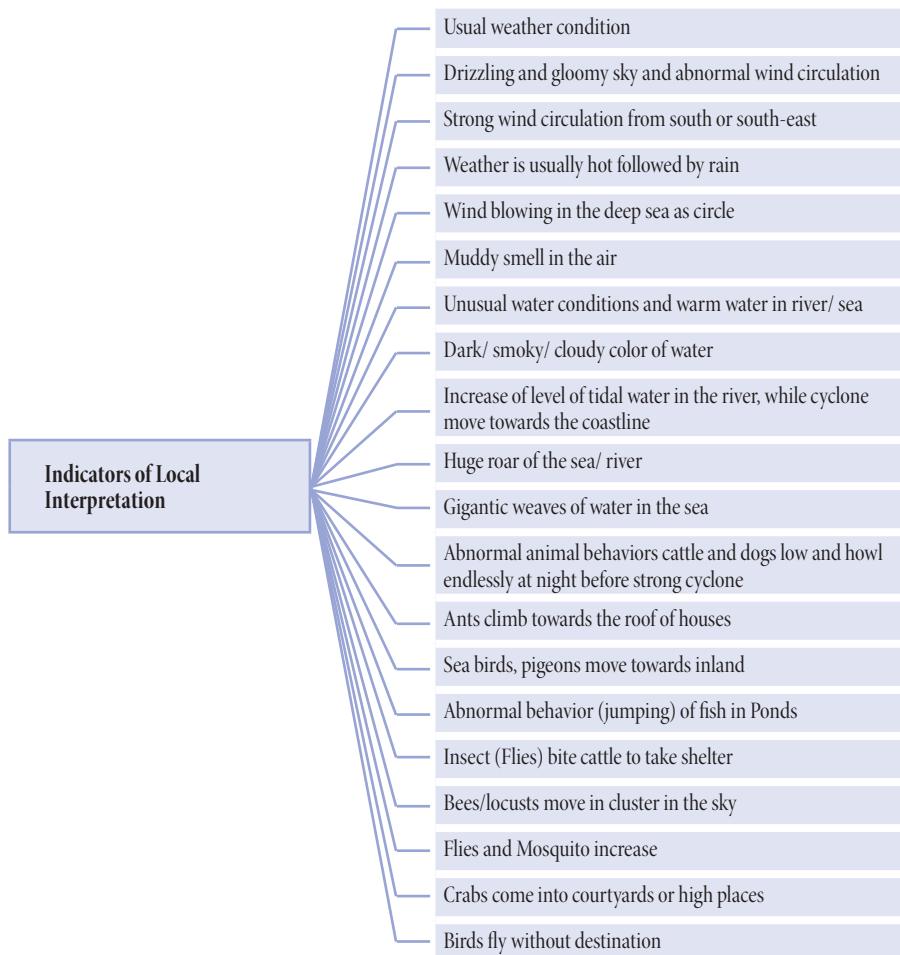
"We have to live with limited assets. So we try at best to save our properties till we breathe. It's our belief that if we die, we will die along with our properties. Till the last moment, we should save our belongings as we need to survive with the help of this limited asset."

This quote was expressed by a respondent sharing one of his previous experiences of facing a natural disaster. He asserted that at that time he did not pay attention to the safety of his life by taking shelter in a cyclone center. Rather he remained at his home to save his belongings and other economic assets. Because in his word if he could not save his properties than it would be more miserable for him and his family to lead rest of their life. Like him, also for other respondents, wealth and economic factor means a lot as they always have

to struggle with their life and limited resources. As such for them, economic properties are the prime priority for their survival. That is why they do not communicate in a responsive way during natural hazards.

In addition, some respondents reported that when they realized it would be much unsafe for them to stay in their home during severe storm or cyclone, then they send their families to cyclone shelter center. Then the male member or the earning members of the family stay in residence to save properties from robbery or from natural calamities. This is how they try to keep their belongings safe and secured putting their life at risk. In brief, it was evident that it is the context of their socio-economic status where they put emphasis on their economic asset rather than their lives because their belongings are considered more valuable to them than their own lives.

Figure– 10.2: Indicators of Local Interpretation



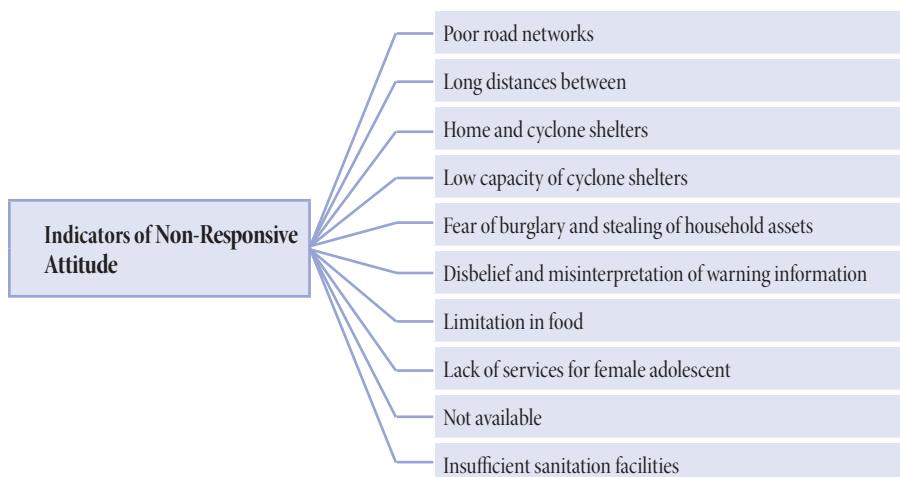
10.7. Local Reading of Early Warning Signs

In addition to experiential processing, this research explored that human behavior of coastal people of Hatiya meant to be shaped by a wide range of normative factors. In fact, it emphasized on the impact of social influences on behavioral actions. In this research, it was found that descriptive and prescriptive social norms of behavior of local people are derived from observing natural signs. Some of the mentioned signs are: muddy smell in air, unusual movement of cattle, coming out a lot of ants from the soil, screaming of animal are some mentioned signs which reflect their way of indicating natural thing as a local interpretation of weather and natural disaster. According to respondents, they, especially senior members of their society try to interpret the forecast of weather and natural disaster observing these enlisted facts.

Factors for Non-Responsive Attitude Towards Cyclone Shelter

Along with economic and other above-mentioned issues, this study also pointed some specific issues which were found as the factors behind the non-responsive attitude of community people towards cyclone shelter center (Figure-10.3). It is evident from the study that due to lack of proper ventilation, light, water supply and sanitation facilities along with insufficient space cause great sufferings. It is reported that there is no allocation of separate space for male and female in any cyclone shelter except one and that is also another major problem. Because, in the study area socio-cultural setting is found as religiously conservative enough to maintain the distinction between male and female. This condition demotivates women to go to cyclone shelter center. Again most of the female respondents claimed that they felt very insecure and vulnerable there in the mass. They are afraid of being assaulted because they specify that in the crowd of cyclone center there remains a possibility for women of being physically assaulted.

Figure– 10.3: Factors for Non-Responsive Attitude Towards Cyclone Shelter



It is also found that the absence of connecting road to the shelter also discourages families to move to shelter. On the other hand, respondents say that the evacuation order disseminates in such a time when it becomes difficult to cross the road and reach the shelter with children and female in the worst weather. In addition, issues of access and ownership of shelter also limit the effectiveness of cyclone shelter center. Access to shelters is dominated by the elites and inactive shelter management committees. Few others indicated that religious minority groups (mostly Hindu) may not be granted to entry in cyclone center because of dominated religious groups like Muslims.

10.8. Reflection on Findings

Disaster warning is considered as a linear process of communication between warning-issuing organizations and recipients of the warnings (Sorensen, 2006). In Bangladesh, a few studies focused only on measures to adapt climate change-induced rise in sea level, coping with cyclone, storm surge and mitigation measures, community responses to multiple coastal hazards (Parvin et al. 2008), dissemination of cyclone forecasting, or adaptive responses, preparedness and management issues (Haque, 1997). But this study emphasizes on local context of preparedness of community people for facing natural disaster which denotes the idea of responsive action addressing forecast communication process.

This research pulls together two angles of the mental model by relating performance as responses to weather forecast system. In these two aspects, local interpretation is treated as a performance of environmental knowledge (Turnbull 1997) and as a kind of verbal art (Bauman 1992). In the initial stage, according to the theory of the performance of knowledge, this study demonstrated how the local production of knowledge determines the action and responses to weather forecast system. And then it was explored how the local interpretation of weather forecast is a kind of verbal art. On that point, it was urged in this study that we need to examine broader historical and cultural contexts of responsive actions of local people regarding weather forecast dissemination. Relegating government's weather forecast system to a position of ignorance or irrelevance local people try to reproduce weather forecast meaning in their communities based on local beliefs and traditional practices.

Irrespective of hazards, the main objective of warning is to reduce disaster impacts by enabling people to take precautionary measures. Therefore, the success of warnings depends on appropriate hazard detection, information dissemination, and responses of affected people (McLuckie, 1970). But in addition to a variety of socioeconomic factors, psychological and cultural factors may also determine human responses to the early warning which have been explored in this study. This study entails the idea that without effective risk communication, the most thorough risk assessment will not be effective to reduce losses of lives during a natural disaster. It explored some gaps between

warning signals interpretation and its heeding. Along with this, it shows apart from modern disaster forecasting, people can understand forthcoming danger by looking at natural signs and their local interpretations of nature. Like, they can predict impending cyclones using traditional knowledge and its interpretation practiced by their ancestors and their experiences of recurrent natural calamities. Nonetheless, it seems such traditional interpretation, practices and experiences are not adequately recognized either by the GOs or NGOs; not formalized in policy mechanisms as well. But this study urges to incorporate these ideas in institutionalized level for ensuring an effective disaster forecast system.

Along with this socio-psychological interpretation; religious belief, disbelief in cyclone warning, scarcity of safe infrastructure, distance and condition of shelter center, socio-economic vulnerability and insecurity of wealth were denoted in this study as the integral causes behind the non-responsive attitude of local people. Therefore, more effective and timely early warning forecast dissemination needs to be ensured with considering the local people's beliefs and own interpretations.

As such the central theme of the paper is the meaning of a local interpretation of weather forecasting goes beyond the statement of expected meteorological events. It is a linguistic and cultural interpretive act: a performance of identity, of ideology, of knowledge, and also a display of verbal skill that provokes a response for the local people (Bauman, 1992). But paying attention only to performance is not enough. In order to understand how local interpretations are performed, we need to consider the interaction among cultural models, local belief and the immediate interactional stance of local people to weather forecast system.

10.9. Conclusion

Understanding how people collaborate with nature is one of the foundational endeavors of anthropology. This paper is an examination of weather forecast system that brings new aspects of local interpretation of weather forecasting. The focus here is an aspect of human-environment relationship that has recently gained prominence in anthropology i.e. the interaction between society and climate variation and change. The estimation of cultural models discussed here helps to provide an approach to recognize the shared meanings of local people regarding weather forecast system. It underlies variations and also inconsistencies in semantic practices for understanding weather forecasting signals and their meanings at a local level. Cultural models are recognizable in anthropological practices and reproducible to a range of contexts. They are used in reasoning and interpreting, despite variations and incoherence. Throughout this study, it was demonstrated how local interpretations are judged by inclinations and understandings encoded in a widely shared model of local belief and practices in terms of early forecast system.

The focal contention behind the framework is that persuasive communication is only persuasive if it is based on an integrated understanding of the psychological process which influences responsive behavior. In order to achieve this, three criteria need to be met which were generated from this study; interventions should be designed conveying integrative communication messages (i.e. cognitive, experiential as well as normative dimensions of human behavior), the context and significance of local belief on weather change should be made unequivocal and particular practices ought to be focused on, and psychological determinants of behaviors need to be considered to design an effective early forecasting system. Finally, in brief, it can be concluded by stating a quote noted from a key informant interview session, where the respondent was a local NGO staff works on disaster;

"Close attention should be paid not only to text but to context itself. Proactive responses should be developed by integrating local knowledge and responsive approaches for establishing reliable weather forecasting for disaster mitigation."

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Migration and Climate Change: Impacts on ‘Slumaisation’ in Bangladesh

Lam-ya Mostaque and Md. Sharif Hasan

Abstract

What is the relationship between climate-change induced migration and ‘Slumaisation’? This paper argues that climate change induced migration is contributing to the increasing of slums in the cities in developing countries. The paper provides evidence on this argument based on existing research and data. It also focuses on the experience of climate change induced migrants living in the slums and problems they face. It next surveys the existing models about climate change induced migration and combine them with primary data in order to develop a model that incorporates different factors that influence people’s choices to migrate, when facing effects of climate change. The paper concludes with a brief discussion of policy imperatives and directions for further research.

Keywords: Slumaisation, Climate Change, Migration, Climate Refugees

11.1. Introduction

In 1990, Intergovernmental Panel on Climate Change (IPCC) predicted that “the gravest effects of climate change may be those on human migration as millions are displaced by shoreline erosion, coastal flooding and severe drought” (Brown 2007). Since ancient times whenever there is a harsh change in nature; people have moved from one place to another. But studies, (Morton, Boncour, and Laczko, 2008) show that climate change now and in the future will affect the world like never before. First, global warming will reduce agriculture potentials and undermine ‘ecosystem services’ such as clean water and fertile soil. Second, there will be increase in extreme weather events like heavy precipitation and river floods particularly in tropical regions. Finally sea level rise will permanently destroy extensive and highly productive low-lying coastal areas that are home to millions of people. All of this will lead to mass

migration. It has been predicted (Mayer, 2011) that these massive internal displacements can create a highly sensitive situation in developing countries, which are in demographic transition and whose environmental resources may be subject to increased competition.

Bangladesh is one of the most environmentally vulnerable countries in the world. Titumir, Kabir, and Baten (2012) predicted that after taking into account of flood, cyclone, riverbank erosion and drought cumulatively; climate change induced migration in Bangladesh may reach to 48.28 million by 2030. Climate change induced migration is causing a large influx of migrations to the urban centers; most of whom are living in the slums. Those who migrate due to the adverse effects of climate change face various problems that need to be addressed. Although climate change induced migration in Bangladesh is significant, there have not been many studies that relate urbanization and climate change; more importantly there is hardly any study that focuses on increase of the slum dwellers or ‘slumaisation’. But it is evident that there is relationship between the two phenomena, and this study is an effort to relate them. Further understanding the needs of the environmental migrants can also help the government manage them better and also strengthen Bangladesh’s bargaining power in capturing more climate funds.

The broad objective of the paper is to identify the dynamics of the relationship between climate-change induced migration and slumaisation. Under that the specific research questions of the paper include: (1) What is the impact of climate change induced migration on slumaisation? (2) Who migrates to escape the climate change effects? (3) What are the main factors that influence their migration decision? However, this paper is organized into several parts. First, it discusses the research methodology. Next, it discusses the theoretical framework, and offers a quick snapshot on slumaisation and its impact on both the people in the slum and on the cities. The authors then focuses on the relationship between climate-change induced migration and gives practical evidence that climate change induced migration with empirical evidence. The concluding section proposes some policy recommendations, and stresses the need for further research.

11.2. Research Methodology

The study focused on two themes, 1) the relation between climate change induced migration and slumaisation, particularly for Bangladesh. 2) Experience of climate change induced migrants living in slums. Therefore, it required both primary and secondary data sources. The collection of primary data was done in two phases. The first phase was the interview of the climate induced migrants. Fifty climate change induced migrants living in the Agargaon squatter settlement were interviewed. Participants were both male and female and of various ages. The second phase of the primary data collection was interview with experts. The authors conducted interviews with experts on climate change,

climate change induced migration, urbanization and internal displacement. Secondary data were generated from standard published materials such as, books, paper articles, peer-reviewed journals and official reports of concerned government organizations.

11.3. Climate Change Induced Migration

There is wide use of terms which denotes people who migrate or have been forced to migrate due to impacts on environment or climate change. These terms include ‘climate refugees’, ‘environmental refugees’, and ‘environmental migrants’. However, all those words are rather problematic. As the refugee creates legal confusion as the UN refugee convention does not state ‘environmental degradation’ or ‘climate change’ as a ground for claims asylum. Further, using this term is misleading as refugees are those people who have been forced to leave their home territory. Many people after being affected by severe climatic events do not have enough resources to travel to distant part and often chose to migrate closer to home, causing internal displacement. The paper uses the term ‘climate change induced migrants’ as it covers both those displaced within the border and those who have crossed it. The definition used by the paper is as follows, “Environmental migrants are persons or groups of persons who, for compelling reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad” (Biermann and Boas, 2008; International Organization for Migration, 2009).

Table– 11.1: Environmental Migrants as per El-Hinnawi Environmental Migrants

Types	Examples	
Category 1	Natural Disasters or Accidents	Hurricanes, Earthquakes
Category 2	Development	Dams, Mining, Infrastructure
Category 3	Inadequate Resources	Drought, Crop failure

(Source: Adopted from Berringer, 2012)

El-Hinnawi (As cited by Berringer, 2012) specified three broad categories of environmental migrants: the first category of environmental migrants encompassed temporary displacement because of earthquakes, cyclones, or environmental accident; the second is those who are permanently displaced due to man made changes to a habitat like dams and Chernobyl; the third are those who migrate temporarily or permanently because the original habitat can no longer support them because the land has been deteriorated (Table– 11.1).

This paper concentrates mainly on the category 1 and category 3 migrants as described by El-Hinnawi. Various studies (Shamsuddoha & Chowdhury, 2009) show that by 2050 one in every 45 people in the world will become displaced by climate change. However, Mayer (2011) points out that as ‘climate migrants’ most often follow preexisting migration flows of economic

migrants, and rarely lead to new and separate migration patterns it is extremely hard to separate them from other migrants. Climate change does not directly cause people to move but it intensifies current vulnerabilities that make it hard for people to survive where they are. Reuveny (2007) shows people can adapt to these problems by staying in place and doing nothing, staying in place and mitigating the problems, or leaving the affected areas.

McLeman and Hunter (2010) shows that the impacts of the anthropogenic climate change can be potentially linked with future population displacements/ migration. They illustrated how climate change will impact the different regions of the world differently but will ultimately lead to migration. For example, in the Arctic region, decreased snow and sea ice cover may lead to economic migrants arriving to take advantage of newly accessible resources. On the other hand, in the high latitudes, some wet tropical areas, higher average river run-off and water availability; heavier precipitation events can cause flood-related displacements. In mid- to low-latitudes and dry tropics; drought-prone continental areas; and in areas receiving mountain snow-melt, climate change will cause lower average river run-off and water availability and more droughts in dry land areas leading water scarcity. This drought and decreased crop productivity will lead to migration, especially higher rates of rural–urban migration. Lastly, in low-lying coastal regions, deltas and small island states effects of climate change can be seen as coastal erosion, extreme storms, sea level rise and is likely to contribute to relocation of entire settlements.

'Slumaisation'

Slumaisation is a term that describes the nature of urbanization in the third world countries. 'Slumaisation' is a term used coined by Barakat and Akter (2003) in "Urbanization and internal migration in Bangladesh: The onset of massive 'slumaisation'. The term refers to the growing number of slums in the urban centers of the developing countries, particularly in Bangladesh. Slums are known by different names in different cities. Many scholars have tried to define slum but there is no general consensus on the issue. According to a report on United Nation Urban land policies, a slum is "a building or a group of building area insanitary conditions or absence of facilities or amenities which, because of these conditions or any of them, endanger health, safety or morals of its inhabitants or the community" (United Nations Habitant, 2001). Bangladesh is seeing rapid growth in the urban population due to internal migration, the number of internal in-migration is double of that of the internal rural in-migration (See Table- 11.2).

At the same time the number of slums and squatter settlements has also increased. The number of slums in the cities is growing in an alarming rate. There are 9,048 slum communities across the six major cities of Bangladesh. Unsurprisingly, by far the most (4,966) were in Dhaka (Centre for Urban Studies, 2005).

11.4. Theoretical Approaches to Climate Change Induced Migration

Theorizing Climate change induced migration is a problem due the environmental migration is often shadowed by other factors such as economic, political and social influences. However,

Table- 11.2: Internal In-Migration Rate

Year	Rural	Urban
2007	28.8	52.3
2005	24.2	53.0
2001	14.0	45.4
1991	13.9	33.2

Source: SVRS, 2008 and BBS, 2001

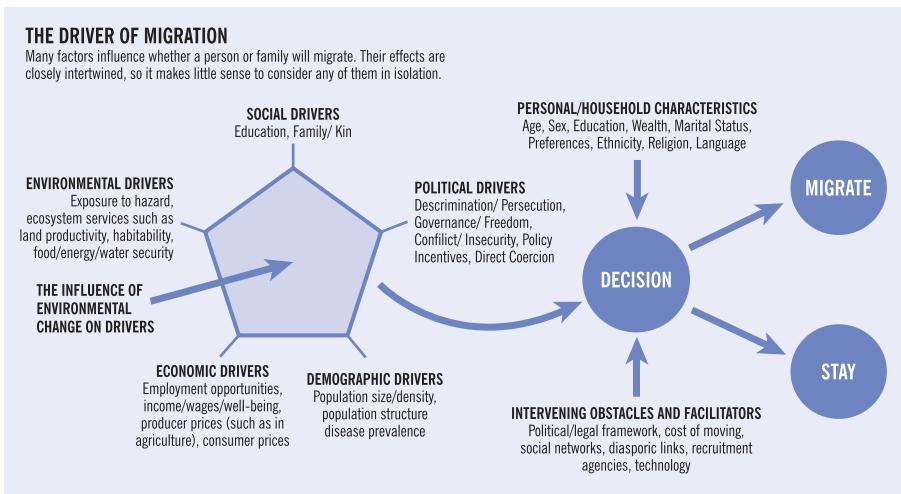
with economic ‘pull’ of the cities, the climate change induced migrants come to cities to influence migration.

Another way of approaching the climate-migration relationship is to begin with the concept of vulnerability. According to IPCC (2001), the term ‘vulnerability’ means “the degree, to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes”. Mclemen and Smit (2012) provide a model attempts to account for both human socio-economic processes and biophysical processes when assessing vulnerability to climate change. One of such approaches is captured in the following conceptual representation of vulnerability to climate change, where:

$$V_{slit} = f(E_{slit}, AC_{slit})$$

- | | | |
|---------------------------|--------------------------------|-------------|
| where, | V= Vulnerability | E= Exposure |
| AC= Adaptive Capacity | s= A given system or community | |
| l= A given location | i= A given climatic stimulus | |
| t= A given period of time | | |

This conceptual model relates to the vulnerabilities of human systems (communities, sectors or regions), and recognizes that vulnerabilities are usually specific to particular types of climatic risk and particular locations and time periods. Vulnerability is dynamic, as it varies over time (t) and from place to place (l) and system to system (s). The two elements of vulnerability (V) distinguished in the model are: exposure (E), which refers to the probability or incidence of hazardous conditions or events relative to human occupancies at a particular location and time; and, adaptive capacity (AC), which refers to the ability of the system to deal with or cope with the conditions or effects to which it is exposed. The main idea of this conceptual model is that changes in climate change increases people’s vulnerability and people’s decision to migrate is depended on their adaptive capacity.



Figure– 11.1: Influence of Climate Change in Drivers of Migration

Source: Foresight Report' (2011)

Another approach is as described in the 'Foresight Report' (2011) builds on while individuals may want to migrate, Political, social and financial factors will also determine their ability to migrate (Figure– 11.1). People's ability to migrate is largely correlated to an individual's level of wealth, as defined by social assets (networks of friends and families in destination areas), political assets (for example visas, legal access to services in destination areas) or economic assets (money to finance a move, transport, accommodation). According to this model, climate change influences the different 'drivers' that determine people's choice to migrate. Also this model takes into account individual's qualities like age, sex, education and marital status.

11.5. Climate Change Induced Migration and Slumaisation

Over the course of the past decade, a growing number of contributions relating to environmental migrants have focused on climate-induced migration. Research in Africa in recent decades shows that populations in rural areas have adopted strategies to cope with recurring drought that incorporate migration. Marchiori, Maystadt and Ingmar (2011) showed that in Western Sudan, for example, male household members have often migrated to Khartoum in search of wage labor when times of low rainfall hinder agricultural production.

Mayer (2009) identifies three scenarios where climate change-induced immigration can occur; they are low-lying islands, coastal areas, and regions affected by land degradation. Low-lying islands suffer from more frequent and more violent storms, the infiltration of saltwater threatening domestic agriculture, rapid erosion, and droughts. A second scenario of climate change-induced migration concerns coastal areas, in particular deltas where the local

rise in sea level could go far above the global average. Third scenario results from desertification and land degradation. The slow destruction of agriculture in low-developed countries leaves no choice for populations but to move to survive. Reuveny (2007) further added that in developing regions, where economic systems and livelihoods are often closely tied to agriculture and natural resources, extreme climatic events and conditions may accelerate already growing levels of rural-to-urban migration.

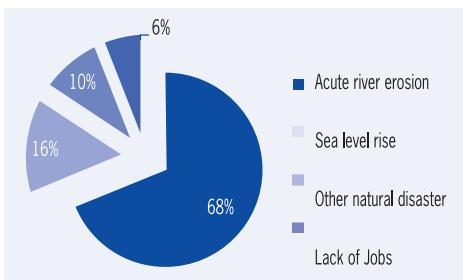
Anwara Begum argued that, unlike the migration in the western countries, those who migrate in the developing countries are more likely to be unskilled, socio-economically backward and poorly informed. The rural poor have been migrating in the metropolitan cities and hinterland and take refuge in slums. Das (2003) informs that it is often difficult for them to find jobs in the city and also decent housing facilities are unavailable. So, they end up living in the slums or the squatter settlements, giving rise to slumaisation.

11.6. Bangladesh Scenario

As shown by Roy (2011), the geographical location of Bangladesh and low-lying characteristics of the country makes it more vulnerable and susceptible to different natural and climate-induced disasters. According to a World Bank report, Bangladesh would face 30 cm to 50 cm sea level rise in 2030 and 2050 respectively. Satellite image shows that the New Moore Island or South Talpotti (the uninhabited territory) has disappeared due to sea level rise. Bhola Island has been affected by cyclone three times only in 2013. On the other hand, northern part of Bangladesh is very prone to drought and desertification.

Over the past 20 years, the frequency of acute disasters has doubled, from 200 to 400 per year (Roy, 2011). Analyzing existing available data, 'Unnayan Onneshan' has found that on an average 2.5 million people displaced permanently in every major flood and within last 5 years, cyclone Sidr displaced 650,000 people; about 20,000 people were displaced by cyclone Bijli; and another 842,000 by Aila (Titumir et al, 2012). Out-migration has become a common coping mechanism for millions of Bangladeshis who have lost their land and livelihoods due to gradual as well as extreme environmental events (desertification, coastal erosion, sea-level rise, as well as floods, and cyclones). It is estimated (University of Sussex, RMMRU and CDKN, 2013) that over the next 40 years approximately 9.7 million people in Bangladesh are estimated to migrate in the long term from locations that are currently experiencing the impacts of climate stresses such as flooding, storms and riverbank erosion.

On the other hand, although the birth rate has decreased, the population in the major urban centers in Bangladesh continues to grow, indicating that the cause of rapid urbanization is internal migration. One of the basic features of the urbanization is that it is not a result of industrialization *per se* (Barakat & Akter, 2003). Urbanization in Bangladesh is basically driven by the push factors like displacements due to disasters, poverty and so on. Barakat and Akter



Graph– 11.1: Reasons for Migration

(2003) argues that the urbanization in Bangladesh is poverty driven rather than the process of industrialization. Poverty in rural areas is further escalated by climate change resulting displacement and influencing the migration process.

Fieldwork done in the Agargaon Bastee also provides evidence that climate change has

forced people to move. Most of the people living in the Agargaon Squatter settlement are from Char Samaya (a part of Bhola), and most of their whole family living in Dhaka, implying that a major part of the village's population has been forced to leave their homeland.

The participants who have migrated to Dhaka are mostly victims of river erosion according to their own opinion. Although only 16% of them also identified Sea level rise, it should be noted that majority of them said that the land they lost did not rise again from the sea (Graph– 11.1). Dr. Haque says,

"The World Bank estimates that a half of Dhaka's population live in slums and most of them are directly affected by Climate Change. In the past, people would come to the slums, earn some money, and return home to their villages, the article notes. But as the effects of climate change increase, more people are staying in Dhaka's slums permanently".

11.7. Experience of Climate Induced Migrants in Dhaka

Jahan, Hulme, Roy and Shahan (2011) states that approximately 40 million people in Bangladesh live in urban areas, out of which 21 per cent live below the poverty line. Most of the poor people live in the city slums, and people are coming from different parts of the country. Most of the migrants depend on their peer network for migration. In the city migrants are forced to work in the informal sector as rickshaw pullers, manual laborers, garment and domestic workers, and within the sex-trade.

While men may quickly become engaged in some unskilled wage laborer employment, women find it harder to be economically active. Back in their village these women usually grew vegetables and reared livestock, thus helping to smooth consumption. But, in urban areas there is no use of those rural-skills. It takes time for these women to accept urban jobs such as housemaid. Their children have dropped out of school, with girls given early marriage and boys put to work security of tenure. Jahan,et al, (2011) states that there is no low income settlement policy in Bangladesh, which creates opportunity for local powerful people to grab these lands, in turn escalating eviction threats. World Bank (2007) estimated that nearly half of Dhaka's population of more than

twelve million live in slums, and said eviction of squatters from public land has been a ‘continuing practice of the Bangladesh government’.

11.8. Life at Agargaon Squatter Settlement

The Bastee in Agargaon provides evidence of all the mentioned problems and add some new findings as well. The Bastee has been moved from here to there several times and now it is situated at the opposite of the Bangladesh Atomic Energy Commission. Mala Begum (50), a dweller in Agargaon Bastee, says,

“... Tell me this sister, who wants to live without roots?” She came to this slum as young girl, and has lived here ever since. But if you ask her where she is from, she will tell you that she is from Bhola. She told us about they lost their land to erosion, while their five cows were killed in a single storm. They chose to migrate to Dhaka as it promised of jobs and peer network. Life in the city is a constant struggle, especially with the threat of police raid hanging over their heads. Police often breaks down or puts fires in their homes. “When police breaks down the slums, we lose both home and work. The government does not care about us and yet we have to stay here. There is no job back in home.” It has been forty years since she left her village, and yet she still calls it her home. When asked if she would like to go back to Bhola or if she could earn a living there, she answered without hesitation, “Of course! I want to go back to my homestead. Tell me this sister, who wants to live without roots?”

The Bastee is a large one, with around 3,500 households residing there. It is mainly composed of houses that are made of tin roof and bamboo poles, some of them are so low that you cannot enter the house without bending down. All of them have electricity in their house, with TV and fans being the common feature. But they have serious lack of sanitation system and other basic facilities like water, only source of water is a single government pump. They have only one latrine, and it is located far away from the main Bastee. The Bastee has three school, all run by BRAC. Most of the people living there are uneducated, and are forced to do jobs that have no job security. Also the literacy rate is very low, but there is aspiration to educate the next generation.

The case of Mujibur Rahman (75) may be cited to understand the life in slum areas of Dhaka city. He says, “after losing everything, I sometime think about suicide.” Mujibur Rahman belonged to an Aristocratic family in his village. He owned four acres of land, two poultry farms and a store. Now at slum, he owns a store. Talking about his home back in village, he fondly talked about how it used be a pompous village, how his father donated to build the village school. He happily reminisces about his farming days, when he used to farm for mustard and IRRI rice. But his expression changes as he talks about his journey to the city. He had lost all of his property due to river erosion and was forced to come to Dhaka. Most part of his Upazila is under water. Most people have left his village and work at marginal jobs in cities. Those who stayed back have to live on the sides of bridges and roads. Mujibur tells us about his struggles in the city. How his wife had to die without treatment, how he could not afford education for his sons. His eldest son was married off so that his in-laws would take care of his education. Tears came running down of this elderly man as he told us that he had “Nothing! I have nothing! ...after losing everything I sometimes think of suicide.”

Our research shows that unlike the common theory of problems such as housing and other basic necessities, the people of the Bastee think that their main problem is police and government intervention. They had been time and again facing police torture as the police drives them away from the government lands they had been residing on. This situation convinced them that police, as government agency, is the major threat to their existence. There are also complains of police burning their houses and looking for young girls to torture. Finding job is another major problem they faced when they arrived and even now. There is a few beggar among them. Drugs were a major problem in the past, but police have been able to control that situation. Even in that case the slum dwellers have grievances against the government. They believe that the government and police are against them, and instead of running intervention in the slum, the government should have caught the masterminds behind drug dealing. The whole scenario demonstrates the lack of attention to the slum dwellers, although they are a major part of the city's population. Seemingly they are not entitled to the basic human rights. Without the proper management of the slums it is not possible to have better cities.

11.9. Rethinking Climate Change Induced Migration

As discussed before, all those models mainly focus on how climate change affects the decision to migrate and takes into account the different factors that influence the migration decision (see Figure– 11.2 and 11.3). Instead of a theory that only discusses the decision of migration; the paper proposes a theory that incorporates the decision of migration, the decision of destination and decision of not returning back to homeland which will link the migration to slumaisation. Further, the paper argues that the decisions and trends of migration is different depending on the impact of climate change. Climate change can cause both voluntary and forced migration. Both climate adaptive migration and displacement causes slumaisation but they do it differently.

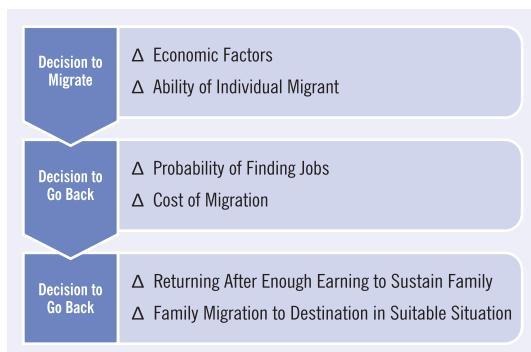
In case of climate processes (long time influence of climate change), the migration is mainly an adaptive measure taken by the family to cope with the existing vulnerability. Here, the decision of migration mainly influenced by the status of individual migrant (age, sex and wealth), people in case of slow onset climatic events do not chose to migrate with the whole family (Islam, M.T., personal communication, July 27,2013). Rather, the able bodied male member of the family will migrate, to places where there is chance of getting jobs. This climate adaptive migration can be characterized as voluntary migration. Examples of seasonal migrants are very good example of this type migration. People will return home after they have earned enough. So, climate change by initiating individual migration is passively initiates slumaisation.

In developing a model for displacement due to climate change, we propose several additions to the existing theories. First, the paper proposes that the decision of migration is not only influenced by community of the climate

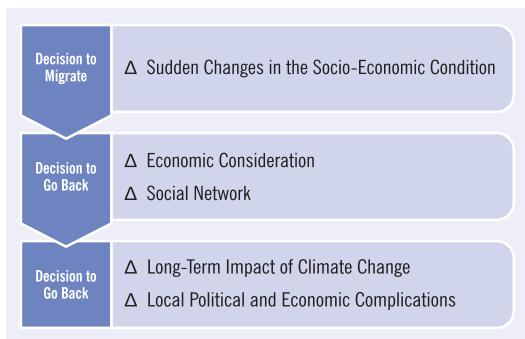
change effected area but the community that the migrant has in the area of destination too. Secondly, it identifies that economic pull and social networks are the two important factors in case of migration due to climatic events. In support of the model the authors draw data from their own field work, which shows that maximum participants migrate to Dhaka instead of Barisal (nearest city to their home), as they think that Dhaka has more jobs than other cities. Haas (2010) defines migration networks as sets of interpersonal ties that connect migrants, former migrants and non-migrants in origin and destination areas through bonds of kinship, friendship and shared community origin, also play important role. Social networks are important because they help to reduce the economic, political and psychological costs of migration. The paper has argued that peer connection and help of relatives are the two main causes that they have been able to live and settle down in Dhaka.

Our survey data show that out of the 50 respondents, a overwhelming 60 percent of them chose to come to Dhaka because of the number of job opportunities. The second biggest reason for choosing Dhaka was that they had some members of their family living in Dhaka beforehand (24%); while another 16 percent identified having better social connections as their main influence behind choice of destinations.

The participants were asked about the sources that helped them to survive in Dhaka in the long run. In their response, ‘peer connection’ (40%) and ‘relatives’ (40%) were noted as the main source of help for the migrants, while another 20% said they had no mentionable help from any significant source in settling down in Dhaka. The evidence shows migrants chose to migrate to Dhaka because they had better social network in the city and thus better chances of survival. Although the participants had very limited resources to migrate, they do not migrate to places closer to home, as they take into account their chances of getting job and survival in the city. Social network has been vital to migrant in this case, as they received no help from any other sources. They also said that after being victim of major climatic events, when found it hard to survive in their home district; they were inspired by the relatively better living conditions of their family members/friends living



Figure– 11.2: Decision-Making in Climate Adaptive Migration



Figure– 11.3: Decision-Making Model of Climate Change Induced Displacement

in the cities. So, social network should also be considered a major factor in choosing the area of destination along with economic factors.

The interview results showed that 16 percent of the respondents are living in the slums for over forty years, while another 60 percent is living here for 30-40 years. The remaining 24 percent said that they were living here for 15-30 years. This shows that the participants are living in the slums for a long time. Although majority of them want to go back to their native village they cannot go back due to lack of proper opportunities. Most of the lands gone into the sea have not risen up, and even when they did the local influential peoples have gotten the hold of the land. Others worry about poor chances of finding livelihood in their own villages, leaving them no option than to stay in Dhaka, for better or worse. Based on these data the Paper suggests model of displacement due to climate change.

Thus due to the availability of various jobs in the city combined with existing social network, people when displaced by climate change choose to migrate to the major cities causing slumaisation. Climate change does not only influence the initiation of migration, they also influence whether migration becomes permanent or not. As the diagram, data from the fieldwork shows that economic considerations are the main incentive for the first batch of migrants while the later batches depend more on social network. The choice of going back is also complicated by various social and political factors; for those who have been staying in the cities for a long time and hence, may not find it easy to migrate back. So there are scopes of further developing this model and making it more comprehensive.

11.10. Conclusion

Climate change induced migration has been happening for a long time, but the impact is going to be more profound than ever before. Our research shows that the impact of the climate change will evidently lead to the increased slumaisation in the cities, although the process of migration from climate affected areas to the cities are depended on various factors such as impact of

climate change on affected areas (long or short term), availability of economic opportunities at the destination and the presence of social networks of the migrants. Even though the process varies from migrant to migrant, most of them live under uncertainties in the slums of the cities and only long to go back to their place of origin.

Though Bangladesh has a large number of climate change induced migrants, major climate change Policies in Bangladesh like 'National Adaptation Program of Action (NAPA)' and the 'Bangladesh Climate Change Strategy and Action Plan (BCCSAP)', do not address the issue of climate change induced migration properly. Climate change induced migration is a double edged sword. In addition to impacting the migrant's lives, it is also creating additional pressure to the cities where they are migrating to. To tackle this issue, therefore, the government of the country and international institutions will have to take a two-way approach. On one hand, attention should be given to adaption in climate affected areas to minimize the impacts of climate change. Balanced economic growth in all parts of the country will also help in countering the problem. At the same time government should also focus on the existing slums, where to ensure the basic rights of the slum dwellers. Ensuring their safety is also the government's responsibility. Climate change induced migration is a growing reality and will continue to affect the cities and urban lives. The government and the international community thus have the responsibility to tackle the problem and provide the basic human rights of the climate change induced migrants.

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Sexual and Reproductive Health Vulnerabilities of the Adolescents in a Coastal District of Bangladesh

Kazi Robiul Alom, Haribondhu Sarma and Md. Golam Faruk Sarker

Abstract

Disaster have miserable impacts on human health. During and as the aftermath of disaster, there are possibilities of increasing vulnerability of sexual and reproductive health (SRH). Because of society's normative ideas related to sexuality, adolescent's SRH is, especially, often a forbidden issue of concern within the society. Disaster makes it more complicated and leaves adolescents without access to required SRH information and services. The adolescents themselves find it a risky situations that they have to take on adult roles without preparation and without support networks. In that context, community and parental acceptance and involvement in sexual and reproductive health issues of adolescents are crucial to minimize their SRH risks. Following a cross-sectional and exploratory study design and using qualitative research tools, this study wanted to identify responsible crucial stakeholders to reduce these risks and to find out their expected roles in a disaster prone area of Bangladesh.

Keywords: Adolescent, Sexual and Reproductive Health, Disaster

12.1. Introduction

Although adolescents make up a large proportion of the population in the developing world, where most humanitarian emergencies occur, their sexual and reproductive health (SRH) needs are largely unmet. In 2000, 29% of the population in developing countries was of adolescent age; in the least developed countries, adolescents accounted for 32% of the total population (United Nations, 2012). Worldwide, adolescent females and males are reaching puberty sooner, marrying later, and having more premarital sex (UNFPA, 2004). The unmet need for contraceptives among adolescents, however, is more than twice

than that of married women (Laski, 2008). One third of women worldwide give birth before the age of 20 (UNFPA, 2004), with deliveries by women under-20 totaling 15 million annually (Laski, 2008). Pregnant adolescents are at increased risk of morbidity and mortality due to complications during pregnancy and childbirth, including obstructed labor, pre-term labor, and spontaneous abortion. Five million adolescents between the ages of 15 and 18 have unsafe abortions each year (UNFPA, 2003), and 70,000 abortion-related deaths occur among this age group every year (UNFPA, 2004). Half of new HIV infections occur in 15-to-24 year olds, and one third of new cases of curable sexually transmitted infections (STIs) affect people younger than 25 (UNFPA, 2003).

Conditions of adolescents in Bangladesh also conform to the global scenario. In Bangladesh, adolescents face a range of social, psychological, sexual, and reproductive health related challenges. They have limited access to sexual and reproductive health rights (SRHR) related information, as well as services. Female adolescents are in a worse situation than male adolescents. A study commissioned by Plan International Bangladesh and conducted by ICDDR,B, showed that 64% of women aged between 20-24 were married before their 18th birthday (Caldwell *et al.* 1998; Kabir *et al.* 2015). Marriage rate of adolescent girls is eleven times higher than that of boys. It is also estimated that 28% of teenage girls are mothers and another 5% are pregnant with their first child (Caldwell *et al.* 1998; Kabir *et al.* 2015). Sexual violence towards women and girls is widespread, while substance abuse is emerging as an important factor behind the issues hampering adolescents (Alam, Roy, & Ahmed 2010).

The situation reflects the deprivation of rights for adolescent girls and boys, particularly their sexual and reproductive health rights, and gender inequality within the family, community, and the wider society. Throughout the world, disasters have considerable impacts on health systems including public health, health infrastructure, and the service delivery mechanism. More than 1.1 million deaths were recorded in over 4000 large-scale natural disasters in the past decade, while an average of over 220 million people were affected each year (Van Langenhove 2012). In 2012, it was estimated that at least 51 million people in 16 countries require some form of humanitarian assistance (Adinolfi *et al.* 2005; Organization, 2012). According to the Adolescent Sexual and Reproductive Health Toolkit for Humanitarian Settings (Kerner *et al.* 2012), adolescents may be separated from their families or communities during disaster or any humanitarian emergencies, because in many cases families and social structures are found to be disrupted, formal and informal educational programs are discontinued, and community and social networks break down. Adolescents may feel fearful, stressed, bored, or idle. They may find themselves in ‘risky situations’ that they are not prepared to deal with and that may cause them to take on adult roles without preparation, positive adult roles, or support networks.

The disruption of families, education, and health services during emergencies, either due to infrastructure damage or to the increased demands placed

on health and social-service providers during a crisis adds to the problem and may leave adolescents without access to SRH information and services during a period when they are most at risk. The lack of access to SRH information, the disruption or inaccessibility of SRH services, and the increased risk of sexual abuse as well as high-risk sexual behaviors among adolescents during emergencies put adolescents at risk of unwanted pregnancy, unsafe abortion, STIs and HIV infection (Kerner et al., 2012).

A study (Krishnamurthy, 2009) based on secondary literature review suggests that disasters in Asia have had an adverse impact on the SRHR of women, adolescents, and transgendered people (particularly the economically and socially marginalized amongst them), though the extent and form of detrimental impact vary with pre-existing gender and social relations, pre-existing SRH services and outcomes, extent of loss to health infrastructure and personnel, attention to SRHR and social determinants of SRHR in disaster policies, and the nature of the disaster itself.

In terms of natural disaster, Bangladesh has been considered one of the most vulnerable countries. Every year natural disasters upset people's lives in some part of the country. The major disasters concerned here are the occurrences of floods, cyclones and storm surges, flash floods, drought, tornado, riverbank erosion, and landslides. These extreme natural events are termed as disasters when they adversely affect the whole environment, including human beings, their shelters, or the resources essential for their livelihoods.

There is a tendency either to ignore the adolescents as a target group during times of emergencies or to conceptualize them as passive victims or active security threats (Sommers, 2006). Adult people tend to have a tendency to overlook the needs of adolescents (Cahill *et al.* 2010). Programming efforts have been hampered by the lack of a strong theoretical base for understanding the needs of adolescents in emergencies and a sparse evidence base about 'what works' (Boyden, 2003). Most of the needs of the adolescents have emerged because of their potential risks and vulnerabilities during and after disaster.

This is why it is very important to identify the vulnerabilities of the adolescent in the areas of sexual and reproductive health, and to suggest preparatory strategies to reduce these vulnerabilities. In the context of this study, we wanted to identify ASRH vulnerabilities during and after a disaster in the Barguna Sadar upazila, and the stakeholders' roles in reducing these vulnerabilities. More specifically the study wanted to identify barriers to adolescents accessing comprehensive information on sexuality and adolescent friendly health services during and after disaster. Another objective of the study is to recognize risks of sexual harassment, violence and exploitation, trafficking, transactional sex, and child marriage that adolescents may face during and after disaster. Finally, the study also attempts to identify the key stakeholders related to ASRH vulnerabilities and define their potential role to reduce ASRHR vulnerabilities during and after disaster.

12.2. Methodology

In the disaster-prone districts of the coastal belt, majority of the population, especially the adolescents, in addition to facing hardships in primary issues of survival like access to food and nutrition, are deprived of sexual and reproductive health services. In Barguna, one of such disaster prone area, Sexual and Reproductive Health services have not yet been fully established. Therefore, in order to explore the ASRH vulnerabilities during and after disaster, Barguna was selected as the study area. The study was conducted in 6 unions and 1 Paurashava (Municipality) of Barguna Sadar upazila (sub district) of the Barguna district under the Barisal division of Bangladesh. However, considering the intensity of the impacts of disaster, the study identified 4 unions for conducting research on adolescents and key stakeholders.

As the study was qualitative in nature, purposive selection criteria have been adopted. The study was a cross-sectional one and exploratory in nature. Qualitative research techniques such as interviews, FGDs, and case studies were used involving adolescents, parents, teachers, community leaders, law enforcement agencies, relief workers, and members of local disaster committees to attain a comprehensive understanding. A total of 50 participants were identified for different qualitative interviews; the number of participants was determined based on data saturation and availability of suitable participants. Structuring and analysis of the data followed a sequence of inter-related steps that included reading, coding, displaying, reducing, and interpreting. The findings of the research will be presented in three parts: the first section gives an overview of the ASRH condition before disaster, second part explores the vulnerability context and the final part presents a cross-sectional view and attempts to draw some inferences based on overall findings of the study.

12.3. Before Disaster Situation

Ambiguity and Contradiction

Defining adolescents is cultural specific and sometimes very confusing even in respective social and cultural contexts. In the study area, adolescents were treated as both children and adults, simultaneously. Social norms expect them to perform the roles of both adults and children, while denying the fun that children have and the freedom adults enjoy. Adolescence is the transitional period of life, when individuals become aware of the physical and mental changes they go through but do not know how to manage these changes.

Because of traditional norms in Bangladesh, ASRH issues are viewed as too sensitive to discuss with others, especially with adults. As such, when adolescents are in trouble with ASRH issues or need empathetic advice, they are unable to find a safe space to share their crisis. The study finds that there is an understanding among the adults that adolescents should have the rights to know about SRH; however in reality, this is not a practice at all.

Adolescents' Access to Services and Commodities Related to SRH

In the study area, adolescents are deprived of adequate access to services and commodities related to SRH. Despite the recent expansion of NGO activities at community level, adolescents are still facing social and cultural barriers to avail such services. Social stigma refrain the adolescents from attaining the ASRH services. It is also important to note that the existing local SRH facilities are commonly viewed as services for female, especially for married and pregnant women. Therefore, unmarried adolescents, both girls and boys, are either ignorant or shy of availing the facilities in order to avoid stigma and perceived 'unnecessary' harassment.

Although current NGO activities have helped adolescents to be more informed about contraceptive use, they still need to be sensitized about their rights and access to SRH. Conventionally, government and NGO service delivery points do not provide contraceptives to unmarried adolescents, while the larger portion of the adolescents are unmarried. As such, marital status is crucial to have access to some basic SRH facilities like contraceptives. Therefore, the adolescents who really need contraceptives were unable to get access to it and in this way their SRH needs are compromised.

Harassments: Part of Adolescents' Regular Life

One of the key threats in ASRH related vulnerabilities was sexual abuse and harassment of the adolescents. In the study area, different forms of harassments are experienced by adolescents, both males and females. Unfortunately, the incidences of sexual abuse taking place within the family settings are not considered as harassments; rather these are often trivialized as a part of adolescents' life experience. Without any surprise, adolescent girls are the most common victims of the harassment. As a girl's virginity, dignity, and purity are highly revered in traditional norms, incidents of harassments and abuses are rarely disclosed. In this way, the victims have to suppress their pains and humiliation.

12.4. Impacts of Disaster on Adolescent SRH

ASRH Experiences from Previous Disasters

In order to identify the barriers to accessing comprehensive information on sexuality and adolescent-friendly health services during and after disaster, the study analyzed first hand experience of the respondents during cyclones Sidr and Aila. During these two devastating disasters, in addition to the damages of lives and houses, health care facilities (hospital, pharmacies, etc) were destroyed and the communication system collapsed. Food, drinking water, and proper sanitation facilities were scarce. Families took shelter in safe houses, on dams and roads, and mostly in local Community Cyclone shelters. Only after 4-5 days, health workers provided some first-aid services to the victims, and nevertheless which were inadequate and there were no ASRH services included.

Linked to those general health contexts during and after disaster, adolescents' sexual and reproductive health had also become vulnerable. Adolescents' health issues often remained unattended because of extreme sensitivity to and secrecy about sexual health coupled with negligence and insensitivity towards adolescents. A number of adolescent girls reported to have suffered from menstruation-related problems during and after disasters. Some girls also reported to have problems related to STIs and excessive menstrual discharge.

The girls, who had menstruation during disaster, suffered greatly in trying to manage their periods, as they had to leave their homes unprepared when tidal surges hit. Along with the scarcity of sanitary napkins or clean cloths, maintaining privacy became a main problem in managing menstruation in this period. Lack of adequate bathroom facilities, unavailability of hygienic and dry napkins or pads, maintenance of menstrual hygiene at camps, or any other temporary shelter became an intricate issue to be dealt with. In addition to the scarcity of napkins, drying the washed napkin cloths in bad weather made the scenario even worse. Furthermore, the adolescent girls found it difficult and shameful to dry and change their napkins or clothes during the day time, with men loitering around, which resulted in using partially or totally wet cloths during that time. These caused various skin diseases and problems relating to their reproductive system as well as trauma and stress. The trauma and stress experienced in disaster also affected regular menstruation afterwards, while some girls suffered from excessive discharge and experienced a sudden pause. The girls who had taken shelter in dams or road had even worse experience.

Access to SRH Knowledge During and After Disaster

Social norms and cultural values on ASRH function as strong barriers to access to information. Many respondents reported that they had prioritized other needs over SRH. During the disaster period, priority was given to shelter, food, and medicine, as these were primary needs required to save lives immediately after the disaster. Some of the adolescent girls had said that considering their situation, they felt that at that time it will not be sensible to seek support about ASRH while other issues were pressing. In FGD discussions, some health service providers (HSPs) expressed their views on SRH related problems during disaster and post-disaster situations:

"We hadn't thought about what sexual and health related problems the adolescents could face during and after disaster. The problems like injury and other diseases caused by disaster damages were our major concerns. Sexual and reproductive health of adolescents was not our primary concern."

Available Disaster Services Related to SRH

Like many other coastal areas, health service facilities of the study area totally collapsed during cyclone Sidr. Many parts of the area remained submerged for a couple of days, the communication systems had broken down, the health centers (FWCs) were also affected and the local service activities got

interrupted. After 4–5 days, some medical teams visited the affected area and provided some primary supports. However, it was insufficient compared to the magnitude of demand. So it was no surprise that there were no extra arrangements made for adolescents or women. A health care provider said:

"During the last cyclone, Sidr, the communication systems had broken down, the health centers were also damaged, and even our own families had became sufferers. Despite all that, we tried to provide service within 3–4 days of Sidr, at least two tried to meet the very basic needs. Our major concerns were injured people, and other primary but prevalent ailments like fever, cold, and diarrhea. At that time, we were unable to continue to provide SRH services because the major concern was to save people's lives."

Even when there were health services available, many of the adolescent girls could not avail themselves because they were too shy to communicate with the service-providers who were often males.

Harassment During and After Disaster

During disasters, risks of harassment and abuse were greater for adolescent girls than it was for boys. Some of the adolescent girls shared their experience of harassment during the time they spent at shelter camps. Use of slang languages by 'bad' people were common in the shelters where many people gathered to stay. Some girls also reported different forms of abuse, in particular groping. Incidents were more frequent when the young girls had to go to the toilet during nights as there was no light. The respondents who had taken shelter in their neighbors' or relatives' houses also faced harassment by relatives and acquaintances who were also staying in the same house. Most of the time, the girls did not share the experiences of abuse with others due to fear of stigma, and the anticipation of repeated and/or increased harassment; these girls felt like they were too young or helpless to protect themselves.

Adolescents, girls in particular, were also subject to sexual harassment in collecting relief. Elder males were busy with the income-generating and unwilling to wait in the long queue to collect relief and therefore, women/young girls were assigned to do this task. This combined with the promise of getting extra relief exposed the adolescent girls to further harassment. A case of such harassment has been described by an adolescent girl after Sidr is given below:

Receiving relief or harassment!

When the cyclone Sidr struck, many areas of our Purba Kewrabunia region were submerged under water, including our house. Swimming through the water, we took shelter in a house of a neighbor, which was less affected. Somehow, we passed that night and my father went back to check our house the next day. He saw that the home was totally damaged and nothing left intact. We were totally hopeless about what to eat, wear, and do. We came back to our place a few days later and somehow managed to live there. We passed the next three days almost in the same dress and had nothing to eat. After three days of the Sidr strike, my father informed us that reliefs would be distributed in the school field. My father with my mother, my younger sister and myself went to collect relief with the intention that we might be provided more relief, if the

relief workers find there are more family members. I was 12 years old at that time. I was feeling very shy to go there wearing only a top and trouser as I had no scarf left to wear. After going there we saw that relief would be distributed on road, a large crowd of people were already there. My mother stood in the queue to collect the relief. My father went to enlist our name for relief. I then observed how they distributed the relief. In the meantime a person, whom I never knew, came to me and asked some questions like—what is your name? Did you come for the relief? He was touching my body, head, and saying some sympathetic words to me. The body language and the way he looked at me made me very uncomfortable. I was trying to move away from there but could not do this because he was holding my hand very tight. All of a sudden the person pressed my breast and I felt a lot of pain. I shouted 'mother!'. The person left the place in a hurry and lost in the crowd.

Sometimes adolescent girls were coerced to provide sexual services to the powerful elites in the community in exchange of the relief packages or financial supports. One of such stories as described by many respondents was:

Exchange of vulnerability with sexual harassment!

An adolescent girl of 15 years, lived in Sonatola village of Naltona union. Their house was almost destroyed by Sidr. A 'dafadar' (an influential village guard), informed them that if they wanted to get tin for the house, they had to pay 5000 taka (US\$60); this was the government's rule for receiving CI sheets. However, the girl's family was too poor to pay that amount of money. One day, the girl, on behalf of her father, went to dafadar to inform their inability to pay and seek advice what they could do in that situation. The 'dafadar' proposed that they would not need money and could get more things in addition to the CI sheets if she would spend the night with him in his office. She informed her parents about the proposal. They felt that there was no other option at the time other than saving life. The girl was coerced by her parents to go there and have relationship with that dafadar man. Later, the girl became pregnant, which was a matter of shame in the society. The 'dafadar's family became aware of the issue. Then the 'dafadar' with personal initiative arranged marriage with the girl.

Some of the respondents also linked the harassment to direct and indirect effects of the disaster. They informed us that one form of relief works involved 'food for work', mainly includes construction works operated by various NGOs and GOs. In this activities under the program of 'food for relief', girls became victims of sexual abuse when they worked alongside men such as during pond digging, reconstruction of school buildings, and so on.

One of the salient features of the study area was the increasing rate of child marriages during and after disasters, which marked the sense of insecurity of parents about the safety and security of their adolescent daughters. Nonetheless, marriage is often viewed as the best solution to protect a young girl from harassment and abuse. The local elites were found to be particularly opportunist by taking advantage of the vulnerable situation while they were more interested in marrying the young girls during and after a disaster. The following is a case of an early marriage of a young girl after disaster:

No option than to marry: The Sidr carried real disaster into my life

I was only 15 when I got married. I was married on 6th October, 2008. My parents have four children and I was the third amongst them. My two older brothers used to assist my father in fishing. My younger brother and I were going to school. I was a student in the 8th grade when the Sidr hit. Our boat was lost in the heavy tidal wave. The tiny piece of land we had was also inundated by tidal wave. We had nothing to live on. Relief was the main source to keep us alive. Although my books and papers were ruined by the water, I started to go back to school after a few days. My father and elder brothers were trying to make a new boat, for which we needed about five to seven lacs taka. It was impossible for our family to arrange such a huge amount of money. My father had to take a boat as 'dadon' (conditional loan) from an influential person in our village. In addition to paying a regular installment, another condition of the loan was: whatever amount of fish we could catch, we had to sell that to the person who lend the boat. As a result, maintaining the family became a burden for my father. Meanwhile, my family had to compromise the future of my study. They were concerned whether they would be able to bear the expenses of my studies in future. So why they would spend money on my studies now when I am already in a marriageable age. The result was to reach the decision to get me married if they found an appropriate groom. She said 'if you see it in another way, the disaster carried actual disaster into my life'.

12.5. Role of Stakeholder during and after Disaster in ASRH

Stakeholders for ASRH in the field, are found to be functional at three levels: at the family level, at service delivery level, and at the community level. Relative like parents, grandmothers, sister-in-laws, siblings, uncles and aunts, were identified as potential stakeholders at the family level. The role expected from this group is to have frankly discussions with the adolescents and considering adolescent issues more seriously. The study found that the parents' decisions or consent of elder members in the family and their roles in those cases were very important. Whether they would give permission to adolescents to get involved with these activities or not, and how they were considering these involvements were crucial to identify the levels of knowledge and the nature of services about SRH of adolescents. The study also shows that addressing harassment issues mostly depended on the parent's initiatives and decisions whether they would inform concerned authorities or not (e.g. complaining to the authority) about harassment, how they perceived harassment (e.g. thought some forms of harassment as 'normal'/regular) and what their decisions would be about those adolescents, considering the consequences of the harassment (e.g. giving early marriage being irritated about harassment). Therefore, the parents and elder family members were recognized as the key stakeholders at family-level and their roles and initiatives must have a huge impact on SRH of adolescents as well as their entire life. A girl stated the importance of parent's role in SRH issues:

"To solve the problem of SRH issues, our parents should have to be more conscious. If they freely talk with us and take the issues seriously, then our problem will be solved more smoothly. For example, suppose I have any SRH problem and I have to go to

the health center. To go there, I would have to give thousands of false reasons to my parent because they will ask thousands of questions and would be very worried if they knew I went there to seek SRH services.”

At service delivery level, the facilitators and counselors of NGOs were working locally on adolescent sexual and reproductive issues; Family Welfare Visitors (FWV) and Sub Assistant Medical Community Officer (SACMO), at the government level, were found to be important stakeholders, and adolescents appreciated the mechanism via which the service providers were providing ASRH supports to them. However, it must be noted that the study found these services as inadequate and often untimely.

As for stakeholders at the community level, the study reinforced that community leaders, teachers, religious leaders, law enforcing personnel, pharmacists, relief workers, and other influential people were important actors for the rights of adolescents. Community leaders were identified as one of the key stakeholders as they play an important role in adolescents' accessing to SRH information and dealing with problems of harassment. In this regard, statement of the council member of Noltona also showed the importance of their role as stakeholders when he said:

'Usually, complaints of adolescent harassment in my area, do not come upto me. If any incident do happens, the issue is resolved at the family level to save honor of both families. If a few small incidents of harassments happened between school children, we tried to resolve them through involving school teachers, and by punishing the culprit.'

Teachers were identified as critical stakeholders because some SRH issues are included in the secondary school curriculum textbook. But in most cases teachers were reluctant to talk about these issues in the class room. A teacher, who participated in the FGD session, described his role when it comes to adolescent issue:

'We, as a teacher, could play an important role in imparting SRH education to adolescents by properly discussing the reproductive issues which remain in the school textbook. But, in this situation it would be wise for the female students to be taught by female teachers, so that the females could feel more comfortable to share the issues with them more freely.'

During disasters, relief workers, both at the GO and NGO levels, were recognized as pivotal stakeholders because of their direct involvement and extent of engagements during and after the disasters. A relief worker said:

'As a relief worker, I had to do two main jobs: first, to survey which families were mostly affected and second to distribute relief to those affected families based on that survey. The adolescents were not selected, through this process, to get any relief or services. ... Now, through some training and awareness activities, I realize that adolescents also become vulnerable during disaster and as a relief worker I also have some major roles to play.'

Stakeholders at all levels do uphold traditional societal norms and views about SRH rights. Some of them found it 'negative' and 'unethical' to provide unmarried adolescents access to SRH commodities. However, the stakeholders

at the service delivery level were more motivated towards adolescents' SRH rights, but they clearly did not have the influence required to change embedded social taboos such as those on SRH in Bangladesh. Greater commitments on the part of the stakeholders at all three levels was highlighted as a major need if significant impact is to be made to resolve the problems related to adolescent SRH in pre and post disaster periods.

12.6. Discussion

Issues of SRH of adolescents and their vulnerability were not new .A number of earlier studies have demonstrated similar findings too. However, it is a new evidence that natural disasters oppress adolescents and damage their SRH. Factors which negatively affected the SRH of adolescents were quite similar with those in other parts of the country, except the difference arising from geo-ecological settings of the study area. In specific settings, some communities have been regularly affected by seasonal disasters which disrupt the lives of adolescents in many ways.

SRH of adolescents is more at risk due to repeated occurrences of natural disasters in the study area. According to the members of the local disaster management committee and the community leaders, SRH of adolescents was not their primary concern when compared to other needs at that time. Consequently, in previous disasters, the SRH of adolescents had not only become more vulnerable but also the adolescents were far away from their existing network of SRH support during that time, and in most cases they had to face such problems all by themselves at their young age. Since victims of the disaster became powerless and passive, adolescents and especially girls encountered worse forms of abuse and harassments, and they easily become the targets of sexual perpetrators. Moreover, existing societal norms related to SRH increased the vulnerability of adolescents and made the issue more complex.

12.7. Conclusions

Overall, the study findings revealed that during disasters, the SRH of adolescents in the study area was vulnerable in different ways: ambiguous perceptions among adolescents and the community on sexual and reproductive health; barriers to access sexual and reproductive health related information and services; lack of awareness about adolescent sexual and reproductive health rights in the community; magnitude of harassment; and geo-ecological settings (e.g. coastal setting) of the community and so on . The adolescents in the study area are facing dual vulnerabilities- caused by natural disasters and traditional social attitudes towards girls and women in general. Due to such dual pressure, sexual and reproductive health of adolescents is at risk. Therefore, multi-pronged actions are required to protect adolescent girls in this regard.

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Climate Change and Gender Role in a Flood Prone Region of Bangladesh

Tahsina Ferdous

Abstract

The study provides an overview of climate change and gender role in the north part of Bangladesh where river bank erosion is one of the most common natural hazards. It states the gender role and adaptation strategy with the danger of the river bank erosion. In erosion prone areas people, especially, women are worried concerning loss of their homesteads and other sufferings and misery. After the river bank erosion affected people lose their original house and suffer without homestead for months and sometimes for years. One of the most vital issues is that since men tend to leave the area in search of employment, all the responsibility of household being falls on the shoulders of women. In this area often male members of the household never come back again. Behind this reason, the cause is that they think the family, women, kids and old persons are burden for them. It is the women in the family who cannot leave her family unfed and unguarded. In the dire poverty and vulnerable situation, women do not give up hope of life and try to cope and survive with the miserable condition due to climate change. Out migration and transfer of the homestead of the village are the coping strategies with river bank erosion. Consequently, women are affected more severely than male but they tolerate their vulnerable situation surreptitiously and hardly show any objection and try to play the effective role for their household and family.

Keywords: Climate Change, Gender Role, Flood, Riverbank Erosion, Adaptation

13.1. Introduction

This paper aims at introducing why gender role is an important factor in understanding climate change impacts and adaptations in Bangladesh. This paper begins with a brief overview of gendered aspects of climate change impacts and gender role in the northern region of Bangladesh.

Riverbank erosion is relatively frequent in our country. The inland rain and annual floods unbolt the path of erosion – one of the most vital natural hazards in the north division of Bangladesh. The study conducted in Bahuli, the river side village of Jamuna, Sirajganj district, Rajshahi division (the northern part of Bangladesh) where river bank erosion is very dangerous and prevalent natural hazard. Kajipurthana is connected with district head quarter Sirajganj by road and river ways. It is situated in the north of Sirajganj district. The river Jamuna is flowing over these areas. Around 1400 people are living in this village having diverse socio-economic and religious backgrounds. Agriculture is the main source of their livelihood which is mainly dependent on nature. But sometimes the farming system is being facilitated by technology such as irrigation and use of modern tools for cultivation, use of chemical fertilizer and seeds etc. Many people are working as carpenter, tailor and small businessman as they have lost their cultivable land through river erosion. The study followed qualitative techniques like case study and in-depth interview to gather and interpret data. I conducted intensive fieldwork and collected data from the village Bahuli, one of the most erosion affected riverside villages of Kajipurthana, Sirajganj district. The area has been selected purposively to know about the gender role and adaptation strategy with the danger of river bank erosion in the north part of Bangladesh. I went to my field in two phases first time in the winter season and at second phase in rainy season; I was there for collecting data. Several of my interviewees said that the current trend of flooding in their area is changing: frequency, duration and intensity of floods are increasing as a result the trend and vulnerability of erosion is also increasing. After the flood of 1988 the father's generation suffered a lot and the flood of the year 2007 their present generation suffered in plenty. They lost several hectars of their cultivable land in the womb of river Jamuna. As a result many of the self sufficient farmers became poor tenants as they lost their farm land with erosion. Basically, here erosion leaves nothing for the affected area and the affected people. The people of this area are facing terrible problems to manage their shelter and livelihood in the vulnerable context of river bank erosion. They have to shift for their new settlements which are mostly temporary as all the time they go through the threat of river erosion. In the study village the environmental significances of climate change affect men and women differently. For this reason the climate hazard and gender have important association. Women play the crucial and fundamental role in adaptation strategy under the danger of the riverbank erosion.

The people of these locations move from here and there for their place of living. They have no permanent settlement as they lost their homesteads with erosion. In this situation women are going through physical insecurity, loss of self as well as family esteem and so on. Moreover they have to face the situation of lack of production opportunities and work and lack of food security in the aftermath of the climate change event. In river bank villages women and girls play the vital and imperative role during and after river bank erosion. Since women have diverse experiences about their household and surroundings, in the

period of hazard they have to protect and care children, elderly people, cattle and poultry. The burden of women's domestic work increase during natural calamity and they try to tackle this situation by their great hardship and prominent role.

Anthropology of the environment or environmental Anthropology is a specialization within the field of anthropology that studies current and historic human-environment interactions. Environmental anthropology is largely considered to be the applied dimension of Ecological Anthropology. The recent shift towards the applied side of the study of the human-environment relationship is driven largely by environmental concern (Kopnina, H & Shoreman-Ouimet, E, 2011). This study has been approached to relate the applied side of the human-environment correlation of environmental anthropology within the discipline of anthropology.

13.2. Climate Change, Hazards and Gender Dimension

In a country smaller than Britain, and with more than twice as many people around one-third of the land is flooded every summer. The monsoon rains cover the low-lying land, and swell the three major river systems that struggle to find outlets to the sea(Cannon, 2002).

The principal climate hazards affecting Bangladesh—floods and cyclones—are likely to increase in frequency, intensity, duration and extent. The summer monsoon rainfall is projected to increase, swelling the main river systems in the wider catchment, and boosting the rainfall impact within the country. More rapid glacial melting in the Himalayan headwaters will also increase spring and early summer flows, further increasing the flood risk. In winter, problems of drought will increase. The current winter dry season which already limits agriculture and particularly affects poorer farmers who cannot afford to irrigate is likely to become significantly worse (World Bank 2000). For the cause of heavy rainfall and flood the banks of river become broken and as a result the erosion happened and it affects the people of Jamuna riverside villages. The villagers have the experiences of river bank erosion from one generation to another generation. Many of my interviewees expressed their great sorrow and misery that they are the witness of this natural disaster. They saw how erosion grasped their homestead and cultivable lands as well as many of established infrastructures in this village as school, college, madrassa, post office; mosque, bank etc were drowned under the womb of Jamuna River in front of their eyes. People of these affected area become adaptable with the natural calamity and they used to be habituated with shifting, transfer and migration as erosion destroy their life and living places.

Women's vulnerability is unlike men that have developed through the socialization process overtime and, therefore should be treated accordingly. Women are more vulnerable to climate disasters not because they are physically weak, but they face different impediments in the societies guided by superstitious customs. Generally, in many developing countries women often live in

conditions of social exclusion, such as cultural limitations to mobilize outside their immediate environment; have less access to information to early warning systems in times of disasters, and to forecasts of climate variability; and have difficulties in participating in training processes (UNDP, 2009). The vulnerability of women in Bangladesh is much higher than men during the disasters due to their poverty, their attitudes, social norms and their marginal position in the social system(Rahman, 2013). Another problem in refugee camps is the common absence of culturally appropriate hygienic facilities for women and men, which may worsen the health and security situation for women especially adolescent girls (Mehta, 2007).

Gender role and adaptation with the changing climate trends are the very important issue on the context of rural village in our country. Because of gender differences in property rights, access to information and in cultural, social and economic roles, natural disasters are likely to affect men and women differently: Following the cyclone and flood of 1991 in Bangladesh, the death rate was almost five times as high for women as for men. Warning information was transmitted to men by men in public spaces, but rarely communicated to the rest of the family. As many women are not allowed to leave the house without a male relative they perished while waiting for their relatives to return home and take them to a safe place (Aguilar, 2004).

13.3. Climate Change and Gender Role

Woman play very crucial role in climate change adaptation and mitigation, even though their contribution is overlooked or less acknowledged. Many of their works related to natural resources management are contributing to mitigation actions. Whereas, women perform many activities for the well-being of their family members, which simultaneously can be regarded as well-designed adaptation practices. Women adopt diverse and intense household resource-use strategies to cope with food deficit situations, especially during lean seasons and natural disasters. They intensify their efforts in homestead production and seek non-farm production options for the well-being of the family. Moreover, women perform some infrastructural development to conserve the soil and water and also to avoid floods by building embankments which presumably make a large contribution to the efforts required to confront climate risks. For instance, women's organization in Senegal have helped to build crescent shaped canals to retain water, recover crop lands and improve agricultural output in the Keur Moussa community, where previously young men and women were migrated to city due to flooding and river bank erosion that were destroying their cropping lands (Dankelman et al., 2008)

There is evidence that floods increase women's domestic burden. The loss of utensils and other household essentials is a great hardship, and floods also undermine women's well-being in general because of their dependence on economic activities linked to the home (Khondker, 1996). Existing gender

norms and power inequalities shape the ability of men and women to adapt to climate risks. The gender-based division of labor leaves men and women with different levels of exposure to climate risks and opportunities (Rossi and Lambrou, 2008).

In the context of climate change and division of labor Denton, F. (2002) argues that the division of labor between women and men leads to differences in the effects of climate change and in the needs for climate adaptation. This has mainly been discussed with reference to developing countries. In many of these the domestic workload of women can be strongly influenced by climate change and by adaptation measures, since in many developing countries women are responsible for fetching water and firewood. Environmental degradation in rural areas will increase the distances that women have to walk to do this (Denton, 2002)

The statement of Denton, F. (2002) is visible in the erosion prone area which is my research field. In the course of my field work I made contact with the people specially women folk of the Bahuli village. In my study area I have seen that the women are engaged with active role both in household works and economic works in the context of climate change as well as river bank erosion. In the case of Nurun Nahar it is visible. Nurun Nahar aged 40; mother of three children shared her struggling life with me that she works in a chatal (workshop of boiling paddy and making rice). Usually she gets a daily payment of taka 100 and midday meals. She has to maintain her family with this limited income somehow. Some eight years back when erosion grasped their homestead and agricultural land, they took temporary shelter on the embankment. At that time her husband went to Bogra town to work as a rickshaw puller. Initially he used to send some money and visited the family but finally he stopped it and cut off contact with the family. As her husband thought that family is a burden for him, she stated. But it is she who could not separate herself from the family as well as the burden of family. Now she lives from hand to mouth with her two sons and one daughter. She adapted herself with her children to the stringent situation.

Generally natural calamity and hazard reinforce, perpetuate and increase gender inequality. The life of village women of Bahuli is dependent on the will of nature. Here women play a fundamental role in natural resources management and in other productive and reproductive behavior at the household and community levels. This puts them in a position to contribute to livelihood strategies adapted to changing environmental realities. Fundamentally climate induced environmental and socio economic changes have increased women burden and hardship. Floods also increase women's domestic burden through loss of utensils and other household essentials like furniture and losses of harvest and livestock. As many of them rely on food processing, cattle and chickens for their cash income. Their extensive knowledge and expertise make them effective actors and agents of disaster reduction and adaptation strategies with river bank erosion.

I am told by one group of women who work in other's household that in order to fulfill the basic needs of their own household they are doing this work. Empirical evidence shows that socio-cultural norms can limit women from acquiring the information and skills necessary to escape or avoid hazards. In most cases, the poorer households do not want to shift to other places as they rely on the rich farmers' households where they usually get opportunity to work. They are known as *kajer jhee* (helping hand in household chores). For example, Aleya (38) has no male person in her household. Only she, her old mother in law and her two daughters live here. They occupy one undisputed vacant plot which is situated on the bank of river Jamuna. Though her husband was a poor farmer with small amount of cultivable land, somehow he could manage the household. But ten years before when erosion grasped their home and cultivable land her husband left the family as he considered it as burden. Now he is a daily labor of a flower mill and lives in Sirajganj town with his new family. Aleya works in a rich farmer's house as helping hand for all household works and maintains her household with her little income. She is the only earning member in her family. With the load of hard work and dire poverty she became weak and sick day by day. She is in a great trauma that if anything would happen to her what will happen to her daughters and old, ill mother in law. Though her son left her, as a daughter in law she is performing responsibilities to her mother in law.

It is difficult to separate the aspects of female vulnerability and poverty, in particular because gender plays a significant role in determining poverty. The report of Asian Development Bank suggested that over 95 per cent of female-headed households are below the poverty line. The proportion of female-headed households in Bangladesh was officially reported as ten per cent, but other evidence cited suggests that a more realistic figure is twenty to thirty per cent (Asian Development Bank 2001). Many of these households consist of women who have been divorced or widowed, and who are culturally discouraged from remarrying. Ninety per cent of those who are single as the result of bereavement of divorce are women (*ibid*). As a result, vulnerability to hazards involves a complex interaction between poverty and gender relations, in which women are likely to experience higher levels vulnerability than men.

13.4. Gender Role and Adaptation to Riverbank Erosion

The qualitative data of Bahuli village show that the female members are playing their role as an active agent in their household and livelihood pattern to balancing and adapting with the erosion and the threat of erosion. In addition, women especially in poor households are largely engaged in labor-intensive agriculture, which is extremely sensitive to weather events. Elderly women are expected to perform household work at an age when men are relieved of work. Household work has to be performed even on extremely hot days or on winter; this workload can have serious health effects towards village women.

It should also be mentioned in this context that it is usually women who work in other people's home. In the village Bahuli, there is clearly a risk that due to the existing gender division of labor, extreme weather events, river erosion and other effects of climate change consign a particular burden on women and imposes on them with this respect.

Men and women have different roles, responsibilities and decision-making power, leading to disadvantages for women. Like other villages in Bangladesh it is therefore not surprising that gender also plays a role in relation to climate change in Bahuli village. Husney Ara's case also shows this situation. She is only fifteen. Her homestead is not far from the river. In the bank side they have around 10.5 acres of land in Kajipur. But due to erosion now they have only 1.5 acres of land for cultivation. Her father was well off and self-sufficient farmer in the past. That time she went to primary school with her brother. But later being dropped out, she had to help her mother in the household chores and look after the hens, goats, ducks and a few vegetable crops and post-harvest operations at the household. Due to erosion they lost their original big homestead and huge amount of cultivable land. For that reason her father said that only her brother will go to school and she should stay at home as she will get married very soon. Though her mother wants the continuation of Husney Ara's study with her son, her will is not being acceptable in her family as her husband is the only decision maker. Husney Ara's case represents a typical example of patriarchal control. Here the role and status of women to play a decisive role is handicapped and women's coping efforts are severely challenged by gender relationship and curtailed by power structure both within the household as well as within the community.

Women try to cope with during and in the aftermath of erosion in Bahuli Village. Here women and girls play dynamic roles before, during and after disasters. They are also involved and serve in search and rescue behavior. Their utmost attempt to survive through the bad times takes a lot of personal sacrifice and compassion as well as accepting psycho-physical burden. However, the anticipated intensity of changes in erosion context under climate change appears to be so overwhelming in the backdrop of women's current vulnerability context that mere coping will not be sufficient even to ensure survival coping. Most of the time in every society, women are responsible for household tasks and care for children and the elderly. They have to secure food, provide clean water and household energy, and care for the sick. At the same time, due to the need for poverty reduction, they have to run income generating activities. Climate change may put additional burdens by doubling and tripling it. This situation is also visible in the village Bahuli.

In erosion prone area, people especially women are worried concerning loss of their homesteads and other sufferings and misery. In the study area I found that after the river bank erosion affected people lose their original house and suffer without homestead for months and sometimes for years. Migration outside and transfer of the homestead of this village are the coping strategies

with river bank erosion. One of the most vital issues is that since men tend to leave outside the locality in search of employment, all the liability of household falls on the shoulders of women. She has to manage both earning generated work and house hold chores at the same time. In the village Bahuli often male members of the household never come back again as they think that the expenditure of family, family members like wife, children and old parents are burden for them. If he comes back to his family he has to feed all the family members in the terrible situation of poverty. But it is the women in the family who cannot leave her family hungry and unguarded. Consequently, women are affected more severely than male but they endure their vulnerable condition surreptitiously and hardly show any objection against this condition and try to play the effective role for their household and family in the context of climate change and adaptation process.

13.5. Shifting Settlement

The critical situation of river erosion is a condition prevalent in the bank of Jamuna. With the on-rush of water erosion starts and people are under terrible apprehension. Their homestead disappears under their nose and they are helpless onlookers. This situation confronts them generation after generation. They are to remove their belongings to safer places. In this process women have to be very particularly careful about whatever belongings they have. Male folk put in physical labor and womenfolk play the part of efficient coordinator. Women of this village preserve fuels, matches, portable mud stoves, ropes, dry food like rice, puffed rice, flattened rice and some other dried rice cakes, sugar etc for their crisis point in time. Monoara aged 45, has two daughters and one son. With her three children her family members are six. She has been living here for more than 20 years. Due to erosion she has migrated with her family from the village of Baruhashi in Trash thana of Sirajganj district with her husband, mother in law and children. She got married at age of 13 and had to perform all the household roles and activities. All the members of her family are very much dependent on her and all the time she took care of them. She supported her husband especially in the time of shifting proficiently as the members of her family did not go through any obstacle. She as well as other women folk of this village think that this natural hazard of river erosion is a part of their life. So, they keep themselves mentally prepared for this disaster always. This condition has a deep-rooted effect on their life and they turn to be a bit fatalist. With the case of Monoara, it is clear that women of the village Bahuli like those of other parts of South Asia display enormous strength and capability all through the entire disaster cycle: preparing for hazards, managing after a disaster and rebuilding damaged livelihoods acting for ensuring food and water for the family, securing seed and other productive materials and taking care of the sick and elderly. Women are also taking steps actively for recovery strategies such as rebuilding houses, re-stocking livestock, repaying borrowed loan, treating affected family members and try to securing income as well as try to restore the education of children and so on.

13.6. Formation of New Settlement

The fear for eviction through erosion always haunts the people of the riverbank areas. When erosion grasps the settlement, the migrants do not have any particular allotted area for their homestead. They occupy any undisputed vacant plot which is not far from the river. Sometimes people move to distant safe place as is seen among the people of Kazipur upazila in Sirajganj district. Many of them have settled in different places of the district Bogra. Almost all the people of river zone live in *kutcha* (raw) houses made by thatch, bamboo, CI sheet. The main reasons of making this type of house are their poverty and easy shifting ability of the dwelling tenants. They live in this condition up to the next erosion, if any. According to the study data, in the rainy season, they suffer a lot as heavy rainfall and flood often damage their temporary settlements. In the dry season, almost all the household members try to repair their houses or living places with unbreakable poverty. No member of the village can deny the necessity of reconstructing and developing physical infrastructure of the community after the erosion, and women and girls are seen to take equal parts as male members in these formation activities. Men tend to focus their attention almost exclusively on productive activity, including agriculture and other waged income sources for the household expenditure. Women tend to prioritize physical and psychological health, economic opportunities, and their children's welfare. If they have any elder person in their home they have to ensure the proper care and concern for them.

Thus climate change adds a new complexity to the areas of human mobility and settlement by exacerbating environmental degradation. The gradual process of environmental deterioration is likely to increase the flows of both internal and cross-border human migration. As increased human migration entails that a greater number of people are being displaced due to severe river erosion, shorelines erosion, coastal flooding and droughts.

13.7. Economic Activities

After the river bank erosion people of the village Bahuli try to cope with the tremendous situation through natural adaptation and economic activities. They have to perform economic activities for their livelihood. The majority of the people are more dependent for their livelihood on natural resources that are susceptible by riverbank erosion one of the prime effect of climate change. Due to river erosion in Bahuli rural areas, women folk generally take care of poultry and other small assets and in a disaster while erosion occurs, they try to sell these in order to meet household financial needs. Selling other valuable things (if any), mortgaging or borrowing against assets, or borrowings from the rich neighbors' are other common strategies for endurance. If doing all these things does not ensure survival they usually take up various professions namely sewing of *katha*, jute and cotton bag making, selling various kinds of rice cakes and also serving as domestic help (*jhee*).

Usually most of the time the male folk work on others' field or as day laborer and the women folk work in the house of well to do people as mentioned earlier. There was a time when they had homestead, cattle, cultivable land. But now they have turned into pauper. Many families become marginal day by day and live from hand to mouth. Women have, on average, lower income and smaller economic resources than men. This applies in particular to single and widowed women. Therefore, it is predominantly women (and in particular single women) who will be underprivileged if expensive adaptation measures are available only to those who can pay for them. Usually differences in economic resources are the cause of some of the disadvantages suffered by women. Several times the displaced people hope for relief, cash and kind from the government and other organization like NGOs. Their strong demand is for their rehabilitation so that they may live somehow happily.

Most of the time as a migrant, male members work as daily wage labor and rickshaw puller both in the villages and also in the Sirajganj and Bogra town. Sometimes, some of them are involved in criminal activities like stealing, robbery, hijacking etc. to cope with the work-less situation. Often young boys are abused by the harmful community people. Teenagers are picked up by racketeers as carriers of contraband goods or narcotics, smuggling etc. which is very harmful and vulnerable for their life. In the dire poverty and vulnerable situation, some extend of trafficking and prostitution may be visible. Young girls and women become vulnerable with this forced trafficking and sometime prostitution and go through with the miserable condition. Usually the abused girls become isolated and detached and cut relation with their family for the sake of dignity as the community and society do not accept them easily.

According to the study data women and men – in their particular social roles – are affected in a different way by the impacts of climate change as well as river erosion. Reasons are to be found in different responsibilities for care work and income generating work for women in dependency on natural resources and so on. Moreover social roles and responsibilities of women and men lead to different degrees of dependency on the natural environment also. In addition women and men – in their respective social roles – are differently affected by erosion and adaptation procedures. In erosion context, women are more vulnerable to the effects of climate change than men in Bahuli village. They face social, economic and political barriers that limit their coping capacity as women and men in rural areas in developing countries are especially vulnerable when they are highly dependent on local natural resources for their livelihood.

The vulnerability of women to disasters increases for a number of reasons. At the time of post-disaster, women are usually at higher risk of being placed in unsafe, overcrowded shelters, due to lack of assets, such as savings, property or land. In the context of river bank erosion, cyclones, floods, and other disasters that require mobility, cultural constraints on women's movements may obstruct their timely escape, access to shelter or access to health care.

13.8. Conclusion

In this paper, I have argued that women play the vital role on erosion adaptation strategy with migration, shifting, formation of new settlement and changing economic activities. The article also described how the gender aspect is related with adapting to climate change in the north part of Bangladesh. To restate my point: gender role and climate change, I have seen that connectedness to the female role with adaptation during and after situation of erosion, women of Bahuli village are flexible in their mental, social, economical, political and cultural subsistence. The substance presented in this paper would appear to indicate that the gender role in erosion prone area is playing the effectiveness with own notion of culture in natural adaptation. Migration is an important way of achieving and maintaining livelihood, as well as a way to cope with natural disaster and shifting. It is another survival strategy here.

It is important to remember here, however, that women are not only vulnerable to climate change but they are also effective actors or agents of change in relation to both mitigation and adaptation. In the circumstance of river erosion women often have a strong body of knowledge and expertise that they often use in climate change mitigation, disaster reduction and adaptation strategies. Furthermore, women's responsibilities in households and communities, as stewards of natural and household resources, put them on a better position to contribute to livelihood strategies adapted to tough changing environmental realities through erosion process. The concerned people constitute a big volume of our population involved in the struggle for existence. They expect that the people and the government of Bangladesh should understand their miserable position and assist them.

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Chapter Fourteen

Community-based Adaptation to Climate Change: Experience of the Coastline of Bangladesh

Mahfuzul Haque

Abstract

The conical shape of the Bay of Bengal, the low-lying coast and Bangladesh's very location on the tip of the sea have made the country most vulnerable to periodic natural disasters like, cyclone and tidal surges. The coastal zone is characterized by a vast network of rivers and tidal channels; erosion and accretion processes continue, siltation takes place on water courses and river beds; and the area is prone to cyclone, storm surges and salinity intrusion. Series of tropical cyclones, tornadoes, tidal bore attack the coast periodically. Threat of sea level rise due to climate change is also looming large. The people of the coast in particular and the country in general have developed through a process of innovation and practices, a variety of coping strategies and community-based adaptation measures that are well-suited to the local environment, economy and socio-cultural system. The paper argues that because of practicing of age-old indigenous knowledge and practices, people of the coast could lessen damages to lives and property to a great extent in the face of natural disaster. The paper further argues that the fierce people of the coast have been maintaining a co-existence with natural disaster by applying their indigenous knowledge and practices acquired from their forefathers over the years. Although, Bangladesh is a low greenhouse gas emitting country, it is one of the most vulnerable countries of the world concerning climate change. Due to its vulnerability, local community over the generations has developed many rural adaptation techniques, based on their localized knowledge and practices.

Keywords: Coastal Ecology, Climate Change, Community-based Adaptation

14.1. Introduction

Projected climate change impacts including sea-level rise, prolonged inundation, increased temperatures, increased natural disasters like cyclones and tornado, decreased water supplies, increased endemic diseases and deterioration

in coastal environment would threaten lives of the coastal people globally. The Intergovernmental Panel on Climate Change (IPCC)'s latest report states clearly that climate change is already having discernible impacts. These are disproportionately affecting poor communities—especially those in poor countries (Huq, 2007; IPCC, 2004). The Fifth Assessment Report of IPCC said, "human interference with the climate system is occurring" (IPCC, 2014). Poor communities are most vulnerable to climate change and are already feeling its impacts, but have contributed least to the problem. Bangladesh is a highly vulnerable country whose emissions are less than 0.35% of global emissions (WRI, 2014). Per capita emission of CO₂ of Bangladesh in 1990 was 135 kg as opposed to Japan: 2240 kg; USA: 5395 kg; and India 204 kg (Haque, 2013).

Although, Bangladesh contributes little to global greenhouse gas emissions, the country is frequently stated as one of the most vulnerable countries to climate change. Due to its physiographic location, Bangladesh would be worst hit by extreme climate events such as droughts, heavy rainfall, tropical cyclones and storm surges (Anik, S.I. & Khan, M.A.S, 2012). According to IPCC Fourth Assessment Report, saline water from the Bay of Bengal is reported to have penetrated 100 km or more inland along tributary channels during the dry season (IPCC, 2007). On Bangladesh, IPCC observed that average temperature has registered an increasing trend of about 1 degree C in May and 0.5 degree C in November during the 14 year-period from 1985 to 1998. The Report further predicted that the production of rice and wheat might drop in Bangladesh by 8 percent and 32 percent respectively by the year 2050. Bangladesh is especially susceptible to increasing salinity of groundwater as well as surface water resources, especially along the coast. Even under the most conservative estimate, the sea level will be about 40 cm higher than today by the end of 21st century. Therefore, building responsiveness to climate change impacts through adaptation has been recognized as necessary for the survival of affected people.

The IPCC defines adaptive capacity as 'the property of a system to adjust its characteristics or behavior, in order to expand its coping range under existing climate variability, or future climate conditions' (Brooks et al., 2005). While adaptation can be undertaken as a response to a climate-related problem, enhancing the adaptive capacity of local communities to climate change implies an approach to adaptation that is forward looking. Adaptive capacity takes adaptation beyond reduction of vulnerability to hazards and disaster preparedness, involving an ongoing change process where communities can make decisions about their lives and livelihoods in a changing climate (Ensor, Berger & Huq, 2014).

Climate Change Adaptation (CCA) as defined by IPCC (2007) is 'an adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits benefit opportunities'. CCA strategies aim to reduce vulnerability to expected impacts of climate change. CCA strategies exist across local and global scales, from

community level responses through to local, national and international government interventions. At the community level, strategies include improvements to agricultural systems such as crop diversification or the introduction of hazard resistant crop varieties; risk assessments and associated plans; the protection of natural resources; early warning systems; education and awareness measures and protection of water resources (UNFCCC, 2006; Mercer, 2010). Until recently, adaptation was a controversial topic in climate change policy debates, with many arguing that too much attention to adaptation could detract from more expensive mitigation efforts. Given slow progress on mitigation coupled with evidence of greater and more rapid impacts of climate change than those previously expected by the IPCC, adaptation is firmly on the international policy agenda as a crucial supplement to mitigation (Ayers, 2009).

Adaptation was not a major part of the debate when climate change came onto the international policy agenda at the UN General Assembly in 1988. Initial approaches generally focused on mitigation through reducing greenhouse gas emissions at source or increasing the sequestration of carbon through managing reforestation and land use. The Third Assessment Report of the IPCC in 2001 defined adaptation as an “adjustment in natural or human systems” (Ayers, 2009). Later, in the 13th Conference of the Parties of the UNFCCC (held in Bali, Indonesia in 2007), adaptation became a part of “Bali Roadmap”, which paved the way for a post-Kyoto policy framework to include adaptation alongside other measures.

14.2. Community-based Adaptation

Community-Based Adaptation (CBA) begins by identifying the communities in the developing world that are most vulnerable to climate change. They are generally very poor, depend on natural resources and occupy areas already prone to shocks such as floods or droughts (Huq, 2007). CBA is based on the premise that local communities have the skills, experience, local knowledge and networks to undertake locally appropriate activities that increase resilience and reduce vulnerability to climate change (Dodman & Mitlin). Community-based adaptation operates at the local level in communities that are vulnerable to the impacts of climate change (Ayers, 2009; Cannon, 2014). It identifies, assists, and implements community-based development activities that strengthen the capacity of local people to adapt to living in a riskier and less predictable climate. Moreover, community-based adaptation generates adaptation strategies through participatory processes, involving local stakeholders and development and disaster risk-reduction practitioners. It builds on existing cultural norms and addresses local development concerns.

CBA to climate change is a community-led process, based on communities' priorities, needs, knowledge and capacities, which seeks to empower people to prepare for and cope with the impacts of climate change (Reid et al., 2009). CBA comprises several components and is rooted in participatory

development programs to strengthen livelihoods and reduce vulnerability, as well as disaster risk reduction thinking to build resilience to climate-related disasters. CBA is multidisciplinary in nature, encompassing livelihoods, infrastructure, disaster risk reduction, economics, food security, ecosystems and sustainable development.

14.3. Theoretical Perspectives

Community Based Adaptation has been conceived by the development practitioners as an effective approach to reduce vulnerability of the poor and marginalized people from climate change impacts. Historical accounts reveal that the seed of thoughts on CBA is rooted in Taoism, which was developed in 600 BC in China (Rashid & Khan, 2013). Founder of Taoism, Lao Tzu has outlined the philosophy of participatory development and narrated the idea of community based development long back in his poem, "Go to the people/ Live with them/ Learn from them/ Love them/ Start with what they know/ Build with what they have/ ...when the work is done/ the task accomplished/ the people will say/ we have done this ourselves (Rashid & Khan, 2013). The seven principles are found to represent important assumptions of the community based approach, they are: a) community focus; b) community members' participation; c) inter-sectoral collaboration; d) substantial resource requirements; e) long term program view; f) multifaceted interventions; and g) population outcome (Nilson, 2006). CBA as a term has emerged from community based program in climate change sub-sector, disability sectors and poverty reduction sectors. This is largely a community based approach to development. Two philanthropic traditions in India and South America led by Gandhi and Paulo Freire to begin the layout of professional community development program are often referred to. (Rashid & Khan, 2013). These two philanthropic ideas of community based or community led development drove the first wave of participatory development in the 1950s, which later had spread in many other countries of Africa, Asia and Latin America.

14.4. Bangladesh Coastal Community

The Ganges–Brahmaputra–Meghna delta covers most of Bangladesh and it is also one of the largest and youngest deltas in the world and is still very active. Sixty-two percent of the land of the coastal zone has an elevation of up to three meters and 86 percent up to five meters (Islam et al., 2006). The major physical change that may occur in the coastal zone of Bangladesh due to global climate change is the sea level rise. Its impacts will also manifest through erosion of beaches and increased salinity both resulting in major dislocations in the society (MoEF, 1997). Adverse impacts of climate change on the low-lying coast of Bangladesh could be summarized as follows: a) increased intensity and frequency of natural disaster due to increase in temperature; b) sea level rise; c) salinity intrusion; d) reduced water flow and river erosion; e) floods; and f) droughts.

Generally, a coast is defined as an area where a) tidal water movements determine agricultural practices, movement of river transport, estuarine commercial activities and everyday life; b) water is saline; and c) the area runs the risk of cyclones and storm surges (Rasheed, 2008; Haque, 2013). Based on the three criteria, an area of 47,201 sq km (32% of the country) of Bangladesh in 19 districts under 147 coastal Upazilas could be termed as coastal area. The area is populated by 35 million people (2005) representing 29% of total population. Bangladesh faces 710km long coast with the Bay of Bengal containing several ecosystems of high conservation value starting from the Saint Martin's Island to the district of Satkhira (Rasheed, 2008). Coastal people over the years, have been facing the wrath of natural disaster and developed many coping strategies related to the vagaries of nature.

14.5. Adaptation Measures

Being one of the most vulnerable countries of the world to climate change, Bangladesh has to go for adaptation measures. The adaptation processes in flood and waterlogged area are hydroponics, duck rearing, ring-based vegetable cultivation. In saline prone area, adaptation processes are mat weaving by reed, reed cultivation, crab cultivation, sheep rearing and kewra cultivation. In drought-prone area, such an adaptation to climate change measures are sheep rearing etc. Considering vulnerability of the coastal people to climate related stresses, following sector-specific CBA measures are looked into: a) Agriculture; b) Fisheries; c) Forestry; d) Health and Sanitation; e) Water; f) Livelihood and Habitat; and g) Cyclones and Tidal surges.

Adaptation: Agriculture

Climate variability makes crop agriculture in Bangladesh highly vulnerable (CCC, 2009). Bangladesh is a highly agricultural society; agriculture accounts for 63% of its labor force and 35% of its Gross Domestic Product (Rawlani et al, 2011). Anticipated higher temperatures and changing rainfall patterns, coupled with increased flooding and rising salinity in the coastal belt are likely to reduce crop yields and crop production, taking their toll on food security. IPCC estimated in a projection that by 2050, rice production could decline by 8% and wheat production by 32% throughout the country (4th IPCC, 2007).

With increased temperature and salinity due to concomitant sea level rise, coastal agriculture would be seriously affected causing food insecurity. Salinity has seasonal variation due to sea level rise and reduced upstream water flow. According to Fourth Assessment Report of the Intergovernmental Panel on Climate Change (4th IPCC), saline water from the Bay of Bengal is reported to have penetrated 100 km or more inland along tributary channels during the dry season (IPCC, 2007). IPCC Report further said that Bangladesh is especially susceptible to increasing salinity of groundwater as well as surface water, especially along the coast. Even under the most conservative estimate,

the sea level will be about 40 cm higher than today by the end of 21st century. We are to go for adaptation and there are many community based adaptation practices in the coastal region of Bangladesh. All adaptation strategies are based on indigenous knowledge and practices (Anik, 2012). Among the adaptation measures, the saline-tolerant variety of crops could be the answer.

During the past few years, two cultivars (BRRI-40 and BRRI-41) have been developed by Bangladesh Rice Research Institute (BRRI), which can sustain up to 10 ppt of soil salinity (Ahmed, 2008). Another innovative practices was bringing some changes in plantation time in line with salinity intensity. BARI introduced potato cultivation using water-hyacinth cover; wheat followed by mustard as relay crops after Aman harvest; and tomato, eggplants, capsicum-high value vegetables in raised platform. Floating garden (Hydroponics) or Baira, is another community-based adaptation measure has been in practice in many water-logged region in the coast for ages. Hydroponics was proved as one of the sustainable agriculture for vegetable productions (Rashid & Khan, 2013). Cultivation process is very much environment-friendly and without chemical fertilizer. Vegetables are grown in small floating patches, prepared by some mud and water hyacinth. It is observed that farmers give mulch to the crop and trees. Another innovative practice of the local community in water logged area is Tidal River Management (TRM), which is very effective in harnessing the tides to carry out the deposition of sediment and silt to raise the level of low-lying lands and reclaim them for agricultural use. TRM helped to raise water-logged land, increase navigability of rivers, reduce salinity and help the community to adapt to climate change (Kibria, 2011; Ahmed, 2008; Climate Change Cell, 2009).

In water logged areas, farmers used to raise their plantation in heaps for easy drainage and prevent root damage from decay to grow vegetables like bitter gourd, cucumber, tomato, beans etc. Mulching is practiced as it protects crops from moisture stress and provide organic nutrient to the crop. Water hyacinth is found as widely used mulching material for its easy availability. Most people practice mulching, as it serves a good barrier against moisture stress (Anik, 2012). Crop damages due to cyclones and tidal surges may not be totally avoided. Best adaptation is re-plantation, if time permits. If not, fast-growing vegetables could be another alternatives. Other high-value Rabi crops, like maize, potato, peanuts are tried in cyclone-hit areas. Crop damages due to seasonal floods (July-Sept) could be lessened by “double transplantation” of Aman rice; more seedlings; flood-tolerant vegetables; early plantation of crops like potato, maize, and relay crops; floating seedlings etc. Conservation of rainwater in ponds and in borrow pits for irrigation during dry season is practiced, when salinity increases. Challenge is how to grow crops in salinity zone during dry season.

Climate Change Cell in its report summarized community-based agricultural adaptation measures as follows: a) Measures to be taken to increase food production are introduction of drought-tolerant crops; cultivation of vegetables on floating

gardens; low-cost irrigation by treadle pump; homestead gardening; and introduction of saline-tolerant non-rice crops; b) Measures to be taken for increased income through alternative livelihoods are embankment cropping; integrated farming; cage aquaculture; prawn fish poly culture; cattle and poultry rearing; crab fattening; duck and goat rearing; honey processing; nursery and homestead afforestation; saline-tolerant tree plantation etc (Climate Change Cell, 2009).

Adaptation: Fisheries

5th IPCC 2014 said many terrestrial, freshwater, and marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundance in response to ongoing climate change. Fisheries are affected due to increased salinity and drying up of rivers; and tidal surges. In many places, "Cage Aquaculture" for rearing of *Telapia* fishes (Anik, 2012) and other saline-tolerant variety of fishes (*Vetki*, *Bata*, *Tengra*), Crabs and shrimps are promoted as an answer to increased salinity. Raising banks of *Chingri Gher* and other water bodies in case of rise in water level and tidal surges is practiced. When salinity decreases in monsoon, other sweet water fishes like *Ruhi* fishes are inter-cropped with shrimps. High temp (32 degree C) could increase mortality rate in shrimp hatcheries and there could be outbreak of virus diseases (Shrimp hatcheries in Cox's Bazar were seriously affected by Thai virus some few years back). In some water-logged areas, low-water surviving fishes like *Shing*, *Magur*, *Koi* are cultivated. Inter-cropping of shrimp (*Bagda*) with rice has been in practice in many parts of the coastal areas. Climatic change may affect propagation and migration pattern of *Hilsa* and shrimp. Impacts of temp increase on corals; shrimp, crabs and sharks have not been studied so far.

Adaptation: Forestry

Sundarbans, the largest mangrove forests of the world is in the forefront to face the calamities of natural disasters, like cyclones, tidal surges and tsunamis. Mangrove forests thrive in tidal zone and in brackish water and they protected the habitat from natural calamities, when the cyclone *Sidr* struck the area in 2007 and *Aila* in 2009. They also protect shrimps, crabs and other marine fishes and biodiversity. Mangrove forests are under threat due to increased salinity (top-dying trees could be a symptom), sea level rise, storms and cyclones. Decreased flow of upstream sweet water rivers would cause salinity intrusion from the south. Depletion of mangrove forests due to massive cultivation of shrimp and salt pans would increase our vulnerability.

Greenbelt forestry project of the Forest Department has successfully introduced some adaptation practices in the coast. The coastal greenbelt project has two main functions: to protect the embankment from tidal surges through plantings on its outer slope, and to protect life and property in the region by embankment plantings as well as planting in the agricultural hinterland. It also enhanced environmental quality of the coast and newly-accreted *charlands*.

Adaptation: Health and Sanitation

Climate change is expected to worsen health principally through increased vulnerability to diseases due to reduced food security, water scarcity and water-borne diseases associated with poor water quality due to floods and droughts (Sen *et al.*, 2009). They take precautionary measures in case of outbreak of cholera, diarrhea, malaria and dengue in flood-prone and tidal surge-prone zones. Some indigenous healing system like use of medicinal plants is adopted to heal common sickness like cold and cough.

Adaptation: Water Resources

In the coastal areas of southern Bangladesh, one further threat of climate change is increasing salinity. Saltwater makes it difficult to grow crops irrigated by fresh-water. Near the mangrove forests of the Sunderbans, villagers are responding to the threats of salinity by building houses on raised platforms and installing sealed containers of freshwater. Small containers- called mokti are often made of pottery and partly buried into the clay soil surrounding houses to provide reservoirs of freshwater for every house (Ayers, 2009). Larger water tanks of plastic or even concrete are also installed near schools or in village centers to provide a more communal and robust reservoir. The freshwater usually comes from rain that is channeled off roofs into containers. Some wealthier farmers are also converting old rice fields to fishponds and using these to fatten crabs for local restaurants. Rainwater harvest in salinity and arsenic contaminated areas has been in practice for ages. In some areas, people excavated canals and created community ponds for ensuring availability of sweet water and rain water in the face of continued aggression of salinity intrusion.

Adaptation: Livelihood and Habitat

It is projected that a one meter rise in sea level would threaten 18% of population, inundate one-eighth of the country's agricultural land, damage 8,000 km of roads, threaten the major port of Mongla and require the resettlement of communities living in entire Khulna region (Agrawala *et al.*, 2003). Displacement of population would be a major concern for a densely populated country like Bangladesh with a population density of 1,237 per sq km. (World Bank, 2015). Climate change is only one aspect of the vulnerability of those relying on coastal livelihoods. Vulnerability to climate change means that climate change adversely affects the capability of people to cope with other 'normal' vulnerabilities such as food and income security and safety of properties (Huq *et al.*, 2003). Local community living in the coast and in water logged areas, specially the fishermen and farmers are more vulnerable to climate change. They are trying to cope with the adverse impacts of climate change with their own knowledge. Local knowledge regarding climate change adaptation is important to cope with the present climate change impacts (Anik, 2012).

Coastal zone vulnerability would be acute due to the combined effects of climate change, sea level rise, subsidence, changes in upstream river discharge,

and cyclone and coastal embankments (Huq et al, 2003). One community-based adaptation project involves raising and reinforcing homesteads to make them more resilient against flooding and cyclonic activity, reducing the need for people to flee their homes during extreme weather events and reducing losses (Ayers, 2009). These include raising foundations, reinforcing house structures, and creating raised platforms within homes where people can take shelter during floods. In wetland areas, some NGOs are found running schools in floating boats with the help of solar power (e.g., *Shidhulai Swanirvar Sangstha*, Natore).

Adaptation: Cyclones and Tidal Surges

In some islands like Sandweep, people go for plantation of *Hurma* trees which are very strong and can withstand tidal surges (Haque, 2000). In newly-accreted coastal *Charlands*, plantation of climate-change resistant mangrove forests is promoted. Many people's lives were saved in cyclones and tidal surges with the help of mangrove trees, like *Keora* and *Sundari*. In another study, it was observed that the coastal people identified five major symptoms in anticipating and predicting velocity and impacts of a progressing cyclone, they are: a) wind direction; b) temperature and salinity of sea water; c) colour and shape of the cloud; d) appearance of rainbow; and e) behavior of certain bird species (Hassan, 2000).

Instead of warning signals, they put a prefix like *choto* (small) *tufan* (cyclone) and *boro* (big) *tufan* to express velocity and impacts of a cyclone. Regarding direction of the wind, the coastal people believed that a wind blowing from *Agni-Kone* (south-east) is more likely to create a storm, while the wind direction from *Ishan-Kone* (north-east) has the potential to generate a cyclone but not to that extent in case of severity (Hassan, 2000). The wind direction is also associated with other attributed, i.e., a rise in sea water temperature, red colored cloud, and appearance of a rainbow (if it is day time) implying formation of deep depression in the sea. Abnormal behavior of the tree living birds and ants and insects is regarded as a signal of rapid approaching storm (Hassan, 2000).

In a study conducted on the people of the coastal islands, it was revealed that the islanders have developed certain short term survival strategies of their own. Simple tactics like holding onto and binding themselves to trees; looking for comparatively more dependable places like embankments and polders; using floating items such as timber, banana trees, thatched roof, straw piles and bunches of coconuts represent spontaneous survival strategies (Hassan, 2000). For example, during the April 1991 cyclone, people held on these trees or even tied themselves to the tree trunks for survival. Another interesting phenomenon was that during tidal surges, people tied rafts to coconut trees so that they could rise and fall with the water level (Haque, 2000; Haque, 2013).

People of the locality have also devised appropriate methods for food preservation during cyclones and tidal surges. Generally, outside help and relief goods

appear 2/3 days after the disaster. What do they do during this intervening period? People eat stems and roots of edible plants. For drinking purposes, they drink rain water, as cyclones are always followed by rain for several hours. In absence of rainwater, they share coconut water. Due to non-availability of medicines, generally, the victims depend on herbs and other local substances for treating minor injuries, fever and diarrheal diseases.

14.6. International Focus on CBA

During the 1990s, most of the scientific research and most of the negotiations concentrated on mitigation. This resulted in the formulation of the Kyoto Protocol in 1997 (Huq et al, 2003). There was a divergence between the priorities of the developed countries, which were to reduce greenhouse gas concentrations (also the main objective of the UNFCCC), and those of the LDCs, which were to reduce their vulnerabilities to climate change, which is primarily caused by the emission of greenhouse gases from the developed countries. However, in the last few years the scientific community has increasingly realized the importance of adaptation, especially for the developing countries and particularly the LDCs, which are most vulnerable countries to climate change.

Annual Conference of Parties (COP) of the UN Framework Convention on Climate Change (UNFCCC) has been discussing for last few years funding mechanism on adaptation measures for the LDCs in particular and the developing countries in general. The focus was on adaptation and not on community-based adaptation *per se*. The Seventh Meeting of Conference of Parties (COP7) of the Climate Change Convention in Marrakesh in 2001 expanded the scope of activities eligible for funding, including in the areas of adaptation and capacity-building, and established two new funds under the Convention, that will be managed by the Global Environment Fund (GEF) in addition to its climate change focal area: a Special Climate Change Fund will finance projects relating to: capacity building, adaptation; technology transfer; climate change mitigation; and economic diversification for countries highly dependent on income from fossil fuels. Also an LDC Fund will support a special work program to assist the LDCs (Adger et al, 2003). Marrakesh Accord set up an “LDC Expert group” to assist the vulnerable LDCs to develop their National Adaptation Program of Actions (NAPAs).

At COP15 held at Copenhagen in 2009, the LDCs demanded that adaptation should have the same footing at mitigations and sought \$50 billion dollars for developing countries per annum for adaptation in addition to regular ODA as mandatory contribution from developed countries on adaptation fund. They sought for allocation of resources for implementation of National Adaptation Program of Actions (NAPAs) in the LDCs. Later, a “Green Climate Fund” was launched during COP17 in Durban, South Africa in 2011 in aid to poor, vulnerable countries by 2020 (initiative of Copenhagen 2009). At Doha (COP18) in 2012, it was suggested that “Green Climate Fund” to be raised

to US\$ 100 billion with \$ 40 billion to start with by 2013. Emphasis given on mitigation, although, developing countries sought emphasis on adaptation measures. At Lima, Peru (COP20) in 2014, deliberations continued on how to achieve a universal agreement to build a low carbon resilient future and operationalization of “Green Climate Fund”. As of now, funding administration, modalities, monitoring and supervision remained a bone of contention.

14.7. Government of Bangladesh’s Focus on CBA

Most of the focus so far has been on assisting LDCs to develop National Adaptation Plans of Action (NAPA). Bangladesh was one of the first few countries to submit its NAPA to the UNFCCC and more recently has developed a National Climate Change Strategy and Action Plan (BCCSAP), 2009 to deal with mitigation and adaptation. NAPA has given emphasis on four security issues of Bangladesh: a) food security; b) energy security; c) water security; and d) livelihood security (including right to health) and respect for local community or resource management and extraction (NAPA, 2009). Implementation of NAPA identified projects is in progress. BCCSAP has incorporated immediate and urgent adaptation projects identified in NAPA. At the same time, community-based adaptation responses are emerging both autonomously and supported by NGOs and local partners (Ayers, 2009). It’s a pro-poor climate change management strategy, which prioritizes adaptation and disaster risk reduction, low carbon development, mitigation and technology transfer.

Some of the project ideas as identified in BCCSAP are as follows: Strengthening institutional capacity; Development of climate resilience cropping systems; Improvement of flood forecasting and early warning; Awareness raising and public education on climate resilience; Repair and maintenance of existing flood embankments; Establish Centre for knowledge management on Climate Change; Renewable energy development; and Mainstreaming climate change in sectoral plans and policies (BCCSAP, 2009). There are currently two funds set up by the government to implement adaptation projects, namely; a) Bangladesh Climate Change Trust Fund set-up by the Government of Bangladesh; and b) Bangladesh Climate Change Resilient Fund established by the development partners.

So far, focus of the government has been on “traditional development” and not on community-based adaptation measures which focus on area-specific resilient building and addressing social vulnerability (Ayers, 2009). CBA embodies adaptation practice that is small-scale, place-based and often grass-roots-driven, engages development practitioners and development approaches, and most importantly is community based (Schipper, et al, 2014). International Community-Based Adaptation Conferences are being held throughout the world to put more emphasis on CBA projects and development partners are showing increasing interests to fund such projects.

14.8. NGOs approach to CBA

A number of NGOs and activist groups led by International Institute for Environment and Development (IIED), UK and Bangladesh Centre for Advanced Studies (BCAS), Bangladesh have been pioneering the CBA movements for a decade. The tenth international conference on community-based adaptation (CBA10) was held in Bangladesh in 2016. It aimed at strengthening the existing network of practitioners, policymakers, planners and donors working on all levels of community-based adaptation and enhancing the capacity of practitioners, governments and donors to help improving livelihoods of the most vulnerable to climate change (IIED, 2016).

CBA conferences are intended to highlight that effective adaptation to climate change takes place at community level. A bottom-up approach to adaptation enables local knowledge and practices to be shared among communities, academics and project managers so that those most exposed to the impacts of climate change are better able to adapt. Past CBA conferences have focused on scaling up of best practice, ensuring a scientific basis to action, communicating and mainstreaming CBA, and ensuring adaptation funding reaches community level. The eleventh CBA conference to be held in Kampala, Uganda in 2017 is expected to consolidate the process both at national and global levels.

14.9. Challenges to Community-Based Adaptation

- A. CBA measure to climate change is a pain-staking process and is developed over the years. One important feature of CBA so far is that learning itself requires practice. CBA is still a relatively new concept, not widely known outside the development community. It is not possible to learn the theory of CBA in a university or training workshop. Adaptation is a classic case of learning-by doing or ‘action research’;
- B. Ambiguity exists between traditional adaptation and community-based adaptation, which has to be cleared. It is unclear how much community-based adaptation differs from community-based “development”. This lack of distinction has presented problems for practitioners and funding bodies who intend to fund successful community-based adaptation projects;
- C. CBA is still in the process of evolution, needed more piloting over the years in different agro-ecological zones of climate-stress countries. Success stories on CBA would depend on adequate funding by the government and the development partners;
- D. Funding for CBA projects may pose another big challenge for the government and the development partners. There could be competing priorities for accessing funds allocated for NAPA identified projects and CBA projects. Question is how to access the limited fund and make it a more complimentary one?

- E. Existing NAPA should incorporate projects related to CBA with adequate funding provisions. A National CBA plan approved by the government following community-based consultation may help accessing funds from the government and the donors;
- F. Mainstreaming CBA in macro and micro level plans, sectoral plans and policies is a big challenge. It could be only possible, if NAPA incorporates CBA related projects based on stakeholders consultation;
- G. Scientific confirmations of the CBA projects would help mobilizing resources. Some donors, such as the World Bank, have called for a greater involvement of official scientific assessments of climate change before using climate change funds for community-based adaptation;
- H. Developing countries called for the measurable, reportable, and verifiable use of new and additional funding for climate change-specific activities (as opposed to more general resilience building). Similar to LDC Fund, discussions are to continue on how to access the fund for CBA projects;
- I. Coastal communities are often marginalized, live in remote areas and receive limited services or support from the government. Reaching the hundreds of millions of people in them will be an immense challenge for any international or national funding mechanisms; and
- J. Accessing vulnerable local communities is a big challenge. The participatory process needs to be documented. Moreover, successful CBA projects needed are to be documented as well as promoted and projected in order to access local and global funds.

14.10. Conclusion

CBA programme has to be people-centred, process oriented, community led, knowledge oriented, empowerment focused and accountability driven. Bangladesh may decrease death and damages in the face of cyclones and tidal surges to a great extent by adopting and intensifying the preparedness programs based on age-old adaptation measures. Number of deaths during the cyclone Sidr in 2007 was 3,363, during Aila in 2009 it was 190 and only 6 people died during *Mora* in 2017 (Source: Bangladesh Met Office). As the country continues to experience frequent climate-induced disasters, local community, especially in the coastal areas in the south, is found to have developed many innovative adaptation practices, which are location-specific and very appropriate in addressing the disasters.

Promotion of Community-Based Adaptation is a painstaking process, requiring continuous research and development in consultation with the vulnerable communities. Support of the government and the development partners is necessary in order to develop successful models concerning CBA. Various initiatives undertaken by local and international NGOs and research bodies are to continue mainstreaming CBA in all plans and policies at national

and global levels. As the community-based adaptation community grows in size and significance, it is likely that the lessons learned from the increasing number of case studies will begin to permeate the climate change negotiations and help create a better understanding of how to build resilience for the most vulnerable communities.

There is a felt need to develop a robust CBA knowledge management system. Currently, there is a Climate Change Cell at the Department of Environment, It could be a storehouse of knowledge generated on climate change, climate variability, climate resilience and community-based adaptation measures stored in various sectors of development. A single and common platform is badly needed to disseminate CBA related information in a user-friendly way. Different organizations and institutions involved in CBA activities need an easy way to disseminate their data. Since CBA measures remain mostly undocumented, it is hoped that an integrated system will be developed to identify the knowledge gaps and bridge the gaps for its efficient use by all the stakeholders.

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Community-based Adaptation to Climate Change: A Case of Community Forestry Program of Nepal

Nirmal Kumar Bishokarma

Abstract

Community forestry program is a major community based climate change adaptation (CBCCA) and potential mitigation mechanism, practiced in Nepal. This paper argues that the program is suitable mechanism for planned, decentralized, cost effective, linked and inclusive adaptation strategies. However, exclusion persists in the group as well as limitation on extraction of forest products in some instances undermining the livelihoods strategies of the forest dependent houses limiting their adaptation capacity. This program also promotes entry points for pro-poor mitigation strategies especially through REDD (Reducing Emission through Deforestation and Degradation of forest) because of increased growing stock of forest and established resource distribution system. However, the significant issues of highly politicized executive committees of CFUGs, high value forest trees and land tenure conflicts does not favor the protection, management and conservation of forest. There is a need of integrating approach in the guideline of constitutions and operational plan preparation process.

Keywords: Community Forestry, Climate Change, Adaptation, Mitigation, Exclusion

15.1. Context

Much evidence shows that community-based adaptation activities are more sustainable practices in developing countries (EC, 2008; Elasha and Parrotta, 2009). Nepal's National Adaptation Plan for Action (NAPA) 2010 and Climate Change Policy 2011 have given high emphasize on the community based adaptation activities to address the negative impacts of climate change in Nepal. The documents focus on integrated management of agriculture, watershed, water, forest and biodiversity as the most prioritized adaptation strategy

(MOE, 2010). These documents also envisioned that these are the appropriate way to formulate and implement low carbon economic development strategies that support climate-resilient socio-economic development of country (Regmi and Bhandari, 2013). In these regards, Nepal considers community forestry program as the most viable community based adaptation strategy. Many finding show this program is an important mechanism for increasing the adaptive capacity of rural population (Bernier and Schoene, 2009). Therefore, community forestry program of country has important adaptation components at policy and practice. This program is also important for carbon financing because it plays important role in conserving integrated ecosystem services (Shrestha and Gautam, 2014).

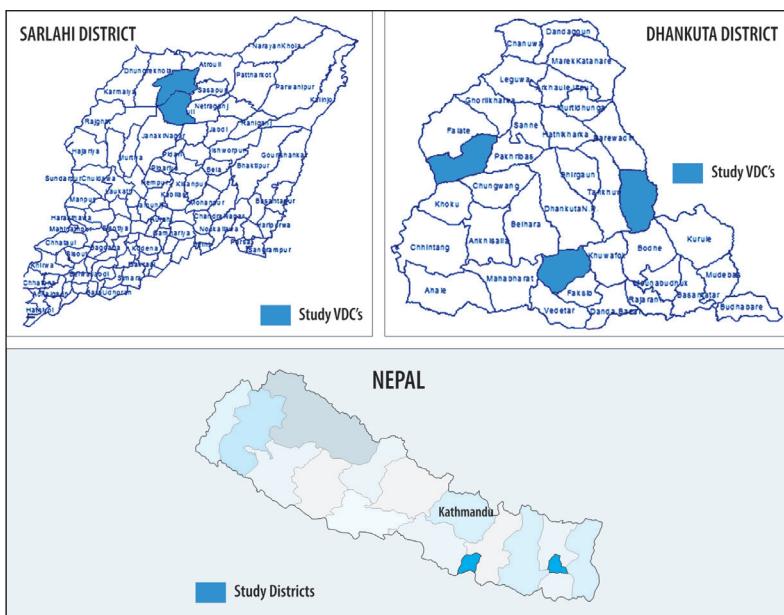
Community forestry has been underway in Nepal since 1980 under which a part of national forest is handed over to local forest user groups. These Community Forest User Groups (CFUGs) are considered self regulated and autonomous institutions in the rural area. According to recent progress report of DoF (Department of Forest), there are 17685 CFUGs who are managing around 1.65 million hectares of forest in Nepal (DoF, 2016). These groups include 2.2 million households which is about 50% of total population of country.

The CFUGs supported by the then Livelihoods and Forestry Program of DFID/UK, world Bank, CARE Nepal, Practical Action and WWF (World Wildlife Fund) have been initiated some planned community based adaptation practices. They do participatory vulnerability assessment, identification and implementation of ranges of adaptation activities and capacity building of their members. However, there is very little knowledge about the process they adopted to make the plan and its implementation as well as current conditions of the adaptation process. Therefore, this study attempts to analyze and document what the members of CFUG perceive to climate change and its impacts on their well being, how they adapted autonomously, what is the process of planned adaptation, its strength and limitations. This article also attempts to document the current and potential synergy between community forestry and mitigation strategies particularly of REDD (Reducing Emission through Deforestation and Degradation) mechanism.

15.2. Study Methodology

This study is conducted in six Community Forestry User Groups. Three CFUGs are Dumre Sanne, Pathibhara, and Dhap CFUG of Dhankuta district of mid hills of the eastern development region of Nepal supported by DFID-UK. And other CFUGs are Sibeswor, Bishnupur and Balanga of Sarlahi district of central development region of Nepal supported by CARE Nepal (Map- 15.1).

This is an exploratory study, used qualitative methods of data collection. Participatory methods such as focus group discussions and key informant interviews using checklist, ranking, timeline, Venn diagram, relationship



Map– 15.1: Location of Study Areas

and resource mapping tools were used to collect the data in Hilly area while extended livelihood profile, ecosystem services change matrix, hazard, vulnerability, and action profile, risk reduction development service profiles and gender role support analysis developed by CARE Nepal used in Terai study area. In addition, the writer used his long experiences including as climate change focal person in DFID-UK supported Livelihoods and Forestry Program to organize this writing. Attempts have made to capture the gender perspective regarding climate change, forest management and livelihood options. The data are analyzed using participatory analysis tools and techniques.

15.3. Community Experience of Climate Change Impacts

Change in temperature: For the last 25 years in the study sites, community members have experienced heat stress in summer season and severe cold in winter season. From last 10 years, the people face critical longer drought (dry season) in summer and winter. Due to drought, the change in the physical and chemical properties of soil has been seen in both sites. The agricultural land is becoming harder, difficult to plough by draft animal as is traditionally done for centuries.

Change in Seasonality: People experience lower amounts of rainfall than before. Rainfall extremes occur during the harvesting period of rice in August and September. Before, there was regular mist for 10-15 days and fog during winter season which is very important for retaining moisture contents in soil needed for wheat and pulses to grow. But there is no such mist now.

Change in Food Security: The cultivation and harvesting of major agricultural crop sifted in an average 15 days later from previous days due change in rain fall patterns. As a result, the production of maize and rice reduced to 30% that of before. The intensive rainfall during the harvesting period (Oct/ Nov) of rice caused the damage of 50% of rice production. Due to winter drought, the cultivation of mustard, wheat and pea cultivation in study area has completely disappeared.

Change in Availability of Forest Products: There is also evidence that the production of fruit trees that give fruit in summer in May/ June (mango, *lichi*, *jamun*, *kusum*) has decreased while the production of fruits that ripens in winter season (Dec/ Jan) like *amla* and *amaro* increased. Due to increasing temperature, the original site of *Chilaune* in Dumre Sanne and *Dalbergia sisso* in Sibeswor sifted uphill sites where traditionally not found. Changes in phenomenology of tree species are also observed in the area. Early shedding of leaf of *Sorea robusta* and *Asna* can be seen in all sites.

Change in Availability of Water: From last 10 years, people have faced critical drought annually. So, there is no existence of traditional well. All wells dried up. However, from last 5 years they also face no water from tube well in Terai. There were 32 tubewells in the sites. Now only two tube wells are providing water regularly due to frequent drought.

15.4. Adaptation to Adverse Impacts of Climate Change

Autonomous Adaptation

Before planned adaptation intervention, communities themselves adjusted their activities with change in climate and their environment and tried to reduce its negative impacts on their livelihoods. For example, they tried to control the floods and land slides in Sibewor, Bishunpur, Pathibhara and Dumresanne CFUGs. They constructed check-dams against the river flow. However, these were not sustainable. It was evidence that the flood of 1993 destructed all physical barriers in Hariban VDC they constructed before. Another drawbacks of these dams were that these were not constructed focusing on the hot spot area and location. Simultaneously, they reduced their number of cattle to cope with scarcity of fodder and grass availability. There were 10 grass lands before hand-over of CF in all areas. As production of grass decreased due to drought and CFUG regulations prohibiting grazing in the forest, community members were forced stall feed, reduced the number of their cattle by 50%. In addition, community members in Terai region constructed three water boring pumps to irrigate land for preparation of seedling bed and plantation to adapt with drought. But these pumps were very expensive to run and maintenance. So, all borings are not usable now.

More noticeably, farmers in Terai region also changed their traditional subsistence farming system to cash crop sugarcane farming which needs less

water and time than rice and maize. The conversion is partially due to the drought and partially due to the establishment of new sugar factory in the area in 1993 and extension services of Government office. The sugarcane farming is beneficial only if there is large track of land, needs at least three years to get benefit from it, needs large investment in machine work, improved insecticides and pesticides and capacity to bear risk. So it hasn't practical adaptation for the poor and marginal farmers. Also, there is price instability and some times factory doesn't pay in time.

Planned Adaptation

To cope with negative impacts of climate change and maladaptation practices they adopted before, local people initiated community led forest resource management. The practice is seen as an adaptation response to reduce the risk and exposure to climatic induced above mentioned natural disasters. For example, before 10 years in Dumre sane, Bisnupur and Sibeswor CFUGs, there was regular danger of floods every year. Some households living in northern side of Bisunpur near to river had displaced due to floods. To save life and livelihoods assets of people, local community did plantation in the forest and grazing land which was later handed over to local user as community forestry. Now, renovation of river is done, location of river sifted and narrowed down. It has made river water more stable and the size of the river is now shrinkage.

Adaptation Plan Preparation

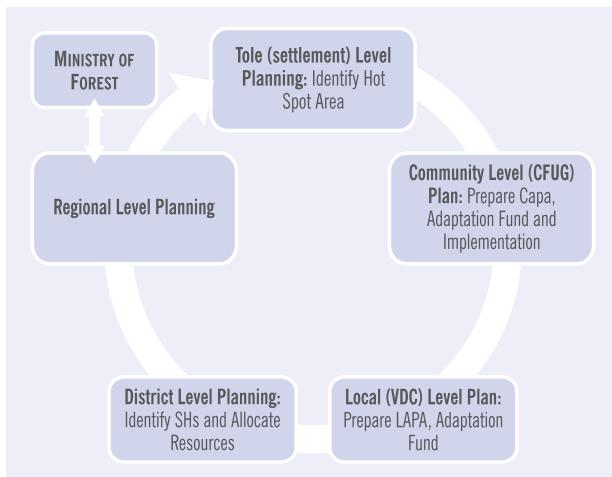
These community forestry user groups initiated the planned adaptation process from last five years. As the adaptation process includes three essential stages: 1) Vulnerability assessment; 2) capacity building; and 3) implementation of adaptation measures (Robledo and Forner, 2005), following are the specific (Figure– 15.1) and general steps the CFUGs have been applying to prepare and implement adaptation plan in the study sites.

Community Level Adaptation Plan (CAPA)

Community Forest User Groups follow bottom up planning process to prepare specific and broader level adaptation plan of the community forest and its members. It includes the individual household and site specific vulnerability assessment and adaptation plan of the community. The identified activities and process are the parts of their regular planning process. These activities are included in operational plan of the groups. Based on the plan, they implement their activities in the groups to adapt to negative impacts of climate change.

Local level Adaptation Plan (LAPA)

The groups in LFP working area have been forming networks at Village Development Committee (VDC) level to coordinate the adaptation activities. These networks have been supporting CFUGs to derive funds from village development committee. Also, 30% CFUGs are leveraging resources from other organization themselves including VDC fund. All networks in LFP working area have been preparing local adaptation plan at VDC level. These



Figure– 15.1:Community based Adaptation Cycle in Dhankuta

networks also organize village level awareness program to their members about climate change and its impacts. However, in CARE supported areas it is lacking and it is performed by FECOFUN (Federations of Community Forestry User Groups, Nepal) committee.

Area Level Adaptation Plan (AAPA)

LFP and CARE Nepal have promoted different area level coordination forums to coordinate and synthesize the area (spatial) level forestry and climate change intervention. These forums prepare adaptation plan which primarily identifies hot spot of climate change incidence and major intervention in the area. The plan is primarily prepared based on two major indicators

Poverty index of the Village Development Committee: All CFUGs in the area of LFP and around 90 percent in CARE Nepal area has wealth ranking process which categories all the members of the groups into the poor and non poor categories. Based on the number of poor households at VDC level, the forum prepare poverty index of all VDC.

Poverty Index of the VDC= Number of households of poor people/ Total households in the VDC

Prevalence of Natural Hazards: The forums also compile major climatic incidences i.e. drought, forest fire, land slide and flood occurred from last five years in all VDCs of the area. The VDCs which have higher frequencies of the events get higher score in the analysis.

Implementation of Adaptation Plan

To implement the plan prepared through the participatory way, the CFUGs have established following mechanisms:

Establishment of Community Adaptation Fund at VDC and CFUG Level: Almost 95% of total VDCs (150 out of 158 VDCs) in LFP supported CFUGs have established the adaptation fund. This is matching types of fund and support the adaptation activities included in the plan. Major sources of the fund are grants received from LFP, VDC and CFUGs. There is provision that at least 10% of total fund is allocated through CFUG members. They have prepared fund mobilization guidelines based on which they expend their money. In CARE supported CFUGs, there isn't separate adaptation fund to climate change, however, the CFUGs have poor focused revolving fund that supports the adaption of the poor members.

Linkages of Adaptation Plan with Ongoing CFUG Activities: CFUGs are well established community development institutions in rural area of Nepal. They have their own established structural and financial mechanism. A record shows that they expend 500 million Nepali Rupee annually in development sectors of the country. The adaption activities prepared by the groups are included in their annual plan so as they can expend their fund for the activities.

Inclusion of Adaptation Activities into VDC Plan: CFUGs annually submit their plan into the planning process of local bodies. They prepare the CFUG plan and submit it into the VDC council. The practices attract the VDC fund in forestry development and climate change adaptation activities.

15.5. Capacity Building of the Team and Members

Livelihoods and Forestry Program (LFP) and CARE Nepal build the capacity of community forestry user groups. They have prepared local resource person who support in adaptation plan preparation process of the networks and community. Simultaneously, they regularly coach and build the capacity of the community members.

Strength of Community Forestry based Adaptation

Community Forestry User Groups provide resources including opportunities of income to the most vulnerable sections of the groups to adapt with negative impacts of climate change. In this regard, all studied CFUGs allocated some parts of forest land to the poor to cultivate improved grass and fruits to generate income. They are also providing revolving fund to them to purchase goat for income earning opportunities. For example, Sibeswor CFUG allocated 15 hectare land for grass cultivation to 220 poor households in compensation to controlled grazing.

The groups are developing themselves as rural financial institutions recently. They provide loan to their members in low interest rate. CFUGs provide loan in 6% interest rate to its members in all sites. The fund mobilization systems in the groups are becoming more equitable in recent times. They have clear guideline to mobilize their fund guided through government's CF (Community

Forestry) guidelines 2007. Accordingly, they expended 25% of their total fund in forest management activities and 35% in poor focused activities like income generation activities and 40% fund in operation and development cost.

Furthermore, CFUGs are providing platform for organization, information dissemination and social capital development of the marginal communities. They follow bottom up process to make their constitutions and operational plan crossing the step of household survey, group discussion including focus group and general assembly. Also, the representation in community forestry users committee comes from all settlement, social and economic categories who can share the information easily to their members. The CFUG process supports actual analysis of climate change vulnerability suit with local people and geography.

Moreover, CFUGs are entry points for wider service delivery. Community forestry user groups have wider linkages with most of the state, local government, NGOs and market institutions working in the area. These development organizations are implementing their services through community forestry user groups. For example NGOs like Bagmati Sewa Samaj implemented saving and credit program, Churia Jaladhar Conservation project has supported goat farming, Dabar Nepal implemented forest based enterprise in Terai region.

15.6. Barriers to Adaptation

There are some community forestry practices that may undermine the adaptation from climate change and can encourage maladaptation practices.

Membership Exclusion: To gain benefits from community forestry, it is necessary to be a member of CFUGs. It is found that during the community forestry hand over process; some households who traditionally used the forest have not been well informed otherwise excluded from the membership processes at that time. Their traditional forest use practices have thus been criminalized. They need to steal the forest product either from the community forest or from national forest. On the other hand, there are the rich households in all CFUGs and they become members of two or more CF.

Restrictions on Forest Product Extraction: After the formation of community forest and accompanying regulations, traditional practices such as grazing of livestock in forest areas, cutting green timber and fuel wood and collection of NTFPs have been completely prohibited. For the rich people, they have tree in private land. But, it is very difficult to households who traditionally live by selling fuel wood in local market, making furniture, and local alcohol that requires timber and more fuel. At a time, prohibition on collection of NTFPs cause to disappearing of the occupation of traditional healer who are mostly from indigenous community.

Exclusion in Decision Making Process: It is issue there that the decision making process is dominated by high caste male. Though there is well

participation of all categories of households in committee, mostly the decisions are made by them informally and submit to the committee for formality. It very much appears that the equity provisions particularly around gender are followed in theory but not in practice. There is token female representation but all decisions made by a proxy ‘sub-committee’ of men.

VDC and Ward Debate: In each VDC structure, there are 9 wards. Though the political unit is not directly related to the delineation and formation of the CFUG, the forests are generally demarcated on the basis of political boundaries. In Hariwan VDC, there are 6 settlements out of nine who have community forest. Three remaining wards have no forests which are residence of religious minority groups (Muslim) and of indigenous people (Tamang). There are 1150 such household not members in CFUGs.

Diverse Forest Growing Stock: All CF are not equal in area, forest species and growing stock. In Balganga and Sibeswor there are good quality high valued tree species which has potentialities of good earning for the groups. In other hand, in some CFUG, the forest is large but users are less which creates difficult to manage the forest. However, it has potentialities to fulfill the demands of forest dependent people if the forest is managed sustainably. But it is very difficult to full the demands of its members particularly of the poor if the forest is small and the population is large.

15.7. Synergy between Community Forestry and Mitigation

Current and Potentialities

There are arguments that adaptation to climate change and mitigation are often linked together to provide greater benefit to the people ((Bernier and Schoene, 2009)). Sustainable forest management is essential for reducing the vulnerability of forests to climate change (Elasha and Parrotta, 2009)). In these regards, CFUGs support in reducing green house gas emission, increasing carbon sequestration and enhancing carbon stocks.

There is evidence that community forestry significantly contributed to increase the Nepal’s forest stocks (Pokharel and Byrne, 2009)). In order to enhance forest conservation and ecosystem-services a number of measures are reflected in CFUG regulations. These include efforts by grazing control, control of illegal cutting, and plantation in barren land. Also, they made fire line, forest road, and regular cleaning. The CF observed increase in forest stock of approximately 50% since the handing over of the CF. In the study sites of Sibeswor and Bishunpur, the community forests were deforested at the time of hand over. The communities initiated plantations in the forest areas with current well vigor forest resulting. The community claims it would have been entirely degraded if it had not been handed over to the local community. There is evidence that community forestry can be highly effective both in maintaining the quality of forests, and importantly in the context of REDD+, generally

more effective in sequestering carbon (MOFSC, 2011). In addition, it has and most likely will play a significant role in reducing of green house gas emissions and providing a carbon sink (Adhikari, 2009). It is one of several modalities for the implementation of REDD+ activities (others are plantations and Payment for Environmental Services).

REDD+ and/ or PES (Payment for Environmental Services) mechanisms can contribute to rural development and poverty reduction- ultimately increasing the capacity of people to adapt to climate change. These groups have their own bank account and budgeting process and retain 100% income and use discretion. Services that should be entitlements of the local communities are now being routinely ‘purchased’ from state actors. Also, the CFUGs have the potential to provide alternative livelihoods to forest dependent people if the capacity of forest fully utilized. There are potentialities of employment for wood workers in wood based industries if sustainable timber harvesting was permitted, promoting the livelihoods of the fuel wood collectors through regulating fuel-wood collection or establishment of fuel wood depots in user groups. The Sibeswor and Balganga CFUGs believe that it is possible to increase the quantity of fuel-wood through better forest management practices. They can provide license to the users who qualify as low-income.

Incorporating a strong adaptation element can promote a more pro-poor and people-centered REDD+. It can address both livelihood issues for forest dependent people and carbon sequestration simultaneously. For example plantation of fast growing species and bamboo in river side area will increased carbon sequestration in one hand while it provides employment in forest based enterprise for the forest dependent people.

15.8. Potential Conflicts between Adaptation, CF and REDD+

In spite of the great potential for CF to serve as a bridge enhancing both adaptation and mitigation, it also presents some limiting issues.

Political Problems: In some CFUGs, the user groups are becoming fora for political identification and competition. As CF as an institution has power over resource access and use and is an important instrument in organizing the community, it is very important forum and mechanism to capture the resources and extend their political agenda of political parties. In Sibeswor community forestry user group it was found that the key posts of CFUGC were allocated based on the political affiliation. Also, there is bias based on political ideology in distribution of timber products.

High Value Timber Forest: The opportunity costs of conservation of timber and other valued products are significantly higher. In the Terai, to generate income, timber products are sold outside of the CFUGs. Operational plans of community forestry are often made in the interest of traders how much needs to them to be included in the plan. Due to this problem, government now bans entirely the cutting of green trees in Terai. Same case is found in Pathibhara

CFUG where high valued pine for rosin and turpentine are sold in market. As there are potentialities of earning more income from the sale of timber products, it will reduce the interest of the groups going towards REDD+.

Problem of Landlessness: Multiple studies illustrate where there is no or insecure tenure, there is little incentive for communities to maintain forests and thus is accompanied by deforestation. Landless people in Terai are forming the networks of landlessness people and organizing campaign to convert forest to agricultural land on the basis of demanding livelihoods primarily? Unless there is some process of land reform or otherwise recognizing land access rights, it will be very difficult to mitigate drivers of deforestation and threats to CF. In Sibeswor community forest, there are 100 households of indigenous landless people living inside the forest. Without focusing their demands and needs, it is very difficult to build consensus on REDD+.

Issues of Land Tenure: There are varieties of land tenure issues in community forestry. The community forestry program provides tenure to access and use right to forest product. It doesn't provide land tenure to the community which rests on government. So, the communities are not confident to invest in forest development. The operation plan of community forest in the study sites are made for five years. To extend their right it needs to receive approval from DFO. In these regards, the question of carbon right is very critical. Also, there are issues of long distance user, collaborative forest management and private forest development.

15.9. Recommendations and Ways Forward

Community forestry program is a major community based climate change adaptation (CBCCA) and potential mitigation mechanism, practiced in Nepal. Before planned adaptation intervention of community forestry, communities themselves adjusted their activities with change in climate and their environment and tried to reduce its negative impacts on their livelihoods. There are some community forestry practices that may undermine the adaptation from climate change and can encourage maladaptation practices. Based on the study, the following interventions are necessary to minimize the maladaptation.

CBA (Community Based Approach) and assessments needs to mainstream and internalized in the process of constitutions and operational plan preparation and the bottom up planning process. Climate change sensitive forest management guidelines needs to developed and linked with DFO and national level forestry activities. To minimize the exclusionary decision making process different sub committee of *dalits*, indigenous community and the poor may effective which can influence the decision making process of main committee of community forest user groups.

Financial resources are very important for increasing the adaptive capacity of the vulnerable communities. Therefore, the role of CFUGs or other credible local institutions should be linked with sources of credit and low-interest loans. CFUG needs to expend fund from 35% budget of poor focused activities in

the provision of improved cooking stoves, biogas, and beehive briquette that increase their adaptive capacity.

There is a need for collaboration between the DFOs, local bodies of governance i.e. DDC/ VDC and CF federations such as FECOFUN, about field level REDD+ awareness raising and training. With the support of national federations such as FECOFUN, CF has been promoting the establishment of Local Resource Persons (LRP). Having a locally-based individual familiar with the local context and with basic knowledge on mitigation and adaptation, they are important to outreach and the development of local-level capacity. These community forestry stakeholders should undertake experiential marketing of forest carbon in a volunteer market. The volunteer market may be flexible, smaller and medium sized projects, it is also suitable in the context of community forestry of Nepal. Simultaneously, there is potentialities of down and upward PES mechanism within the community where the people from low land should provide some payment to the people of *Churia*.

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Exploring Cross-Sectoral Adaptation Challenges in the Coastal Areas of Bangladesh

Abstract

Shamima Akter Shanu and Md. Saidur Rahman

The south-western coastal people of Bangladesh are always stressed with historically changing climate and environment. To cope with this mutable situation, these people initiated different adaptation practices, and the multiple stakeholders' challenges related to this practices are poorly explored. In this study, we followed bottom-up approach to reconnoiter local adaptation challenges from Shyamnagar upazilla at Satkhira district. High salinity, cyclone and high temperatures are the prominent drivers to exert numerous challenges to the specific adaptation practices. The most quintessential challenges for shrimp farming, crab farming and rice farming are unstable market, scarcity of crab fry and lack of fresh water, respectively. The main challenge for getting GO support is the lobbying, whereas those received from NGOs are short term support and they stress on high profit return. The GO officers face lack of logistic support and NGOs activities are mostly crisscrossed by political influences, posing extreme challenges. Eliminating or reducing challenges faced by local actors are crucial for developing long term climate-resilient adaptation planning.

Keywords: Climate Change, Adaptation Challenges, Social Inequality, DPSIR Framework

16.1. Introduction

Around the world, coast is a unique and valuable natural ecosystem for countless benefits. In Bangladesh, coastal area has a great contribution for socio-economic development of the country as it supports 50 million people, about 30% of total population (Cash et al., 2014). Because of low-lying geographical setting, almost every year, these people are experiencing with frequent cyclone, storm surge and sea level rise (Huq & Rabbani, 2014).

This coastal area is under stress with multiple natural hazards, environmental degradation, socio-economic issues e.g. continuous shrimp farming on agricultural land, weak governance of institutions, high base vulnerabilities of people, and inadequate governance at community, local and national level (Mahmuduzzaman et al., 2014).

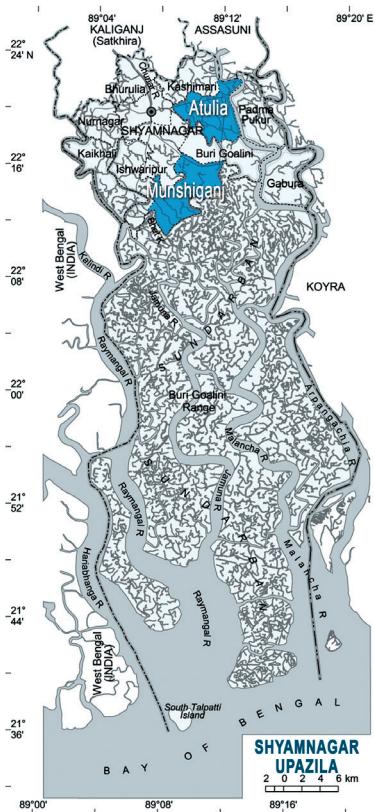
South-western coastal people of Bangladesh are adjusting with the mutable situation by addressing numerous adaptation strategies. To adapt with this changing condition, most of the farmers have already changed their cropping pattern (Minar et al., 2013). In a changing climate and environment, adaptation is highly challenging as many stakeholders are anchored in decision making and implementation activities and these are mainly regulated by top-down approach (Srinivasan, 2012; Humphreys et al., 2015). Adaptation challenges are basically barriers and limits, where barriers are defined as obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, institutions, etc. This adaptation barrier differs from adaptation limit that can be overcome through technological innovations (Adger et al., 2007). In this study, we refer adaptation challenges comprising both barriers and limits. Bottom-up approach is required to bridge the gap between policy maker and adaptation challenges faced local community. It is urgent to incorporate local experiences with long term climate resilient adaptation planning and sustainable development (Shameem et al., 2015).

This paper examines the cross-sectoral adaptation challenge faced by multiple actors in south-western coastal area of Bangladesh. The objectives of this study can be met by answering the following questions: Firstly, what are the existing climatic and environmental events fostering local people for adaptation practices? Secondly, what are the existing adaptation strategies practiced by the local people? Finally, how do adaptation challenges differ among different stakeholders?

16.2. Materials and Methods

Study Area

This study was conducted in four villages (South Kadamtala, Kultali, Naobeki and Henbchi) of Shymnagar Upazila (sub-district) in south western district, Satkhira of Bangladesh from September to December, 2015. The upazila is located between 22°36' and 22°24' north latitudes and between 89°00' and 89°19' east longitudes (BBS, 2016). The upazila has an area of 1,968 sq. km. from which 78% is covered by the mangrove forest, The Sundarbans. It is the largest upazila in terms of area and the second largest in terms of population of Bangladesh. The upazila consists of 13 unions, of which two unions, Munshiganj and Atulia were taken for this study (Map- 16.1) (BBS, 2016).



Map- 16.1: The Study Areas

includes all the steps taken to overcome the impact in the natural system.

16.3. Research Design

We used both primary and secondary data, where primary data were collected through quantitative and qualitative methods, whereas secondary data were taken from different scientific articles, international reports and the internet. Quantitative data were gathered from household survey from four villages and qualitative data source was focus group discussions with community people and in-depth-interviews with different officials and academicians, who have practical experiences about the area.

Household Data Collection

A reconnaissance survey was conducted in the study area in order to get insights about the existing situation of the area. The objectives of this reconnaissance survey were i) to get an idea about socio-economic condition,

DPSIR Framework

DPSIR stands for driving forces-pressure -state- impact- response framework for structuring the connections between environment, economic and social system (Figure- 61.1). This framework is a robust and integrative approach and it works as a scheme for finding inter-relationships between human and environment to understand ecosystem structure and functioning (Ness et al., 2010, Pinto et al., 2013). Driving forces comprises mainly the basic needs of the people to survive in the world and these needs initiate some human intervention to the natural systems exerting disturbances. The natural and human manipulation of the natural system creates condition unsuitable for human being, is regarded as pressures. Due to pressure the people are bound to take some modifications in physical, chemical and biological condition, which are considered as state. The state brings some changes in the physical, chemical and biological conditions and these are treated as impact and the response

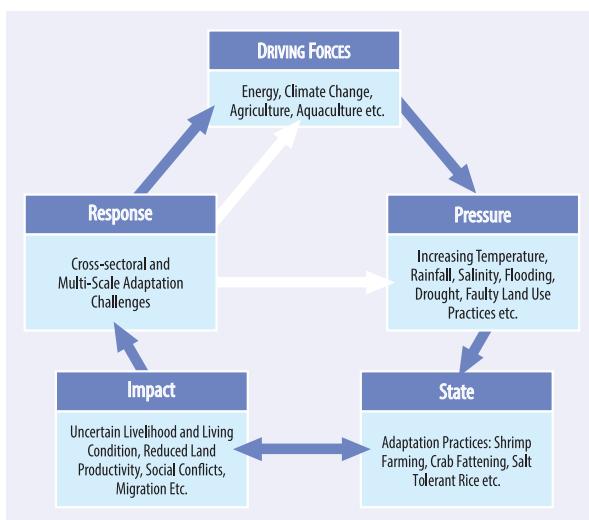
adaptation practices along with challenges in the area, and ii) to test the draft questionnaire survey and finalize the questionnaire for data collection. Based on the reconnaissance and draft questionnaire survey, the questionnaire was finalized. The questionnaire was semi-structured and consisted of several open and closed questions and followed the DPSIR framework to get the interrelationship about environment and human activities.

Forty-four selected households were surveyed randomly for primary data from four villages. Through this survey, the socio-economic status (education, profession, income sources) of respondents and individual adaptation challenges were explored. Qualitative data source was FGD and in-depth-interviews with resource persons. Four focus group discussions (FGD) were conducted in each village. About 8-10 people were participate in FGD, where community people joined to share their opinions. After getting farmer's opinions, nine resource persons (three Govt. officials, two NGOs professionals and four academicians) who had working experience in this area.

16.4. Results and Discussion

DPSIR Framework

From the household data, we explored DPSIR framework for our study area. To fulfill the basic need, the respondents are dependent on different sectors like energy, environment, agriculture etc. are considered as main driving forces of the area. Driving forces lead people to implement various activities that exert pressures (e.g. increasing salinity, temperature, rainfall, cyclone, drought, flooding etc.) in the area. These pressures trigger local people to generate various adaptation practices to cope with changing climate and environment.



Figure– 16.1: DPSIR Framework for Southwestern Coastal Area of Bangladesh

In the study area, existing adaptation practices are shrimp production, crab fattening, salt tolerant rice etc. represent the State of the study area. Therefore, different impacts (e.g. unsustainable adaptation practices, social conflicts, migration, health problems like malnutrition and diseases) take place and community people respond with different cross-sectoral adaptation challenges that also influence driving forces and pressures (Figure– 16.1).

General Characteristics of Residents

The general demographic and socio-economic characteristics of the 44 surveyed households are summarized in Table– 16.1. The average age of respondents is around 47–48 years, where Muslim men are dominant. More than half of the interviewed respondents completed primary school and just over a quarter remained as illiterate. Only 15% respondents completed their secondary education. On an average, the households consist of seven people, of which two (usually men) are responsible for income.

Table– 16.1: Demographic and Socio-Economic Characteristics of the Respondents

Demographic and Socio-economic Characteristics	Parameter	Per cent
Percentage female respondents in sample		31.8
Respondent average age (median value)		47.5 (51)
Respondent religion (%)	Muslim	81.0
	Hindu	19.0
Literacy rate (respondent) (%)	Illiterate	28.7
	Primary school	55.4
	High school	15.9
Respondent Occupation (%) (multiple response)	Agriculture	19.5
	Shrimp Production	81.1
	Business	11.3
	Sundarbans	55.4
Average number of family members (min–max)		6.5 (5-10)
Average number of earning members (min–max)		1.8 (1-3)
Average size land owned by household (ha)		1.5
Average household income (US \$/year) (St. dev.)		3960 (5117)
Average per capita income (US \$/year) (St. dev.)		514 (619)
Income inequality (Gini coefficient)		0.59
Percentage with solar electricity		72.8
Average number of livestock (min–max)		8.5 (3-14)
Average number of trees in homegarden		6.3 (3-14)

Over 80% households are involved with shrimp production, either directly or indirectly, in their own/ leased land or business. More than half of the households are dependent on nearby Sundarbans for collecting shrimp and crab fry, fishes, fuel-wood or non-timber forest products such as honey, nypa palm leaves etc. In the surveyed households, about three-quarter of the respondents use solar electricity, however there is no electricity connection from national grid. The rest of them use lamps fueled by kerosene (paraffin). The average annual household income varies considerably (high standard deviation) and income inequality is high in the sample population (high Gini coefficient (0.59). The average annual per capita income is US\$ 514, which is significantly lower than the national average (US\$ 1466) (BBS, 2016).

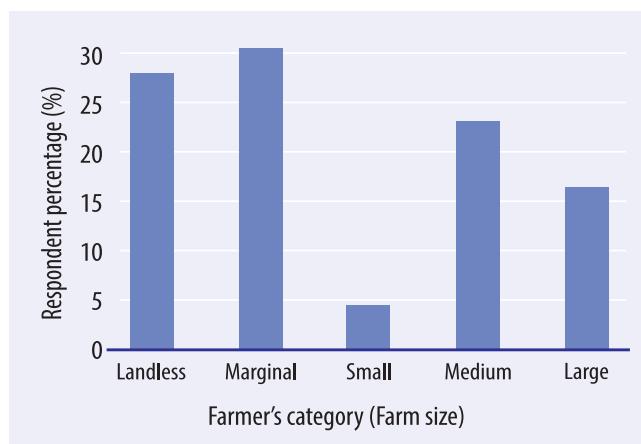
16.5. Existing Pressure in the Area

The findings of the survey indicate that about 91% respondents perceived high salinity as the main challenges in the area. Approximately 80% people also identified cyclone and high temperature as the key pressures whereas others mentioned that erratic rainfall, drought and flood as remaining pressures, however the percentage is significantly lower than the previous findings (Table- 16.2).

Table- 16.2: Existing Drivers for Adaptation Practices

Climatic and Environmental Variables	Men n= 30	Women n= 14	Total n= 44
High Salinity	26 (59.3)	14 (31.8)	40 (90.9)
Cyclone	24 (54.5)	12 (27.3)	36 (81.8)
High temperature	25 (56.8)	10 (22.7)	35 (79.5)
Erratic rainfall	12 (27.3)	3 (6.8)	15 (34.1)
Drought	3 (6.8)	3 (6.8)	6 (13.6)
Flood	4 (9.1)	2 (4.5)	6 (13.6)

There is clear differentiation between men and women about the perception to different pressures in our studied area. All the surveyed women (100%) identified high salinity as the main challenge during their domestic activities. Those farmers who claimed high salinity is the main pressure, were subsequently asked the causes for high salinity in that area and the respondents mostly identified three causes: increased cyclone, shrimp farming and upstream water reduction. About one-third of the farmers also perceived increased temperature, tidal water and river salinity as the probable cause of high salinity in this area. All the respondents agreed that this salinity varies with the season, and it decreases in wet season (June – November) because of high precipitation and more upstream fresh water through the river, and increases in dry season (December– May).



Graph- 16.1: Farmers' Category According to the Owned Farm Size

16.6. State of the Area

Above 60% respondents have their own land for cultivation and homesteads, whereas 20% respondents rented lands for shrimp production. More than 15% respondents are involved with shrimp and crab business. Despite having some lands, about half of the respondents are dependent on nearby Sundarbans for collecting fish, crab or shrimp fry, fuel wood, honey etc.

Table- 16.3: Existing Adaptation Practices in the Study Areas

Adaptation Practices	No. of Respondents (N)	Percentage of Cases (%)
Shrimp production	17	48.7
Shrimp and crab production	9	25.0
Salt tolerant rice production	9	25.0
Vegetables in raised area	9	25.0
Vegetables cultivation in bag	8	22.2
Roof top vegetables	8	22.2
Goat farming	8	22.2
Livestock in raised area	5	13.9
Integrated aquaculture with rice	3	8.3
Monosex fish cultivation	3	8.3
Crab production	2	5.6
Integrated aquaculture with rice and vegetables	1	2.8
Dyke plantation	1	2.8
Banana cultivation	1	2.8
Sour fruit horticulture	1	2.8
Grass cultivation	1	2.8

Farm size also varies among the farmers, with high percentages of medium-large farmers (about 38%) and landless-marginal farmers (approx. 57%) (Graph- 16.1). According to the national classification of Bangladesh, farmers are categorized in accordance with the size of the farm (in acre) owned by the respondents: landless (0.00– 0.49), marginal (0.50– 1.49), small (1.50– 2.49), Medium (2.50– 7.49) and large (over 7.50) (MOA, 2003).

Different Adaptation Practices

To overcome the complex situation, respondents preferred different adaptation practices. Due to high salinity and availability of saline water, about half of the respondents preferred shrimp cultivation as one of their main adaptation practices. Because of salt tolerance capacity and quick economic benefit, shrimp farming expanded largely in the last 30 years. Recently, crab is a rising sector in the area and about 6% of respondents practiced crab farming because of high market demand and less virus infections (Table- 16.3).

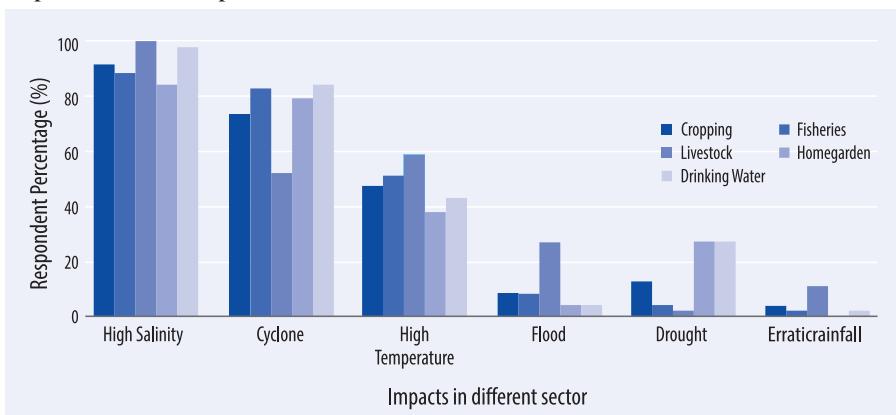
Impact of Adaptation Practices

The respondents were asked to mention the effects of different pressure on different sectors like cropping, fisheries, livestock, home-garden and drinking water. Among all pressures, high salinity, cyclone and high temperature affect largely in all sectors (Graph- 16.2). It is also evident high salinity affects largely and equally to all sectors. The respondents prioritized livestock and drinking water as the high impact sector due to high salinity.

16.7. Adaptation Challenges Faced by Local People

In the studied area, more than 80% respondents are involved with shrimp, which is facing various challenges now. Among 75% respondents mentioned unstable market condition and 60% respondents claimed continuous virus attack

Graph- 16.2: Sectoral Impacts of Different Pressures

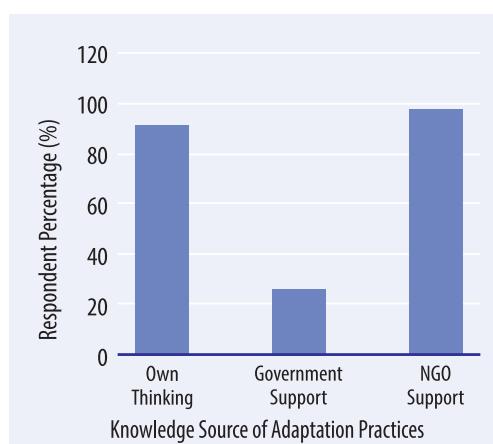


as the crucial challenge for shrimp. One FGD participant mentioned, because of less price they collect shrimp fry from nearby hatchery which have higher chance of being virus infected. One affected fry could disseminate the virus within the whole farm, even to the surrounding farm as well. About 56% respondents revealed higher mortality rate as another challenge, whereas production loss and increasing river salinity were also indicated by the respondents.

Because of these discrete uncertainties of shrimp, many shrimp farmers are interested for crab fattening because of higher market demand. One crab farmer mentioned that crab is more virus resistant than shrimp and required small amount of land and both shrimp and crab can be farmed in same piece of land. Though this crab has a great potentiality, small and marginal farmers are not involved with crab because of high expense. FGD participants claimed that the crucial challenge of crab is the dependency on nearby natural sources (river, forest) that have limited supply of crab fry.

During focus group discussion, one paddy cultivator mentioned that still a percentage of farmers are cultivating paddy for own consumption. The challenges faced during rice farming is high soil salinity and insufficient fresh water during dry season. One old FGD respondent informed that salt tolerant rice varieties can tolerate salt at a certain level and some interested farmers cultivate these rice varieties during rainy season. But, these varieties can not tolerate high salinity during winter time. Availability of saline tolerant seed is also another challenge for paddy farmers. Even they get limited or no advisory support from local Government office for paddy cultivation.

From the field survey, 80% respondents mentioned, they themselves are the main contributor for initiating different adaptation practices whereas, more than 85% respondents mentioned, local NGOs are providing supports (water reservoir, fertilizer, seed, solar panel, chicken, fish fry, goat, loan) that are product based and GO's support is mainly allowance based (Graph- 16.3). A very few percentage of people got training from the local Govt. office as well.



Graph- 16.3: Sources of Knowledge on Different Adaptation Practices

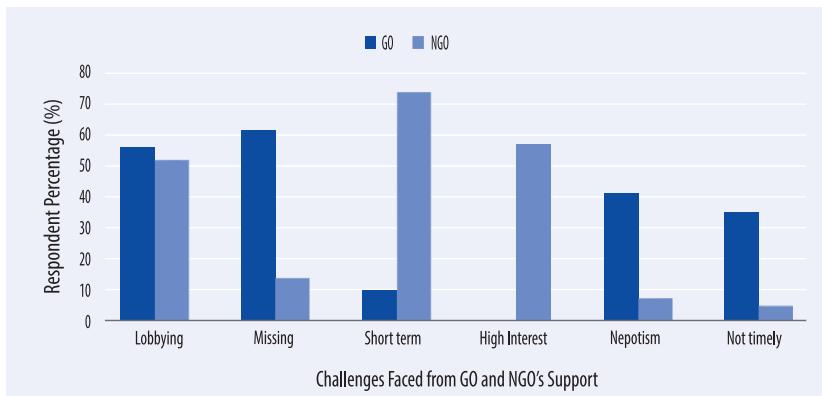
Table– 16.4: Type of GO's and NGO's Supports

NGO's Support	No. of Respondents	GO's Support	No. of Respondents
Loan	28 (71.8)	Rice	29 (90.6)
Water reservoir	19 (48.7)	Allowance	14 (43.8)
Fertilizer	14 (12.8)	Training	1 (3.1)
Seed	13 (11.9)		
Solar electricity	12 (11.0)		
Chicken	12 (11.0)		
Fish fry	7 (6.4)		
Goat	4 (3.7)		
Total	109 (279.5)		44 (137.5)

The FGD participants claimed, they always face challenges while getting supports from GO's and NGOs. More than 50% respondents claimed lobbying as the main challenge during getting supports from GOs and NGOs (see Graph– 16.4). About 70% respondents mentioned drawback of NGO's support is for a short span of time i.e. too short to implement any activity. However, 50% respondent claimed high interest rate for loan is another important challenge faced from NGO's supports.

On the other hand, 30% respondent faced challenges with GO's support as not being timely. In the study area, women are experienced with lots of challenges. More than 45% respondents mentioned uncertain livelihood is their main challenge and their earning mainly depend on nearby Sundarbans forest. At the same time, they are also responsible for collecting drinking water from far distance, almost 8 or 9 kilometers for bringing a jar of water. Thus, women are suffering from bone pain (15%), malnutrition (25%), skin diseases (30%). About 25% women respondent claimed that their husbands already migrated outside for searching job.

Graph– 16.4: Adaptation Challenges from GO's and NGO's Supports



16.8. Challenges Faced by GOs and NGOs Professionals

Both GO and NGO professionals face challenges during implementing their activities. Three upazilla officers (agriculture, fisheries and forest officer) were interviewed to know the challenges that they face during implementing adaptation activities. They mentioned lack of resources (fund, technical support, manpower etc.) as their challenges. According to upazilla Fisheries officer, though the environment is very much favorable for shrimp farming but the sector is under threat because of traditional farming. To overcome the situation, many training programs are arranged by the local Govt. office but farmers do not attend the training because of less/no monetary benefits. He also added that most of the farmers follow less expensive way of farming without following scientific measures (water height, dyke height, soil and water salinity) that are mandatory for long term shrimp farming. The upazilla forest officer mentioned, along with resources (fund, manpower) problem, inadequate research/piloting of any big project lead to implementation failure. One NGO official mentioned, they are forced by local political leaders to include their recommended person instead of their target group. Sometimes they also challenged with high local demand that hinder their activities.

One environmentalist from Khulna University stated that salinity is not an individual element in the coast rather an effect of many interactions of environmental components and it should consider as a vital issue of coastal management. To withstand this increasing salinity, land zoning for different adaptation practice might be an important option for coastal adaptation planning. He also mentioned that increasing embankment's height is also a good option to protect the coastal area, but it is very much expensive rarely possible to construct. Tidal river management can be an effective option to increase land height naturally by using tidal forces.

The fisheries academician explained that environment of the coastal area is very suitable for shrimp farming and it has high market demand that possess greater prospects for future. For long term shrimp farming, scientific shrimp farming is essential but the farmers follow traditional shrimp farming that negatively affects the whole environment. Instead of traditional farming, semi-intensive scientific farming should be introduced among the farmers to increase the longevity of the shrimp farming. He also mentioned that though crab fattening holds greater possibility but sources for crab fry are limited.

According to the biodiversity point of view, the coastal areas are now more economically sound but they are living in a very poor environment as there is scarcity of common water. On the other hand, Biodiversity in this area is decreasing day by day because of rapid conversion of rice farm into shrimp. Due to decreasing rice field, domestic animals (cock, hen, cow, goat and birds) are also decreasing, because of insufficient fodder and food/ green plantation. Both economic and environmental assessment is necessary to make a good balance among different components of the coastal ecosystem. He also added that rice researchers should continue their research for growing more saline resistant rice

verities, so that farmers will be interested for rice cultivation. Another expert suggested that, the physical environment of the area is complex and NGO's are implementing their projects activities without performing any need assessment or small scale piloting. They are involved in implementing a lot of activities to develop the area with a blink of eye, but without mental development, no development activities will be sustainable. Moreover, because of many NGO's involvements, relief-mentality developed among the local people.

16.9. Discussions

From survey data analysis and FGD, numerous adaptation practices are being implemented in the study area to cope with the changing situation. Because of favorable environment and economic benefit, shrimp farming became widely practiced adaptation option. Within the last three decades, most of the farmers changed their rice land into shrimp farm. In recent time, along with shrimp farming, crab fattening has become another vital adaptation practice. Field findings suggested that crab has market demand and more salt tolerance capacity than shrimp, a remarkable percentage of shrimp farmers already got involved with crab sector. Although, having unfavorable environmental condition, still a quarter of the respondents are involved with rice farming by changing cultivation time and crop verities. During rainy season, they store rainwater and cultivate salt tolerant rice varieties (BR 30, BR 28, BR 10) instead of local rice varieties (*Patnai, Geti dhan, kajrangi, durba, najir shyel*), because traditional rice has less or no salt tolerant capacity and lower production in comparison to salt tolerant rice varieties.

The study explored that every sector is stressed with ongoing climate and environmental challenges. Although shrimp farmers are now facing challenges (unstable market, production loss, virus attack, mortality rate), still large and medium categories of farmers preferred shrimp farming with expensive crab fattening. At the same time, these categories of farmers are not interested for rice farming whereas small and lower medium farmers are practicing rice in their field. It is clear from the research findings that adaptation practice varies among farmers. It may be because of inequality in land ownership and socio-economic condition. Farmers, having more resources (land), have more capacity to take instant challenge and to invest for future farming whereas, small and medium farmers have less capacity for shrimp farming and highly dependent on their own crops. One recent study by Swapan & Gavin (2011) suggested that rich farmers and outside entrepreneurs' controls coastal land more than 15 times that of small-marginal farmers, and 71% people do not have any authority over land practice in coastal area. Paul & Røskift (2013) suggested that variation in different adaptation options increase complexity among different groups and creates social conflicts through powerful hierarchical shrimp farmer's society.

Farmers, living in the study area not only face challenges from changing environment but also from getting GO's and NGO's supports. From our

findings, most of the respondents mentioned, NGO's are providing supports for implementing new adaptation practices, but most of the activities are short-timed and market oriented that creates challenges for the farmers. The Govt. has limited activities for implementing new adaptation practices and mostly focused on allowances. On the other hand, both GO and NGO's professional are also facing challenges to implement adaptation practices because of limited manpower and inadequate resources availability. Mitchell, et al (2015) mentioned limited capacity of government is the central challenge that creates governance problem for the whole system through inappropriate land-use planning and management.

The overall context of coastal area can be represented by using 'challenge and support theory'. According to this theory, for sustainable growth/ development, appropriate support is required to overcome huge challenges (Figure-16.2) (Sanford, 1966).

Here A is used to indicate the level of challenge and B indicates the level of support. If the level of challenges increase, more support is required for long term development. From Our research findings, the study area is associated with unlimited challenges that has arisen not only from climatic events but also from changing environment. To cope with this complex situation, farmers select different adaptation options depending on their own ability and supports from GO and NGO's. Though most of the farmers are well-aware of future challenges but they have less capacity to accept this huge challenges and their response measures stay behind. This is partly due to the farmers' limited efforts, adequate knowledge, cultural mind-set, and the hierarchically managed local system influenced by the local elites. Government has limited activities/ supports in the study area and less control over the NGO's activities.

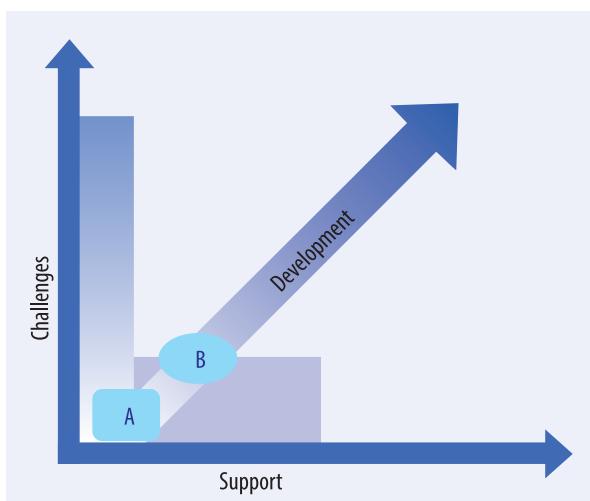


Figure- 16.2: Modified Diagram of Sanford's Challenge and Support Theory

16.10. Conclusion

Coastal people are crisscrossed with unlimited challenges both from climate initiated impacts and complex environment. Every sector is facing challenges from different angles and select the adaptation options randomly. Adaptation strategies vary among different groups based on their capacity to overcome the challenges. Haphazardly practiced adaptation option causes social conflicts and instability. Thus, local community suffers seriously due to unplanned adaptation and these practices does not reflect to the existing drivers and pressures in the South-western vulnerable community people. Susanne & Ekstrom (2010) provided a simple matrix to overcome adaptation barriers while introducing a framework for identifying and organizing barriers to adaptation. This matrix could also be used not only in the study area but also for whole coastal management planning and action to reduce the adaptation challenges.

Government needs to pay more attention to develop long term, climate resilient coastal management plan focusing on every coastal sector. To ensure protection of large coastal community, community-based information and advisory services can be installed to support them by providing necessary information and advice for selecting suitable and environment friendly adaptation practices. Total support system can be rearranged by initiating strong partnership between GO and NGO. Therefore, a paradigm shift is required for climate resilient adaptation planning to ensure long term development of coastal communities by enhancing their coping capacity.

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Chapter Seventeen

Legal Protection and Management of Aqua Biodiversity: What Maldives can Learn from Bangladesh?

Shahab Shabbir

Abstract

The Republic of Maldives has one of the richest marine biodiversity of the world. The country's coral reefs are the seventh largest in the world, representing some 5% of the global reef area and are home to 250 species of coral, which teem with over 1,000 species of fish. Fisheries and tourism are their two largest industries, which are heavily dependent on a healthy and diverse marine ecosystem. These two industries alone provide three quarters of jobs, 90% of the GDP and two thirds of foreign exchange earnings for the Maldives. However, in recent years, the economic and environmental health of Maldives has been put to jeopardy by taking the biodiversity as granted and neglecting the natural environment for earning short-term benefits. The real time protection of the Maldivian biodiversity is, thus, not only important for the country's environmental health but it is also an economic and developmental imperative. On the other hand, Bangladesh, being a remarkable growth holder in terms of aqua biodiversity conservation, could be a source helpful in shaping the future legal mechanism for the preservation and management of marine ecosystem in the Maldives. Though Bangladesh do not have any specific legislation addressing the coastal ecosystem issues, yet a sincere review of the available laws and policies gives clear implication of coastal area conservation and development and thereby learnings from Bangladesh could be helpful in shaping the future legal compliance mechanism for the protection and conservation of Maldivian aqua ecosystem.

Keywords: Marine Biodiversity, Legal Mechanism, Aqua Ecosystem, Protected Areas, Conservation

17.1. Introduction

The term biodiversity has been derived from 'biological diversity', which actually refers to the differences between living organisms at different level of biological organization— gene, individual species and ecosystems. The

Convention of Biological Diversity (CBD) defined biodiversity as; ‘the variability among living organisms from all sources including; *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part’ (see Article 2 of CBD, 1992). Biodiversity encompasses multiple values and is vital for the production of food and to conserve the ecological foundations needed to sustain people’s livelihood. Biodiversity is not only the richness of species; it is also their genetic variety and the multiple habitats and ecosystems in which these plants and animals live (CBD, 1992). The aquatic ecosystem or the aqua biodiversity is also one of the genetic varieties of habitat in the vast biodiversity system.

The Aqua or Aquatic biodiversity is the rich and wonderful variety of flora and fauna— from crayfish to catfish, from mussels to mayflies, from tadpoles to trout— that live in watery habitats. It is the number of different native species, or species richness. Over 1.4 million identified species live on earth, and experts estimate that as many as another 10 million to 100 million unidentified species may exist (*ibid*).

17.2. The Maldivian Situation

The Maldives harbors a rich aquatic biodiversity. Its coastlines at atolls are significant because they are by far the largest group of coral reefs in the Indian Ocean, with an area in excess of 21,000 km² and a total reef area of more than 3,500 km². Over 1,100 species of reef fishes and over 250 species of corals are found. However, this rich asset is threatened due to human activities at the local level and more importantly from impacts of global warming. Since Maldives is a nation comprising of small islands; it is more vulnerable to environmental threats (Emerton, et al. 2009). One of the most serious land related problems is that of beach erosion, which is evident on a majority of the islands. Maldives coral reefs are the seventh largest in the world and represent as much as 5% of the world’s reef area. They not only provide coastal protection, but are the mainstay of both the fisheries and tourism sectors. They are however, under threat due to improper waste disposal and unsustainable coastal development practices, which are resulting in increased pollution and coral reef destruction. There is also evidence of overexploitation of several reef fish and other species (MEE, 2015).

Several government departments are responsible for ensuring the conservation and sustainable use of marine and coastal biodiversity in the Maldives, including the Ministry of Environment, Energy and Water (now the Ministry of Housing, Transport and Environment), the Ministry of Fisheries, Agriculture and Marine Resources, and the Ministry of Atolls Administration. A total of 26 Marine Protected Areas (MPAs henceforth) have been identified and gazetted across the country. With the exception of traditional live bait fishing and recreational diving, all other activities have been planned to be officially prohibited in the MPAs. While Maldives is home to many different and not so common aquatic

species, a lot of them have reached to the level of the threat to extinction in the recent years. Though the barracudas and turtles can still be spotted, sharks have now disappeared from the Maldives due to over extraction.

While the country has recorded a steady yet continuous growth in the last decades, it has lost a big share of its aquatic biodiversity, which were peculiar to it. This loss has many reasons with the prime ones being the growing economy and deficiencies in professional and institutional policy framework. The institutional policy framework is responsible for the proper management and legal protection to the aquatic biodiversity and its absence is certainly making Maldives to suffer tremendous loss at present and in the years to come. Given that the major part of the Maldivian economy depends on aquatic biodiversity resources and natural ecosystems, the failure to integrate aqua biodiversity into management policies and legislative strategies may undermine the very basis for sustained and equitable economic growth in the future.

17.3. The Bangladesh Scenario

Bangladesh is one of the biodiversity-rich countries in the world. The five broad types of biodiversity in Bangladesh are coastal and marine ecosystems, inland freshwater ecosystems, terrestrial forest ecosystems, hilly ecosystems and man-made homestead ecosystems. The Government of Bangladesh gives special importance to its biodiversity and it thus has constituted the National Technical Committee on Biodiversity and National Committee of Biosafety to ensure monitoring and reviewing implementation of the Convention on Biological Diversity and all other issues related to the Protocols there under (DoE 2016).

The framework of Biodiversity Conservation Action Plan in Bangladesh, also called as the National Biodiversity Strategy and Action Plan (NBSAP) happens across an institutional level, an individual level and in policy/legislative frameworks. At an institutional level, the Ministry of Environment and Forests (MoEF), through its National Technical Committee on Biodiversity (NTCB), oversees activities related to biodiversity conservation. At an individual level, researchers and professionals are working on different components of the environment and ecosystems, without having explicit aims to translate the research results into achieving the objectives of the NBSAP, although it is true that much research work is closely connected with different NBSAP components.

The level of mainstreaming of the NBSAP into individual policies and strategies achieved, so far in Bangladesh, can be said to be satisfactory. The NBSAP advocated that legal, regulatory and policy regimes should be aligned with biodiversity conservation. In this regard, it can be claimed that the strategic arrangements and legislative frameworks of the country are strong enough to safeguard habitats, ecosystems and their associated biodiversity. The environment and biodiversity-related policies, such as the Bangladesh Environment Policy 1992, Forest Policy 1994, Water Policy 1999, National Land Use Policy 2001, National Fisheries Policy 1998 and the National Environment

Management Action Plan (NEMAP) 1995 contain considerable elements related to biodiversity conservation (Mazid 2002).

17.4. Coastal and Marine Resources

Bangladesh coast and the marine zone are especially rich in diverse natural resources. The challenge is that natural resources in the coastal zone will have to be managed in a manner that will not only ensure their sustainability but will also secure access to the poor for meeting their livelihood needs. The strategies to meet this challenge include estuary and coastal ecosystem management, coastal land zoning, integrated management of coastal water infrastructures, environmental and socially responsive shrimp farming, and marine and coastal environment development.

Main Threats or Drivers of Change to Biodiversity

There are many threats that drive biodiversity loss, among which some are direct and dynamic while the others are indirect. Direct threats include changes in land use, habitat destruction, introduction of invasive alien species, etc. On the other hand, examples of indirect threats are the economic system and policies of the State; unsustainable exploitation of resources and weak management systems; gaps in spatial information; lack of public awareness. Other threats are emanated from the effects of natural calamities. In addition, habitat loss is considered the single largest threat to biodiversity.

17.5. Aqua Biodiversity Management in Bangladesh

Aqua biodiversity management is the control and movement of marine water to minimize damage to flora and fauna due to the climate change effect and to maximize efficient beneficial use for achieving the sustainable development goals. In another word, Aqua biodiversity management is the activity of planning, developing, distributing and optimum use of marine water resources under defined water policies and regulations. In this management strategy avenue, the fisheries sector generally used to be the prime target.

Management Strategies

Management strategies are typically employed for the resource that is desired to be maintained or improved, and tend to be specific for each resource. The management of marine fisheries is basically met by closed season and input control, i.e. licensing of fishing vessels. In the 2004-2005 fiscal years, 122 trawlers were licensed to fish; there is no control over the artisanal sector. Government has also banned the use of set bag nets and a complete ban on shrimp fry catchers along the coastal belt to preserve the biodiversity. All these management activities are executed under the Marine Fisheries Ordinance 1983, and Marine Fisheries Rules 1983 (Alam, 2005).

Community-Based Fisheries Management in Bangladesh

The community-based fisheries management (CBFM) initiative, implemented by Bangladesh's Department of Fisheries in partnership with the world Fish Center and 11 NGOs, thus aimed to use research-based approaches to promote more equal access to sustainably managed inland fisheries to be run by community-based organizations (CBOs). The CBOs would then establish sustainable fisheries practices such as creating fish sanctuaries, restoring habitats and reintroducing endangered species (Alam 2005).

Management Steps Taken by Different Agencies

Fisheries Institutions: The Ministry of Fisheries and Livestock (MoFL) is the major public sector institutions in the fisheries sector. For the fisheries matters it includes the Department of Fisheries (DoF), the Fisheries Research Institute (FRI) and the Bangladesh Fisheries Development Corporation (BFDC). The Upazila administration contains a fisheries office technically guided by DoF. The administration of the sector comprises about 5,200 persons, including some 1,200 professionals.

Non-Government Organizations (NGO) and Aid Agencies: NGOs are becoming increasingly active in the fisheries sector. There are close to 300 NGOs in the country— about 30% of them are funded externally. NGOs involved in fisheries mainly work on promoting aquaculture, and to a lesser extent on community based management of wetlands. Only very recently, a few NGOs have become involved in cooperative based fish sanctuary management involving traditional fishermen.

External Influences in the Fisheries Sector: Donors like IDA (World Bank), ADB, UNDP, FAO, ODA, IFAD, DANIDA, CARE, EU, USAID, CIDA, IUCN, and Ford Foundation are involved in Bangladesh's fisheries sector with the aim of increasing the fish production and improving the fisheries management (Khan, 2009).

17.6. National Policy and Legislations for Aquatic Ecosystem

National Plans

National development strategies and programs for the fisheries sector are formulated in the context of the country's five-year development plans (Khan, 2009). The major objectives of fisheries sector development during the Fifth Five Year Plan (1996-2000) are to: (1) generate additional employment opportunities in fisheries and ancillary industries to help poverty alleviation; (2) increase fish production and improve nutritional level; (3) improve socio-economic conditions of the fishermen, fish farmers and other engaged in the fishery sub-sector; (4) increase export earnings from shrimp, fish and fish products; (5) improve environmental conditions; (6) improve the biological and institutional management mechanisms for judicious use on fisheries resources; and (7) strengthening

research, extension, management and co-ordination in order to transfer technology and encourage production activities in the private sector.

National Water Policy, 1997

Availability of water is essential for sustenance and growth of fisheries sector (Khan, 2009). Accordingly, several provisions have been made on the National Water Policy that includes the following: (1) fisheries will receive due emphasis in water resources planning when the anticipated social impact is high; (2) attempt will be made to keep the impact on natural aquatic environment to a minimum; (3) state owned swamps and marshes that are important for fish, waterfowl and other wild life will not be drained; (4) water bodies such as haor, baor, beel, road-side ditch will be reserved for fish production and development to the extent possible; (5) perennial links of these water bodies with rivers will be properly maintained; (6) water resources projects will not interrupt fish movement and adequate provisions in controlled structure will be made to allow fish migration and breeding; (7) brackish aquaculture will be confined to specific zones designated by the Government for this purpose.

National Fish Policy, 1998

With the growing importance of the fisheries sector, Bangladesh Government formulated the National Fish Policy in 1998 for sustainable management of fisheries resources (Khan, 2009). For open water fisheries, the policy calls for minimizing damage on fish and fish habitat during development activities. It aims for improving the current leasing system to ensure participation of real fishermen in fisheries management. The policy also calls for setting up fish sanctuary, open water stocking and integrated fish cum rice farming. The policy specifically prohibits draining out of natural open water bodies. In furtherance of the purpose of this particular legislation, the New Fisheries Policy has also been planned to implement whereby the Fishermen will get freedom from the hold of middlemen and thus will ensure more a rule of law and thus thereby ensuring more support to the orderly exploitation of the aqua biodiversity of Bangladesh.

Nishorgo Support Program (NSP)

Bangladesh is already burdened with over population and the problem has become serious due to high presence of poverty. According to Hardin, individual rational actions may lead to the tragedy of the common. In such a situation, tragedy of common pool resources is a possibility (Hardin, 1968). Thus to protect the forest area, the government, under the Bangladesh Wild Life (Preservation) Order of 1973, has established 19 PAs covering an area of 2,42,675 hectares where any extraction of forest products is declared as illegal and punishable offence (Huda 2006). Bangladesh Forest Department has launched Nishorgo Program (with the financial support of USAID) to protect and conserve biodiversity in PAs with the help of the community through co-management.

Moving further on the NSP line, the government announced ‘the Swatch of No-Ground’ as the first marine protected area of Bangladesh, restricting fishing and other offshore commercial activities there. It is a 1738 square km area with an average depth of 900 meter, located in the southern side of the Dublachar Island in the Bay of Bengal. The area is a key breeding and spawning ground of dolphins, whales, sharks and turtles. The Environment and Forest Ministry on October 27, 2014 issued a circular announcing the area as protected under the Wildlife (Conservation and Security) Act, 2012 which would restrict fishing and other offshore commercial activities there. The initiative would ensure long-term protection of the cetaceans (the dolphins, whales and porpoises) species inhabiting in the offshore waters of Bangladesh . This particular move of the Bangladesh government gained so much popularity in the aqua biodiversity conservation arena that scholars started seeing it as an inspiration for others to follow. Even the US ambassador in Dhaka back then, termed Bangladesh’s ‘Swatch of No Ground’ a model and said world leaders can learn from it.

17.7. Legislation for Protection and Conservation of Aqua Biodiversity

Bangladesh is not only rich in biodiversity but it has also got an array of legislative and institutional arrangements that strongly deals with the protection and conservation of Aqua Biodiversity in the nation.

Policy and Legal Framework for Coastal Zone Management

Legislations and policies related to coastal zone management of Bangladesh mainly include: (1) Priority Investment Program (PIP), (2004); (2) Coastal Zone Policy (CZPO), (2005); (3) Coastal Development Strategy (CDS), (2006); and (4) United Nations Convention on the Law of the Sea (UNCLOS,1982).

Priority Investment Program (PIP), (2004)

The priority areas of investment program are: (1) Mitigation of natural disasters, safety and protection; and (2) Environment management– protection and regeneration of the environment; (3) Water resources management; (4) Rural livelihoods and sustainable economic opportunities for coastal communities; (5) Productive economic activities and focused development of tourism and fisheries sector; (6) Infrastructure development; and (6) Social development including health and nutrition, education, and water and sanitation.

Coastal Zone Policy (CZPO), (2005)

The Government of Bangladesh has formulated this coastal zone policy (CZP) to provide a general guidance to all concerned for the management and development of the coastal zone. The specific objectives of the Coastal Zone Policy are: (1) Economic growth; (2) Meeting basis needs and creating livelihood opportunities for coastal communities; (3) Reduction of vulnerabilities

and enhancement of coping capacities; (4) Empowerment of coastal communities; (5) Women's advancement and promotion of gender equality; (6) Sustainable management of natural resources; and (7) Preservation and enhancement of critical ecosystems. However, the coastal policy includes legislation and policy on:

- **Land:** Planning to control unplanned and indiscriminate use of land resources
- **Water:** Adequate upland flow in water channels to preserve the coastal estuary ecosystem threatened by the intrusion of soil salinity from the sea
- **Capture Fishery:** National Fish Policy, in relation to exploitation, conservation and management of marine fisheries resources
- **Aquaculture:** Environmentally adopted and socially responsive shrimp farming be encouraged
- **Agriculture:** Increasing the production of crops suitable for the coastal area with attention to maintenance of soil health
- **Livestock:** Grazing land for livestock be arranged
- **Afforestation:** Measures taken in the coastal areas including newly accreted chars
- **Energy:** An assessment of all types of energy resources (e.g., oil, gas, coal, nuclear minerals, hydropower, biomass fuels, solar, wind and tidal waves) undertaken on a regular/continuous basis.

Coastal Development Strategy (CDS) (2006)

The CDS prepares for coordinated priority actions and arrangements for their implementation through selecting strategic priorities and setting targets. The CDS is a targeted process and the targeting is identified with respect to: (1) Regions (islands and chars, exposed coastal zone or districts; high tsunami risk area; South-West region); (2) Disadvantaged groups (erosion victims, women and children, fisher and small farmers); (3) Issues (shrimp culture, land zoning; groundwater management, climate change); and (4) Opportunities (tourism, renewable energy, marine fisheries). The CDS has nine strategic priorities: (1) Ensuring fresh and safe water availability; (2) Safety from man-made and natural hazards; (3) Optimizing use of coastal lands; (4) Promoting economic growth; (5) Sustainable management of natural resources; (6) Improving livelihood conditions of people; especially women; (7) Environmental conservation; (8) Empowerment through knowledge management; and (9) Creating an enabling institutional environment.

The CDS (2006) also include legislation and policy on: (1) Industrial Waste (Including Ship Break yards); (2) Sewage Disposal; (3) Unplanned extraction of coastal resources include gas, oil, minerals, aquatic flora (including algae), and aquatic fauna (snails, fishes, amphibians, mammals, reptiles etc); (4) Erosion in the coastal zone; (6) Rapid urbanization; (7) Salinity Intrusion; (8) Deforestation Agrochemicals/Persistent Organic Pollutants (POPs); (9) Solid Waste Management; and (10) Coastal tourism.

United Nations Convention on the Law of the Sea (UNCLOS, 1982)

Notable in the development of the law of the sea is the United Nations Convention on the Law of the Sea (UNCLOS), also called the Law of the Sea Convention or the Law of the Sea treaty. The UN held its first conference on the Law of the Sea (UNCLOS I) in 1956, while the third conference (UNCLOS III) took place in Montego Bay, Jamaica, in 1982, which resulted in the 1982 Law of the Sea Convention (LOSC). The Convention was opened for signature on 10 December 1982 and LOSC came into force in 1994 upon receiving the necessary number of UN signatories. The UNCLOS it requires its signatory parties to make rules that includes legislation and policy on: (1) Marine protected area; (2) Transit and innocent passage; (3) EEZ (Exclusive Economic Zone); and (4) Exploitation of natural resources. The lawmakers of Bangladesh have time and again, consulted and included many potential provisions of UNCLOS in their different legislations that deals with the protection and conservation of aqua biodiversity in Bangladesh. Others legislation and policies related to coastal zone management of Bangladesh mainly include: (1) Policies and legislation for the management of coastal forests and trees; (2) Policies and legislation for the management of coastal Land; (3) Policies and legislation for the management of coastal Water; and (4) Policies and legislation for the management of coastal Fisheries.

17.8. Supportive Sectoral Policies for Coastal Zone Management

The supportive legislation and policies related to coastal zone management are policies for: (1) Management of Coastal Forests and Trees; (2) Management of Coastal Land; (3) Management of Coastal Water; and (4) Management of Coastal Fisheries

Policies for the Management of Coastal Forests and Trees: A policy is a document that outlines what a government is going to do and what it can achieve for the society as a whole. A policy is an informal document that just lists and states what must be done and what is intended to be done in the future. Policies normally assist decision making. It is important to note that policies are formed normally over a period of time. They are not formed all of a sudden. There are some vital coastal forests and trees management policies that are broadly clubbed in and as: (1) Environment Policy (1992); (2) Forest Policy (1994); and (3) Coastal Area Policy (2005).

Protection of the country against natural disasters is the main objective of the national Environment Policy (1992), which focuses on the maintenance of ecological balance and sustainable development. The Forest Policy (1994) emphasizes the establishment of plantations on all newly accreted lands in the coastal areas. It is committed to conserving the resources and ecosystems of the Sundarbans. Regarding coastal forest, the Coastal Area Policy (2005) has a similar commitment. It generally emphasizes sustainable development in the coastal region and thus directly supports the establishment of coastal plantations and conservation of existing coastal forests and preservation of coastal habitats.

Policies for the Management of Coastal Land: According to government Land-use policy (2001), usually the coastal char land is initially handed over to the Forestry Department for 20 years. During this period, mangrove forests are planted as part of the coastal protection system. As accretion progresses, the land behind the mangrove belt is converted into agricultural land for settlement. Hence, the government also has a land settlement program, although limited in scale. Landless families who are victims of river erosion have priority in the allocation of land.

The Environment Policy (1992) encourages land use depending on the ecosystem prevailing in different parts of the country. It emphasizes that efforts should be strengthened for land reclamation, erosion protection, soil fertility and reduction of soil salinity and alkalinity. This policy also mentions transferring newly accreted land to the Forestry Department on a priority basis to stabilize and protect the land from erosion.

The Forestry Policy (1994) mentions that “effective measures will be taken for afforestation in the newly accreted char in the coastal areas, as it protects soil and reduces the velocity and intensity of cyclones, tornado and tidal bores”. Afforestation also helps to stabilize newly accreted land.

Policies for the Management of Coastal Water: The National Water Policy (1999) suggests undertaking surveys and investigations of the problem of riverbank erosion; developing and implementing master plans for river training and erosion control; and planning and implementing schemes for reclamation of land from the sea and rivers. The National Policy for Safe Water Supply and Sanitation (1998) recommends that each and every village shall have one pond set aside for drinking water, which should be protected from contamination and surface runoff. The water logging problem has generated widespread discontent among the people. The Development Strategy of the National water management Policy (NWMP, 2001) considers it of foremost importance to rationalize coastal embankment schemes on the basis of environmental audit.

Policies for the Management of Coastal Fisheries: The two policies on the management of coastal fisheries are: (1) Marine Fisheries Ordinance, 1983; and (2) National Fish Policy, 1998.

17.9. Conclusion and Recommendations

There is further need to develop an understanding of the marine biodiversity in Maldives. There is a need to build on the information base taking in to consideration the vast Bangladeshi experience of various water management initiatives. The economics of proper utilization of the available resource is potentially concerned with the community approaches. Not only in the legal and management arena, but also the Bangladeshi experience of stocking programs can be considered which indicates that where resource values are increased, the distribution of benefits on an equitable basis is not guaranteed. The establishment of community management of marine water resources is

faced with the problem of establishing the costs of resource use. The results of stock enhancement, both in terms of production and socio-economic impact, thus contribute to this policy debate.

There is, though not adequate, yet availability of some very weak laws and rules to protect and conserve the aqua biodiversity in the Maldives. Another problem is that these are not effectively enforced, however, for many reasons, the chief being the lack of strong legislations, the lack of political will and the lack of a proper inspiration to learn as how to enforce them. There is an immense need of new laws and revised regulations to the level of inevitability in the Maldives for the proper protection, conservation and promotion of its aqua biodiversity. There is further need to develop an understanding of applicability of the suitable participatory programs to deal with the challenges of deteriorating marine biodiversity. The experience of Bangladesh indicates that much could be done even in the times of political crisis or lack of adequate resources, provided the proper community participation under an all agreed management plan has been put on the surface. The policy debate will then be able to focus on the most appropriate response for each situation. Also Bangladesh has an array of smart legislative arrangements and strong policy framework which not only deals with the specific subject of aqua biodiversity, but also with all those areas which directly or indirectly affects them. An inspiration drawn from the policy structure, management initiatives and legislative framework of Bangladesh could provide potential points in the formulation of effective management strategies and legislative arrangements of aqua biodiversity conservation in the Maldives in future.

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