FINAL REPORT for APN PROJECT

Project Reference Number: ARCP2012-23NSG-CRAWFORD

Scoping Workshop: Human Responses to Catastrophic Monsoon Events in South Asia, Designing a Spatially Explicit Model in Low-Lying Coastal Area

The following collaborators worked on this project:

Dr. Thomas W. Crawford, East Carolina University, USA, crawfordt@edu.edu

Dr. Thomas Allen, East Carolina University, USA, allenth@ecu.edu

Dr. Ahsan U. Ahmed, Centre for Global Change, Bangladesh, ahsan.ua@gmail.com

Dr. Donald Bradley, East Carolina University, USA, bradleyd@ecu.edu

Dr. Scott Curtis, East Carolina University, USA, curtisw@ecu.edu

Dr. Ashok Mishra, Asian Institute of Technology – Kharagpur, India, amishra@agfe.iitkgp.ernet.in

Dr. Anuradha Mukherji, East Carolina University, USA, mukherjia@ecu.edu

Mr. Kehella Premalal, Department of Meteorology, Sri Lanka, spremalal@yahoo.com

Dr. Ahmed Salahuddin, East Carolina University, USA, salahuddin0812@gmail.com

Scoping Workshop: Human Responses to Catastrophic Monsoon Events in South Asia, Designing a Spatially Explicit Model in Low-Lying Coastal Area

Project Reference Number: ARCP2012-23NSG-Crawford
Final Report submitted to APN

PAGE LEFT INTENTIONALLY BLANK

OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

Settlements in coastal lowlands are vulnerable to risks associated with climate change and extreme weather events. Sea level rise and higher intensity storm events increase the risk of shoreline erosion, low land flooding and ecological disruption. The quantities and characteristics of affected populations have the potential to threaten economic and political stabilities of host countries.

A team of international researchers from Bangladesh, India, Sri Lanka and the USA conducted a scoping workshop and related activities to help develop a research initiative aiming to investigate human responses to coastal hazards in low lying coastal areas. Team members hold expertise in a range of disciplines including meteorology, hydrology, geography, sociology, economic development and geospatial technologies. The overarching goal was to share knowledge among assembled experts and to listen and learn from the various topical and regional expertise encountered about the best strategies to develop a larger-scale research project. Workshop participants identified key science question, data gaps, and the need for both natural and social science collaborative approaches. Relationships with key science agencies and two universities were established. Village interviews identified riverbank erosion as a key research theme that future initiatives plan to investigate.

Keywords: coastal risk, flood, riverbank erosion, human response

Objectives

The main objectives of the project were as follows:

1. Plan and execute a one-day expert workshop attended by the research team and 20 local scientists.
2. Establish relationships with local science agencies and universities.
3. Village field trip to conduct scoping interviews with village leaders and residents.

Amount received and number years supported

The Grant awarded to this project was US$ 15,000 for Year 1 (a one year project).

Activities undertaken

- September 18, 2012: Expert workshop was held at the Hotel Eastern Residence in Dhaka, Bangladesh.
- September 19, 2012: Research team met with personnel from two Bangladesh science agencies, (1) Bangladesh Disaster Management Bureau (DMB), and (2) Institute of Water Modeling (IWW).
- September 19-20, 2012: Research team met with representatives from Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Noakhali Science and Technology University (NSTU).
- September 20-21 2012: Field trip to meet with leaders and community members of Char Algi, a village located in Lakshmipur District.

Results

1. **Workshop:** Project collaborators presented eight presentations covering topics relevant to project goals. Experts from the region attended to provide input and feedback. Three breakout sessions were recorded and transcribed to synthesize answers to the following three questions: (1) What are the big science questions?, (2) What expertise is necessary for meaningful results?, and (3) What are the data gaps?

2. **University relationships:** Meetings with vice chancellors and faculty from two universities included presentations of research capacities provided by Bangabandhu Sheikh Mujibur Rahman Agricultural University and Noakhali Science and Technology University. These meetings established relationships with strong potential to result in future international collaborative research.

3. **Science agency relationships:** Bangladesh Disaster Management Bureau (DMB) staff presented an overview of disasters relevant to Ganges-Brahmaputra-Meghna basin with special emphasis on Bangladesh management issues. Institute of Water Modeling (IWW) staff provided information regarding their mission and relevant geospatial data sources. Both agencies agreed in principle to support future research initiatives of the research team via potential data sharing and collaboration.

4. **Char Algi village field trip:** After a group-wide meeting with the village Chairman and other leaders attended by 60-70 people, team members separated into three group interview sessions with village residents representing fishermen, farmers, and other occupations. Each group consisted of approximately 25 people. These sessions took place near the banks of the Meghna River, and audio was recorded using digital recorders. Recorded sessions were transcribed to synthesize local perceptions regarding coastal hazard challenges and future research needs.

Relevance to the APN Goals, Science Agenda and to Policy Processes

- Climate Change and Climate Variability: addresses human response to environmental change connected to climate change.
- Ecosystems, Biodiversity, and Land Use: investigates land use change as a consequence of monsoon events and sea level rise.
- Changes in Atmospheric, Terrestrial, and Marine Domains: integrates theme of terrestrial inundation coupled with atmospheric change and marine change.
- Resource Utilization and Pathways for Sustainable Development: obtains expert scientific and rural householder information regarding human adaptation including migration and altered land use strategies as sustainable responses to coastal hazards.

Self evaluation

The research successfully planned and executed all activities stated in the seed grant proposal. Our initial proposal identified catastrophic monsoon events as a focal topic. A key lesson learned was that riverbank erosion, which may be chronic or acute, emerged as the most relevant topic that needs to be addressed. This topic may include monsoon events but is not limited solely to monsoons. Workshop participation from invited experts met or exceeded expectations. Almost all invited experts were able to attend the workshop and provided valuable input. Team members especially learned an appreciation of the difficulties in engaging in this type of research in

developing regions and the critical importance of strong international collaboration involving local experts with connections to local universities, science agencies, and development issues in rural areas.

Potential for further work

Results established strong potential for future collaborative work. The team anticipates submitting a full proposal to APN in October 2013. We also anticipate submission to other funding sources such as the U.S. National Science Foundation, the National Aeronautics and Space Administration (NASA), or the Agency for International Development (AID). Future work would benefit from strong collaboration with the two universities engaged with during project activities: Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) and Noakhali Science and Technology University (NSTU).

Publications

Crawford, T., A. Salahuddin, S. Curtis, A. Ahmed, T. Allen, D. Bradley, A. Mishra, A. Mukherji, K. Premalal. 2012. Scoping workshop: human responses to catastrophic monsoon events in South Asia: designing a spatially explicit model in low-lying coastal areas. *APN Science Bulletin*, March Issue 3: 125-27.

Acknowledgments

We gratefully acknowledge the contributions from Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Noakhali Science and Technology University (NSTU), the Bangladesh Disaster Management Bureau (DMB), Institute of Water Modeling (IWW), and the Chairman, Mr. Seraj Uddin, and residents of village Char Algi. We also express gratitude to Dr. Giashuddin Miah of BSMRAU for his significant help in project planning. We appreciate the contributions of Ms. Lisa Dozier, Ms. Jolene Evans, and the Center for GIScience at East Carolina University.

TECHNICAL REPORT

Preface

Settlements in coastal lowlands are vulnerable to risks associated with sea level rise and higher intensity storm events. Coastal lowlands of the Asia-Pacific region have among the highest population densities in the world. Economically marginalized populations in the region are likely to be disproportionately affected by climate change impacts. This research planned and executed a scoping workshop that hosted a multi-partner planning workshop and a field trip to support future research that designs models human responses to catastrophic monsoon events and sea level rise in South Asia. Results will provide a framework and an agenda for a sustained, place-based research program that investigates human responses.

Table of Contents

1.0 Introduction

Settlements in coastal lowlands are vulnerable to risks associate with climate change. Sea level rise and higher intensity storm events increase the risk of low land flooding and ecological disruption. Many coastal lowlands in Least Developed Countries are heavily populated with among the highest population densities in the world. These economically marginalized populations are likely to be disproportionately affected by climate change impacts (McGranahan et al. 2007). The quantities and characteristics of affected populations have the potential to threaten economic and political stabilities of host countries. The recent monsoon floods in Pakistan demonstrate the reality of such threats whose frequency and intensity may increase in future decades. This research therefore proposes to hold a scoping workshop and related activities to support design of a spatially explicit model that models human responses to catastrophic monsoon events in coastal Bangladesh and India to project scenarios of human behaviors coupled with biophysical climate and landscape dynamics. A coupled human-landscape research approach can inform regional policy development as well as modeling efforts translated to other high density developing coastal regions.

Project impacts include development of a stronger conceptual foundation for new ways of thinking about human responses to coastal hazards in low lying heavily populated regions. This foundation is connected to paradigms associated with complex systems research that investigates coupled human and natural systems. Such systems are complex in that they typically are not amenable to reductionist scientific strategies and instead often require multidisciplinary teams and frameworks to describe and understand system behavior. Agent-based models implementing relatively simple behavioral rules operationalized for many interacting agents are often capable of reproducing observed realities and are also useful for simulating various "what if" scenarios across a continuum of input model parameters. A major challenge of agent-based modeling involving representations of agent characteristics and behaviors, the structures (networks) that they are embedded within, and the natural environment that they interact with is the need to invest such models with empirically grounded data. As a precursor to modeling, investments in empirically grounded data on human behaviors and knowledge of data uncertainties and fidelities regarding agent (i.e. humans) and natural landscape characteristics and behaviors are desperately needed. Learning the most relevant science questions and supporting empirically grounded data is the goal of this scoping project which is designed to provide information needed to design a spatially explicit model in low-lying coastal regions of South Asia. Our workshop and fieldwork focuses on low lying Bangladesh with the expectation that these findings can be adapted as necessary to other regions.

Rainfall Variability and Change: The IPCC predicts a greater frequency of heavy rain events in the region (Solomon et al. 2007). Unnikrishnan et al. (2006) report an increase in the number of tropical cyclones in the 2050s in the Bay of Bengal during both May and November. This is consistent with observations, where Singh et al. (2001) find a trend in enhanced cyclogenesis over the North Indian Ocean during these same months from 1877 to 1998. Recent studies on long-term changes in observed rainfall over Bangladesh identify an increasing trend. Singh (2001) examined cause and effect relationships in the climate system, showing consistent increases in mean tide level from 1977 to 1998, SST over the Bay of Bengal from 1985 to 1998, and country-averaged rainfall from 1961 to 1991 during the monsoon months. Singh (2001) concludes that 50% of the rising tide levels, ranging from 1.1 to 17.5 mm per year, are monsoon-induced. In summary, coastal Bangladesh will likely suffer a greater risk of fresh water flooding and storm surge into the future according to past trends and current climate change theory, leading to enhanced vulnerability of agriculture, flood control, and infrastructure.

Environment and Migration: Migration decision-making is conceived as an individual process where the anticipated net benefits of migrating are compared to the anticipated net benefits of staying (Borjas 1994). Scholars warn that global climate change will produce hundreds of millions of 'environmental refugees' (Myers 2002) with dramatic negative impacts on host regions (Longergan 1998; Reuveny and Moore 2009). The 'environmental refugee' scenario is not universally accepted and has inspired spirited critique (Black 2001) in part due to lack of strong empirical support. Few quantitative migration studies have incorporated measures of environmental degradation and results from this body of work are mixed (Gray 2009). Migration decision-making is complex and is conditioned by social context. According to the "new economics of migration", decisions are often made at the household level; selected members may migrate as part of a strategy to minimize risks (Stark and Bloom 1985). The feasibility of a move also depends in part on the character of the social networks in which individuals and households are embedded; moves are less costly where friends and family are available at destinations (Massey et al.1987). The capacity of households and communities to adapt to environmental degradation varies substantially. In any given area, the amount of out-migration accompanying worsening environmental conditions should depend partly on collective adaptive responses (e.g., protective infrastructure) (Tacoli 2009).

Remote Sensing and Geospatial Modeling: Developing low-lying, populous countries in South Asia exhibit dire vulnerability for populations with potential for massive population migration and harnessing of remote sensing and associated modeling capabilities (Zaman and Wiest 1991.) Satellite imagery and derived elevation data enable resource inventories, the monitor of land use change and biophysical processes, the mapping of flood extents, damage assessment and relief operations, and input and verification of spatio-temporal modeling. Active sensors are overcoming traditional challenges in seasonally cloudy monsoon locations through all-weather synthetic aperture radar (Zhang et al 2009). Multi-sensor observations with complementary spectral and spatial resolution can also provide for synoptic temporal surveillance (e.g., rice paddy cultivation, Motohka et al. 2009). We envision an integrated modeling system that capitalizes on available synoptic and landscape remote sensing from civilian satellite earth observations. Such a system offers three critical capabilities for risk assessment: (1) Regional monitoring of monsoon onset and intensity with high temporal resolution MODIS and AVHRR satellite data (Islam and Sado 2000); (2) Mapping flood extents and hazard risk zones (Gianinetto and Villa 2004; Sanyal and Lu 2004), and (3) Modeling future risk and vulnerability to expanded riverine and storm surge flooding in the Bay of Bengal (Roy et al. 1999).

2.0 Methodology

Expert Workshop:

Planning the workshop began on August 1, 2012 culminating with the workshop event held on September 18, 2012. Workshop goals were: (1) to contribute to and learn from the collaborative international team and other invited local experts the state of the science regarding coastal hazards and human response, and (2) to establish relationships that can grow into longer term US-Asia collaborative research partnerships. Our US personnel were assembled to include thematic science expertise across various relevant domains but not all are experts in these domains with specific reference to south Asia. Two of our US team members are native to Bangladesh (Salahuddin) and India (Mukherji) and have conducted research in the region. Our Asian personnel were assembled to also bring thematic science expertise but with specific application to south Asia. The intent is to bring together US expertise with South Asian expertise to collaboratively learn from each other important aspects that will be necessary for inclusion in a spatially explicit model of human response.

Planning work prior to the workshop event involved (see Appendices 1-4 at end of document):

- Securing an appropriate venue with appropriate technical capabilities
- Establishing the workshop program (i.e. speakers, presentation content, etc.)
- Confirming attendance of approximately 20 experts

Appendix 1: Final workshop program
Appendix 2: Invitation letter
Appendix 3: Workshop registration form
Appendix 4: List of attendees

University and Science Agency Relationships:
Planning similar to that for workshop planning was involved to arrange dates and venues for the research team to meet with local universities and science agencies. US team member and Bangladesh native Dr. Ahmed Salahuddin arrived in Bangladesh one week prior to the rest of the team to finalize preparations for these meetings. Additionally, Dr. Giashuddin Miah of BSMRAU contributed significantly to this effort. Dr. Miah was not a formal investigator but had a prior professional relationship with Dr. Salahuddin that proved invaluable. Collectively, Dr. Salahuddin and Dr. Miah finalized preparations for the team to meet with:

- Vice Chancellor and faculty of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), September 19.
- Vice Chancellor and faculty of Noakhali Science and Technology University (NSTU), September, 20.
- Staff of the Bangladesh Disaster Management Bureau (DMB), September 19,
- Staff of Institute of Water Modeling (IWW), September 19

Village Field Trip:

Dr. Ahmed Salahuddin organized the date and structure of a meeting with leaders and residents of village Char Algi located in Lakshimpur District (Figure 1). Char Algi was selected because it has a history of low-land flooding, riverbank erosion, and migration which made it particularly suitable. Additionally, Dr. Salahuddin's personal background in the region (but not in this village) provided contacts that helped explain the nature of our visit so that field work would proceed smoothly. We anticipated that leaders and residents would provide information confirming lessons learned during the expert workshop in addition to providing new empirically grounded information only available via local place-based knowledge.

A meeting was planned with the village Chairman and leadership council after which other team members would separate into three group interview sessions with village residents representing three groups: (1) fishermen, (2) farmers, and (3) other occupations (Appendix 5). We anticipated that each group would consist of approximately 25 people, and that sessions would take place outside near the banks of the Meghna River. Digital audio devices recorded all group discussion to be transcribed later. A poster size satellite image map of Char Algi was prepared to be presented to the village Chairman (see Appendix 6).

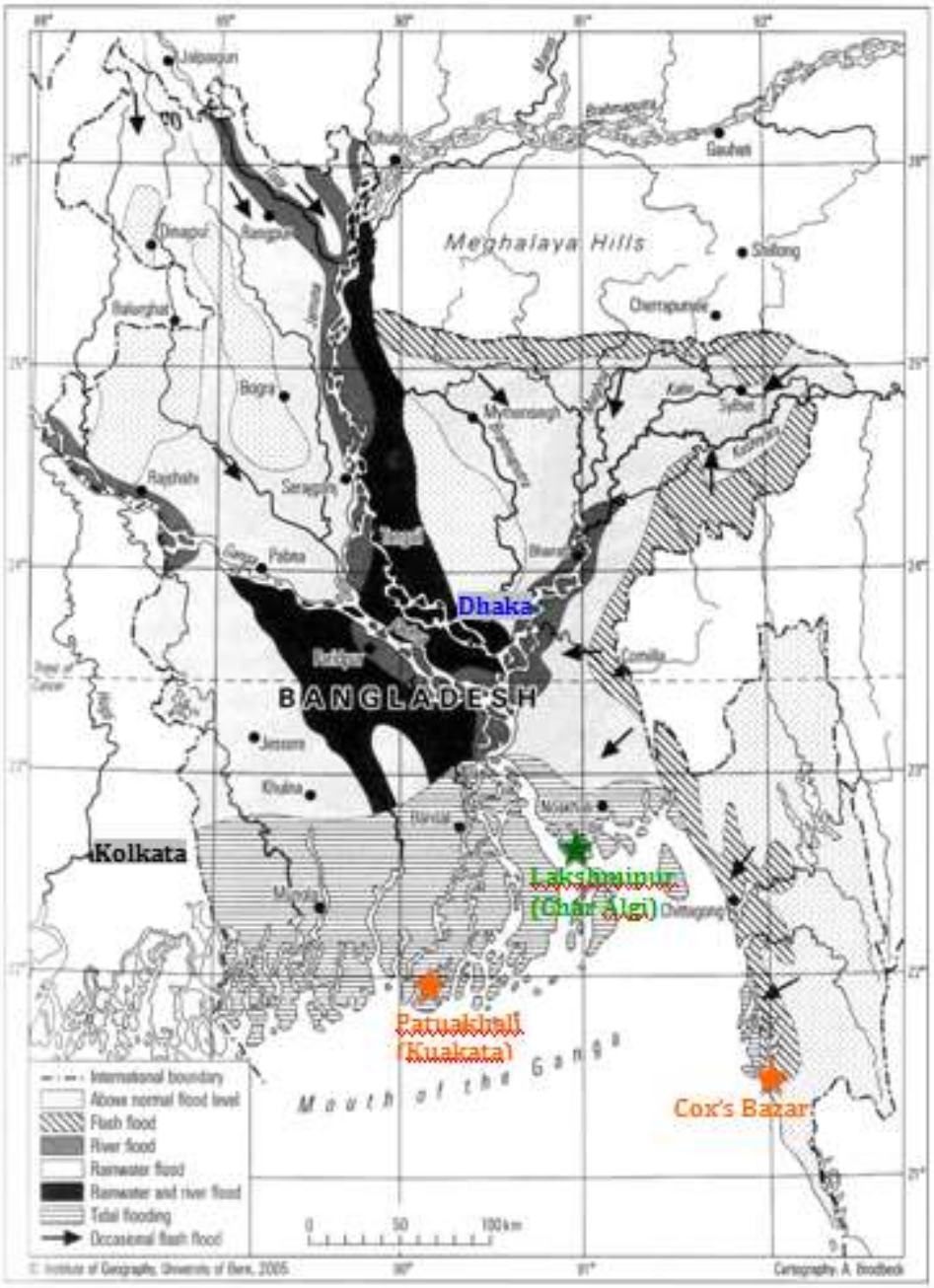

Figure 1. Village Char Algi (green star). Two other sites (orange stars) were considered during pre-trip planning but were not selected for final implementation.

3.0 Results & Discussion

Expert Workshop Results:

The key results from the workshop were associated with breakout sessions implemented in the afternoon following presentations. The attendees were asked to self-select and join either the *physical science*, *social science*, or *integrative* group. The charge for this session was to answer "What are the big science questions?", "What expertise is necessary for meaningful results?", and "What are the data gaps?"

Figure 2. Expert workshop attendees.

Physical science group results: The physical science group identified the utilization of natural resources at the coast as a large source of uncertainty. They believed that soil was the most important resource due to the importance of crop production, but it is becoming degraded with erosion. The physical science group focused their attention on data gaps. Soil, hydrological, and meteorological data are lacking throughout Bangladesh with available data resources often out of date and not reflective of changes that are occurring in the country. They also believed that the data should be available at multiple scales from satellite products to agrometeorological stations.

Social science group results: The social science group identified a plethora of unknowns in responding to natural hazards in coastal Bangladesh, including quantifying losses, mitigation strategies, political actions, barriers for adopting technological innovations, and migration decisions. They hypothesized unevenness in adaptive capacity, especially in regards to gender. This group also saw a need for hierarchical data, beginning with an assessment of background demographics and changing resources. Surveys and interviews should address farmer perception of land use changes and governmental response, whether they are receiving warnings about impending disasters, and migration patterns (e.g. rural to rural or rural to urban). Like the physical science group, the social science group wanted data in a variety of temporal and spatial scales to adequately address these research objectives. Short, medium, and long-term data of individual, household, community, and local government actions would be ideal.

Integrative science group results: The integrative group saw the need for a multidisciplinary team to tackle the difficult issues culled from the workshop. Due to the complex and coupled system,

biophysical scientists, economists, geographers and sociologists/anthropologists would be needed. This group cautioned that concern over hazards is dependent on perspective and level of acceptable risk. For example, a consistent theme was that rural communities are more directly impacted by extreme monsoons and riverine erosion than urban areas. They believed that the two most important science questions are i) salinity ingress as a response to the changing monsoon in the coastal belts and its subsequent impact on rice production and ii) the impact of migration, in particular women, on the demographic patterns of the region. Finally, the integrative group echoed the need for data from a variety of sources, which needed to be location specific and integrative. As one participant stated: "we know the symptoms from a distant view, we don't have a detailed understanding".

Figure 3. Workshop breakout group sessions.

Establishment of research relationships:
Our meetings with science agency staff lasted approximately one hour each. During these sessions we established fruitful relationships and support expressed by Bangladesh Disaster Management Bureau (DMB) and Institute of Water Modeling (IWW) to provide available assistance in future project work. The expressed willingness to share available expertise and GIS datasets germane to project work was the most significant result of this initial relationship building effort.

Our meetings with the two universities identified the respective strengths of these universities and our research team and how these strengths might complement each other in future work. BSRMAU has many strengths which include significant prior research experience and infrastructure related to sustainable livelihood strategies and rural development in low lying areas. Support was expressed by the Vice Chancellor. Dr. Giashuddin Miah, one of the attendees, is a senior faculty at BSRMAU with expertise in the project's topical area. Two junior faculty, Drs. Roshidul Hasan and Rafiqul Islam, also were present with strong backgrounds in hydrology, riverbank erosion and GIS. In fact, these two faculty presented a talk titled "Decision Support System of Riverbank Erosion of Bangladesh" during the expert workshop.

NTSU also provided an impressive array of resources. The Vice Chancellor graciously provided a group sit down meal after which the team met with a group in the VC's office to discuss project goals. The mission and strengths of NTSU align well with project topics. In particular, NTSU is well suited to engage in local field-based research related to coastal villages in its surrounding area. Faculty have expertise in coastal science issues including fisheries. Given the importance of fishing communities in low lying regions of Bangladesh, this has clear relevance. Also, the close proximity of NTSU to the lower Meghna River and estuary affords possibilities to engage students in field based primary data collection efforts such as household surveys and/or interviews.

Figure 4. Dr. Ahmed Salahuddin speaking with the Vice Chancellor and faculty of Bangabandhu Sheikh Mujibur Rahman Agricultural University

Figure 5. Meeting with the Vice Chancellor and faculty of Noakhali Science and Technology University.

Results of village field trip:

Interview with village Chairman: The team met with Mr. Sera Uddin, village Chairman of Char Algi, at the village post office. Approximately 60-70 adult villagers were present and observed the meeting with interpretation and translation provided by Dr. Ahmed Salahuddin.

Dr. Crawford thanked the villagers for their time and gave a brief introduction on the purposes of the meeting. The villagers also thanked the visitors for being visiting them and hoped that the team engages in efforts that might ultimately be beneficial to the villagers. Dr. Crawford mentioned some challenges the village faces, such as river bank erosion, cyclones, crop loss due to climate variabilities. Dr. Crawford's short list of challenges the villagers are facing generated a group discussion lead by the current Chairman, Mr. Seraj Uddin. The Chairman described the life in Char Algi and how it has changed in last 30-40 years. We have heard from our parents and grandparents that people's life and livelihood in Char Algi area were very good. They were able to do well in the past and survived well through enough through catch from the river (Meghna). Agricultural practices were very good, but now everything has changed. Pointing to the two Union Parishad (UP) council members present, Mr. Seraj Uddin stated that their previous fishing business from the river were very good but now they are now out of the business because of the lack of fish catch in the river. Also, one of the two council members was dislocated due to river bank erosion. The majority (about (90%) of the people living in Char Algi are somehow related with river and fishing business. The rest of the people are making their life and livelihood through agricultural practices. "The river bank erosion drastically made people's life and livelihood so miserable" as mentioned by the Char Algi Union Parishad chairman Mr. Seraj Uddin. The river bank erosion is severe during rainy season (or *Borsha*, short-lived rainy season locally known as *Borsha*). The river washed away people's residence and cultivable lands and that made their life so miserable. Dr. Crawford was reconfirming the magnitude of the severity of the problem, and the chairman reiterated that river bank erosion is the main problem in the area. In the past six months the villagers lost 2-3km due to river bank. The affected people move to the interior of the village and take a temporary shelter on relatives' land and on illegal lands with the perception that they will be able to find a better place for further move. They usually live in their temporary shelter for about 6-12 months. The chairman mentioned that there is nothing they can do with their dislocation, and there is no scope of doing anything to the affected people. The Chairman conveyed the problems and extent of the impacts to the local administration and as well as to the highest level of administration but all went unsuccessful. Referring to the solution of the problem, the villages and chairman suggested that channel dredging could be helpful. River water pollution through oils spillage from the trawler (boasts used for fish catch) and rising riverbed is the cause of decline catch in the river. Also, people living in upper catchment areas using insecticides and pesticides in the agricultural lands impacts the people living in downstream. Over exploitation due to population increase in the area may be another cause of decline fish catch in the river. Referring to the climate change perceptions in the locality, the Chairman repeatedly mentioned that both the number of frequency and the severity of cyclone were gone up in the last 5 to 10 years. Frequent inundation during pre-monsoon and post-monsoon seasons is very common in the area. Homesteads and crops are severely affected due to high tidal waves and salt-water intrusion in the village. While there is no large-scale cyclone (a national scale), this area still the area is frequently visited by higher tidal salt water surge which severely affected

the local livelihoods. From the Chairman's perspective the major problems in Char Algi are: river bank erosion, tropical cyclones and coastal inundation associated with untimely heavy rainfall.

Cyclone preparedness: Loud speakers provided by the Red Cross play a major role in disseminating the cyclone preparedness and evacuation information in the area. Their preparedness and warning are implemented through the local administrative unit in coordination with the local agencies and communities. In this case local administrative agency takes a role for mandatory evacuation in an event of extreme weather condition. The villagers are informed through radios and televisions. Announcement through cell phone would be very efficient but it is not yet in place as suggested by Mr. Seraj Uddin, the Chairman of Char Algi Union. Almost everyone living in the village has a cell phone (popularly known as "mobile"). Community-based cultural organization (*Satodol*, a grass-root level cultural organization, meaning hundreds of group) is also playing role in disseminating the information in the event of cyclone or tidal surge in the area. There are few cyclone shelters in the village of which two of them were washed away recently by the river bank erosion. There is no other option but to move interior during cyclones. Answering to Dr. Crawford's question on how far the storm water go inside the village – the storm water goes up to 3-4 km interior of the village.

Finally, Dr. Crawford thanked the current Chairman Mr. Seraj Chairman and the former Chairman Mr. Abdul Wares for their valuable time spent outside in hot conditions. Dr. Crawford also thanked Mr. Abdul Motaleb for coordinating and arranging the interview sessions. At the very end Dr. Crawford offered an East Carolina University T-shirt and a satellite-based Char Algi poster map to Mr. Seraj Uddin as a token of appreciation for the help.

Figure 6. Meeting with the village Chairman and villagers of Char Algi.

Fishermen group discussion:

Questions were asked by the discussion facilitators regarding the present problems in the village within the context of context of Climate Change. The group consist about 20 fishermen. Facilitators for the group were Dr. Scott Curtis, Dr. Ahmed Salahuddin and Mr. S. Premalal. According to the fishermen point of view, the major problem in this area is river bank erosion. The key points mentioned by the Fishermen are as follows:

1. The river bank erosion is major problem in the area. They are losing their jobs due to river bank erosion. Last six months the river washed away about 2km.
2. Fishermen were well-off 30 years ago and now they are despaired.
3. Due to river erosion, many people migrate to newly formed island land, which is owned by the Government. 1000's of people already moved to the other shelters supported by the family members, friends and neighbors.
4. Fish catch in the river has gone very low.
5. During the last 30 years they had better weather pattern. For the last 6 to 7 years it has changed and become more unpredictable.
6. Flooding is one of the severe hazards they are facing every year. Flooding got worse in recent years and is very unpredictable. This flooding is basically caused by storm surge.
7. Onset of the monsoon has been changed. The amount of rainfall is high when it rains and subsequently there were long dry spells.
8. Seasonal migrations are insignificant and not critical.
9. Tide level is high compare with past during the astronomical high tide. The range of high tide and low tide has gone increased significantly.
10. Government officials (Parliament members) do not much care about the people living in this area. No relief has been given by them during the hazards. Therefore they resort to borrowed money from the relatives and friends during hazards.
11. Local administrators provide some relief in the case of hazards.
12. Some people used to borrow money, if their family members are well off.
13. Compare with the past, cyclones are very severe. Strong winds and sometimes tornadoes are visible during cyclones.
14. They are losing everything day by day and it is terrible to describe.
15. According to their observations, sea level has encroached inland.
16. During the cyclones they need to move 1 to 1.5 km towards inland for cyclone shelters.
17. Almost all fishermen have a mobile phone. In addition they have radio sets in the boats. Bad weather warnings and early warnings are received through radio messages. Occasionally, they also receive signals from Naval Forces.

Quotes

"We are losing all hopes and life is becoming very challenging"

"We are losing everything we have and sometimes we feel like we do not have any existence"

Farmers group discussion:

The facilitator, Dr. Ahsan Ahmed, thanked the farmer's community for being present for a group interview. Following the field interview guideline, the facilitator asked questions relating to the impact of climate change in agricultural practices in Char Algi and how these climate changes impacts their life and livelihoods in the locality. Based on their personal understanding and experiences, the farmer's view of climate change impacts in their existing farming practices are as follows:

1. Frequent saline water intrusion during high tide (storm surge) destroys their crops.
2. Farmers losing their major crop and crop production, paddy, due to coastal inundation during the event of cyclone and high tide.
3. During high tide, storm surge goes up to 2km inland and it is about 4 feet deep.
4. Coastal inundation during storm surge is more frequent now compared to last 30 years.
5. Coastal inundation area has increased nowadays compare to last 30 years. The coastal inundation was there in the past but not as extensive as it is now.
6. Seasonal variability is another cause of their crop loss. Early and late arrival and departure of monsoon destroys their crops
7. Food production in the area has gone up due to the cultivation of High Yielding Varieties (HYV). 40% of the people in the area use HYV in their rice cultivation.
8. Other than paddy farmers grow soybeans, sweet potatoes, chili, peanuts, pulses, and okra (locally known as rabi crop).
9. Salt and backwater seriously impacts their *Rabi* crops.
10. Farmers affected by river bank erosion take shelter to the relatives' homesteads temporarily.
11. About 200 families moved out from the area in last 2 months
12. Farmers migrate to a nearby town, Choumuhani which is about 30 miles from Char Algi, and other areas in search of work. They mostly do earthen work (a very hard labor work) and help well off people in their harvest. This earthen work (digging earth and carrying the loose earth in other places for raising homestead and building new infrastructure) offers very good remuneration.
13. Farmers seasonally migrate to the southeast and north for 3-4 months when they do not find any work in their areas.
14. Also people from the northern part of the country migrate to these areas (southeast and Choumuhani area) for work.
15. Seasonal rainfall variability is reported. Sometimes frequent rainfall and no rainfall are observed. This rainfall is associated with tropical cyclones.
16. Farmers receive cyclone-warning system through local Red Cross. Farmers move if and when the warning signal goes 3 and above (it's not a mandatory evacuation). Farmers who do not move following the warning have suffered the most.
17. The latest severe cyclone they were affected by was in 2008. But they frequently observe small scale events that destroy their livelihood.
18. Whenever there is a new embankment is built a new sandbar emerges in nearby area.
19. Farmers are rigid to stay in their area even if they do not find work because they want to be around with their friends and neighbors and relatives where they born and brought up. If they move to other place they will not have these regular social connections.
20. About 60-70 shelters were eroded away by the river. Currently, there is no shelter within 2-4km.
21. Farmers lost their critical infrastructures such as, schools and mosque (worship places).

Quotes
"I have lost my lands 2 times"
"Salt water storm surge takes away our crops"

Other village members group discussion:
This group consisted of villagers not self-identifying as fishermen or farmers. These were largely business workers, day laborers, or the dependent elderly. The facilitator, Dr. Giashuddin Miah, thanked the group for being present there for a group interview. Following the field interview guideline, the facilitator asked questions relating to the impact of climate change in their village in

Char Algi and how climate change impacts their life and livelihoods in the locality. The problems mentioned by the villagers are as follows:

1. Elderly people are totally dependent on their younger children.
2. People living in the village are getting poorer due to river bank erosion because it takes their land away and make them landless and jobless.
3. River bank protection (embankment) can protect them and will help them to sustain.
4. After the river takes away their land they take shelter to the nearby relatives and friends for a short period and look for a better place where they can live permanently.
5. They seasonally migrate to nearby towns and areas where they can find jobs.
6. Life was good here 15 years ago.
7. Unpredicted heavy rainfall and occasional tidal surge destroys the crops.
8. Salty tidal surge goes up to 1-2 km inland of the village.
9. Coastal inundation goes in different heights at the beginning and end of the monsoon season.
10. Warning announcements by loud speakers from the Red Cross helps the villagers to evacuate the area during cyclones. During evacuation they take their livestock with them.
11. People in their community commonly have friends and neighbors to help each other to rebuild their houses.

Quotes

" I have a son - he is a Rickshaw Puller (three wheeler)- and he takes care of me"

"I have a son – he is a Day Labor – who works in a nearby town and send money to me" "I have relocated 4 times due to river bank erosion and only God knows where I will go next"

"Before the river was so deep and now it's very shallow"

"Before the community help was more and now it gets limited because lots of people move out of the area in search of jobs"

"We want our homestead back"

Figure 7. River bank erosion on the Meghna River,
Char Algi, Bangladesh.

4.0 Conclusions

A team of international researchers from Bangladesh, India, Sri Lanka and the USA conducted scoping work to help develop a research initiative aiming to investigate human responses to coastal hazards in low lying coastal areas. Team members hold expertise in a range of disciplines including meteorology, hydrology, agriculture, climate science, geography, sociology, economic development and geospatial technologies. The overarching goal was to share knowledge among assembled experts and to listen and learn from the various topical and regional expertises encountered about the best strategies to develop a larger-scale research project.

The main objectives of the project were:

1. Plan and execute a one-day expert workshop attended by the research team and 20 local scientists.
2. Establish relationships with local science agencies and universities.
3. Village field trip to conduct scoping interviews with village leaders and residents.

The scoping project accomplished all three objectives which are summarized below:

Synthesis of lessons learned from expert workshop: A summary of the key issues identified by the three breakout groups is summarized below:

- Uncertainties regarding utilization of natural resources at the coast.
- Importance of soil resources and the threat of soil and shoreline erosion.
- Lack of current soil, hydrological and meteorological data.
- Need for data at multiple scales from satellite products and agrometeorological stations.
- Need to quantify losses, mitigation strategies, political actions, for adopting technological innovations and migration decisions.
- Problem of unevenness in adaptive capacity especially in regards to gender.
- Need for data measuring farmer perceptions of land use changes and governmental responses.
- Adequacy of warning systems for natural hazards/disasters.
- Need for multidisciplinary team(s) including biophysical scientists, economists, geographers, and sociologists/anthropologists.

Establishing relationships: Regional science agencies are willing to partner and support future work by providing scientific expertise and sharing existing digital data where possible. Regional universities (BSMRAU and NTSU) expressed a strong desire for future collaboration and clearly have the requisite faculty expertise and facilities to engage in such work.

Synthesis of lessons learned during village field trip: A summary of the key issues identified by the village Chairman and three group discussions is provided below:

- River bank erosion is major problem in the area. They are losing their jobs due to river bank erosion. During the prior six months, the river washed away about 2km.
- Fishermen were well-off 30 years ago and now they are despaired.
- Flooding caused by storm surge is one of the severe hazards they are facing every year.
- Flooding has worsened in recent years and has become more unpredictable.
- Onset of monsoon has been changed.
- Frequent saline water intrusion during high tide (storm surge) destroys crops.
- Coastal inundation during storm surge is more frequent now compared to last 30 years.

- After the river takes away their land, villagers take shelter with nearby relatives and friends for a short period and look for a better place where they can live permanently.
- River bank protection (embankment) can protect the village and will help to sustain it.
- About 60-70 shelters were eroded away by the river. Currently, there is no shelter within 2-4km
- People living in the village are getting poorer due to river bank erosion.

5.0 Future Directions

As a result of seed funding from the Asia-Pacific Network, our research team has identified a research agenda that we will take forward in efforts to secure funding for a larger scale project. Our immediate next step is to submit a full proposal for the next Asia-Pacific Network competition in October 2013.

Overarching theme for future research: Complex coupled natural and human systems involving drivers and feedbacks between riverbank erosion and human mitigation and/or adaptive response within a context of global environmental change (i.e. climate, SLR, monsoon, etc.) for low lying coastal zones.

Future research objectives:

(a) Characterize monsoon rainfall patterns in the Ganges-Brahmaputra-Meghna basin using inter and intra-annual time series TRMM satellite observations and available gauge data.

(b) Characterize shoreline change and land loss/accretion using Landsat or other satellite observations across decadal time scales.

(c) Create models establishing quantitative relationships between (a) and (b) that can be used in a predictive framework for future riverbank erosion and associated land loss/accretion.

(d) Document human mitigation and adaptive responses via household survey and/or interview data collection.

A list of potential funding programs includes (not in any prioritized order):

Funding Program
1. A-31 NASA Interdisciplinary Research in Earth Science
2. A-20 NASA Precipitation Measurement Mission
3. A-37 NASA Water Resources Applied Sciences Team
4. A-13 NASA Modeling, Analysis and Prediction
5. A-22 NASA Earth Surface and the Interior
6. NSF Geography and Spatial Sciences
7. NSF Coupled Natural Human Systems
8. NOAA Broad Agency Announcement (BAA)
9. NOAA Climate Program Office
10. USAID Bangladesh

References

Black, R. 2001. Environmental refugees: Myth or reality? Working Paper no. 34. United Nations High Commissioner for Refugees.

Borjas, G. J. 1994. Economics of migration. *Journal of Economic Literature* 32, 1667-1777.

Gianinetto, M. and P. Villa. 2004. Monsoon flooding response: A multi-scale approach to water-extent change detection. *ISPRS Proceedings of International Symposium on Spatio-Temporal Modeling*, Istanbul, 36: 8pp.

Gray, C. L. 2009. Environment, land, and rural out-migration in the southern Ecuadorian Andes. *World Development*, 37(2), 457-468.

Islam, M. M. and K. Sado. 2000. Development of flood hazard maps of Bangladesh using NOAA-AVHRR images with GIS. *Hydrological Sciences Journal* 45(3):337-355.

Lonergan, S. 1998. *The role of environmental degradation in population displacement. Global Environmental Change and Human Security Project*. International Human Dimensions Programme on Global Environmental Change. Research Report 1.

Massey, D. S., Alarcon, R., Durand, J., & Gonzalez, H. 1987. *Return to Aztlan: The Social Process of International Migration from Western Mexico*. University of California Press: Berkeley, CA.

McGranahan, G., D. Balk, and B. Anderson. 2007. The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment & Urbanization* 19(1): 17-37.

Motohka, T., K.N. Nasahara, A. Miyata, M. Mano, and S. Tsuchida. 2009. Evaluation of optical satellite remote sensing for rice paddy phenology in monsoon Asia using a continuous in situ dataset. *International Journal of Remote Sensing* 30(17):4343-4357.

Myers, N. 2002. Environmental refugees: A growing phenomenon of the 21st century. *Philosophical Transactions of the Royal Society of London B*, 357, 609-613.

Reuveny, R., and Moore, W. H. 2009. Does environmental degradation influence migration? Emigration to developed countries in the late 1980's and 1990's. *Social Science Quarterly*, 90(3), 461-479.

Roy, G.D., A.B.M.H. Kabir, M.M. Mandal, and M.Z. Haque. 1999. Polar coordinates shallow water storm surge model for the coast of Bangladesh. *Dynamics of Atmospheres and Oceans* 29:397-413.

Sanyal, J. and X.X. Lu. 2004. Application of remote sensing in flood management with special reference to Monsoon Asia: A review. *Natural Hazards* 33:283-301.

Singh, O.P. 2001. Cause-effect relationships between sea surface temperature, precipitation and sea level along the Bangladesh coast. *Theoretical and Applied Climatology* 68(3-4):233-243.

Singh, O.P., T.M.A. Khan, and S. Rahman. 2001. Has the frequency of intense tropical cyclones increased in the north Indian Ocean? *Current Science* 80(4):575-580.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.) 2007. Contribution of Working Group I to the Fourth Assessment report of the

Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Stark, O., & Bloom, D. E. 1985. The new economics of labor migration. *American Economic Review*, 75, 173-178.

Tacoli, C. 2009. Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment & Urbanization,* 21(2), 513-525.

Unnikrishnan, A.S., et al. 2006. Sea level changes along the Indian coast: Observations and projections. *Current Science* 90:362-368.

Zaman, M.Q. and R.E. Wiest. 1991. Riverbank erosion and population resettlement in Bangladesh. *Practicing Anthropology* 13(3): 29-33.

Zhang, Y., C. Wang, J. Wu, J. Qi, and W. A. Salas. 2009. Mapping paddy rice with multi-temporal ALOS PALSR imagery in southeast China. *International Journal of Remote* Sensing 30: 6301-15.

Appendices

Appendix 1: Final Workshop Program

Scoping Workshop: Human Responses to Catastrophic Monsoon Events in South Asia, Designing a Spatially Explicit Model in Low-Lying Coastal Area

Location: Hotel Eastern Residence (http://www.easternresidence.com/), Road # 27, House # 14,
Block # J, Banani, Dhaka-1213, Bangladesh

Date: Tuesday, September 18, 2012

Time: 8:00am – 5:00pm

Workshop Agenda

Time	Task	Presenter
8:00 – 9:00	Check in and Breakfast	
9:00 – 9:15	Welcoming Remarks	Tom Crawford, Ahsan Ahmed
9:15 – 9:30	Overview and Charge	Tom Crawford
9:30 – 10:00	Flood Inundation and Hydrological Modeling	Ashok Mishra
10:00 – 10:20	Issues in Flood Mitigation and Adaptation	Anuradha Mukherji (via teleconference)
10:20 – 11:00	Break	
11:00 – 11:30	Bangladesh & Eastern North Carolina: Sea-Level Rise and Surges	Tom Allen (via teleconference)
11:30 – 12:00	Satellite Precipitation Data	Scott Curtis & Ahmed Salahuddin
12:00 – 12:30	Climate Data Availability and Catastrophic Monsoon Events	Kehellala Premalal
12:30 – 1:30	Lunch	
1:30 – 2:00	Decision Support System of Riverbank Erosion of Bangladesh	Roshidul Hasan & Rafiqul Islam
2:00 – 2:30	Monsoon and Regional Development Issues in South Asia	Ahsan Ahmed
2:30 – 3:00	Break	
3:00 – 3:30	Environment and Migration: A Recursive Conceptual Model	Don Bradley
3:30 – 3:50	People and Pixels: Spatially Explicit Human-Environment Interactions	Tom Crawford
3:50 – 4:00	Break	
4:00 – 5:00	Facilitated Group Discussion and Strategy	Facilitator: Tom Crawford
5:00 – 5:15	Summary Remarks and Closing	Tom Crawford

Workshop Presenters

Dr. Thomas Crawford*, Associate Professor, Department of Geography, East Carolina University, Greenville, NC 27858 USA, crawfordt@ecu.edu
http://personal.ecu.edu/crawfordt/main/crawfordt.html

Dr. Ahsan U. Ahmed, Executive Director, Centre for Global Change, House 12-Ka/A/1, Road 2, Shaymoli 2nd Lane, Dhaka 1207, Bangladesh, ahsan.ua@gmail.com

Dr. Roshidul Hasan, Associate Professor and Head, Dept. of Computer Science and Information Technology, Bangabandhu Sheikh Mujibur Rahman Agricultural University Gazipur 1706, roshidul@roshidul.com

Dr. Rafiqul Islam, Associate Professor, Dept. of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh, rafiarib@yahoo.com

Dr. Ashok Mishra, Assistant Professor, Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur - 721 302 (W.B.) India, amishra@agfe.iitkgp.ernet.in

Mr. Kehelella Premalal, Deputy Directory, Department of Meteorology, 383, Bauddhaloka Mawath, Colombo, Sri Lanka, spremalal@yahoo.com

Dr. Thomas Allen, Associate Professor, Department of Geography, East Carolina University, Greenville, NC 27858 USA, allenth@ecu.edu

Dr. Donald Bradley, Associate Professor, Department of Sociology, East Carolina University, Greenville, NC 27858 USA, bradleyd@ecu.edu

Dr. Scott Curtis, Associate Professor, Department of Geography, East Carolina University, Greenville, NC 27858 USA, curtisw@ecu.edu

Dr. Anuradha Mukherji, Assistant Professor, Planning Program, East Carolina University, Greenville, NC 27858 USA, mukherjia@ecu.edu

Dr. Ahmed Salahuddin, Post-Doctoral Research Associate, Department of Geography, East Carolina University, Greenville, NC USA 27848, salahuddin0812@gmail.com

*Workshop lead coordinator

Appendix 2: Letter of Invitation

Dear _____:

I am writing on behalf of a collaborative Asia-US research team led by Dr. Thomas Crawford of East Carolina University, USA to invite you to a research workshop on September 18 at the Hotel Eastern Residence in Dhaka titled, "**Scoping Workshop: Human Responses to Catastrophic Monsoon Events in South Asia, Designing a Spatially Explicit Model in Low-Lying Coastal Areas**". This workshop is funded by the Asia-Pacific Network for Global Change Research (http://www.apn-gcr.org/). The included attachments provide a registration form, venue information, a preliminary schedule/agenda, and the list of Asia-US team members and presenters who will be traveling to Dhaka for this meeting. We are inviting you because of your expertise in topics related to the workshop themes. Below is a synopsis of research themes that will be addressed at this workshop:

Workshop Synopsis and Themes: Settlements in coastal lowlands are vulnerable to risks associated with sea level rise and higher intensity storm events. Coastal lowlands of the Asia-Pacific region have among the highest population densities in the world. Economically marginalized populations in the region are likely to be disproportionately affected by climate change impacts. This research scoping workshop will host a multi-partner planning workshop to support research that models human responses to catastrophic monsoon events and sea level rise in South Asia. Results will provide a framework and an agenda for a sustained, place-based research program that investigates human responses.

Themes:

1. **Climate Change and Climate Variability:** human response to environmental change connected to climate change.
2. **Ecosystems and Land Use:** land use change as a consequence of sea level rise and monsoon events.
3. **Changes in the Atmospheric, Terrestrial, and Marine Domains**: terrestrial inundation coupled with atmospheric change (i.e. climate change and monsoon dynamics) and marine change (i.e. sea level rise).
4. **Resource Utilization and Pathways for Sustainable Development**: human adaptive responses including migration, land use allocation and livelihood strategies as sustainable pathways to respond to terrestrial inundation.

We hope you can attend this meeting during which there will be a series of 30-minute thematically focused session. Each session will include a 15-20 minute presentation followed by opportunities for your feedback and input. An afternoon facilitated breakout session will have small groups discuss research needs and strategies related to the topic of human responses in low-lying coastal areas of South Asia. We anticipate that this workshop will generate recommendations for a larger research effort on this topic and that participant interactions may lead to opportunities for future research partnerships that incorporate expertise from invited workshop attendees.

Please fill out the included registration form if you plan to attend and send via e-mail . This is no registration cost for you to attend. Lunch and refreshments will be provided at the workshop.

If you have any question regarding the workshop, please feel free to me (Dr. Thomas Crawford) or Dr. Giashuddin Miah who is assisting with local arrangements. Dr. Miah's contact information is:

Dr. Md. Giashuddin Miah
Professor, Agroforestry and Environment
Dean, Graduate Studies/Programs
Treasurer of the University
Bangabandhu Sheikh Mujibur Rahman Agricultural University
Gazipur-1706, Bangladesh
giash1960@gmail.com

We hope you will be able to attend.

Sincerely,

Dr. Thomas Crawford
Associate Professor
Department of Geography
East Carolina University
Greenville, NC USA 27858
crawfordt@ecu.edu
http://personal.ecu.edu/crawfordt/main/crawfordt.html

Appendix 3: Workshop Registration Form

Scoping Workshop: Human Responses to Catastrophic Monsoon Events in South Asia, Designing a Spatially Explicit Model in Low-Lying Coastal Area

Location: Hotel Eastern Residence (http://www.easternresidence.com), Road # 27, House # 14, Block # J, Banani, Dhaka-1213, Bangladesh

Date: Tuesday, September 18, 2012

Time: 8:00am – 5:00pm

Registration Information

Please type information in the boxes below and e-mail to:

Dr. Thomas Crawford, crawfordt@ecu.edu and/or Dr. Giashuddin Miah, giash1960@gmail.com

Name:	
Job Title:	
Mail Address:	
e-mail Address:	
Phone:	
Name of Institution:	
Nationality:	
Topical Area(s) of Expertise :	**Please list:**
Countries or Regions of expertise:	**Please list:**

Appendix 4: List of Workshop Attendees

Scoping Workshop: Human Responses to Catastrophic Monsoon Events in South Asia, Designing a Spatially Explicit Model in Low-Lying Coastal Area

Participant List

First Name	Last Name	Institution	Email
Ahsan U.	Ahmed	Centre for Global Change	ahsan.ua@gmail.com
Thomas	Allen	East Carolina University	allenth@ecu.edu
Donald	Bradley	East Carolina University	bradleyd@ecu.edu
Md. Abeed Hossain	Chowdury	Bangladesh Agricultural Research Council	dir-computer@barc.gov.bd
Thomas	Crawford	East Carolina University	crawfordt@ecu.edu
Scott	Curtis	East Carolina University	curtisw@ecu.edu
Md. Roshidul	Hasan	Bangabandhu Sheikh Mujibur Rahman Agricultural University	roshidul@roshidul.com
Abu Wali Raghib	Hassan	Department of Agricultural Extension	hassan58_dae@yahoo.com
Jahangir	Hussain	IDE Bangladesh	jahangir@dhaka.net
M. Nazrul	Islam	Jahangirnager University	mnislam.geo@gmail.com
Md. Rafiqul	Islam	Bangabandhu Sheikh Mujibur Rahman Agricultural University	rafiarib@yahoo.com
M. Kamruzzaman	Kamruzzaman	Bangabandhu Sheikh Mujibur Rahman Agricultural University	kzamanau@yahoo.com
Md. Abdul	Mannan	SAARC Meteorological Research Centre (SMRC)	mannan_u2003@yahoo.co.in
Giashuddin	Miah	Bangabandhu Sheikh Mujibur Rahman Agricultural University	giash1960@gmail.com
Ashok	Mishra	Indian Institute of Technology, Kharagpur	amishra@agfe.iitkgp.ernet.in
Anuradha	Mukherji	East Carolina University	mukherjia@ecu.edu
Shitangsu Kumar	Paul	University of Rajshahi	shitangsuk@yahoo.com
Kehelella	Premalal	Department of Meteorology, Sri Lanka	spremalal@yahoo.com
Md. Abiar	Rahman	Bangabandhu Sheikh Mujibur Rahman Agricultural University	abiarbd@yahoo.com
Ahmed	Salahuddin	East Carolina University	salahuddin0812@gmail.com
Md. Zahidul Hoque	Sardar	Bangladesh Bureau of Statistics (BBS)	hoquesardar@yahoo.com

Appendix 5: Village Group Discussion Guide

Group Discussion Guide: Char Algi

Overview: Arrive and meet with the village chairman and his council. This may entail a walking (or driving tour) of selected village sites/themes or it may be a sit down discussion.

- Introductions: Crawford provides overview of our project, etc.
- Explanation of why we are here: to learn more about village livelihood strategies and how people perceive weather/climate/hazards risks and respond to them.
- Ask chairman/council about how the village has changed in the past 30 years (or 10 years).
- How does weather/monsoon/flood hazards impact the village?
- How does the village deal with these challenges?

Discussion Groups:

- Group 1: Fishermen
- Group 2: Farmers
- Group 3: Other occupations

General Village Perceptions

- How would you describe life in this area? (main jobs, lifestyle, etc.)
- How has the village changed in the past 30 years or so? (what new things have happened?)
- Do many people move away from the village? Where do they go (migration question)?

Weather and Hazards Perception

- Has the weather or seasons changed much since you've been living here?
- What have been your experiences with flooding and monsoons?
- Is flooding or monsoons getting worse?
- How does weather/monsoon/flood hazards impact the village?
- What do you do when a flood is expected?
- What do you do after the flood? (migration, money borrowing, new job)
- Do you have family/friends in this village or other villages/districts that you have (or would) rely on for help if there was a bad flood?
- Do you hear much about sea level rise and is this something of concern to the village?

Wrap Up

- What are the biggest challenges you face living in this area?

Appendix 6: Poster Map of Char Algi

(Note: full size was 4ft x 3ft and presented to the village chairman)


Char Algi, Bangladesh
Char Algi
APN
Centre for Global Change (CGC)
East Carolina
On September 20, 2012 a research team with representatives from the Asia-Pacific Network, Centre for Global Change, Department of Meteorology, Sri Lanka, Indian Institute of Technology, Karagpur, and East Carolina University met with the Chairman of Char Algi and village residents to discuss "Human Responses to Catastrophic Monsoon Events in South Asia". This trip was supported by the Asia-Pacific Network.