Climate Services for Improved Adaptation Decisions

Focus on Coastal Bangladesh

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1. Introduction:

How do sea level rise, cyclones, coastal flooding, and storm surges affect vulnerable populations around the world? It is often said that people who live in disaster – prone regions are highly vulnerable. However, vulnerability is as much affected by social conditions as physical exposures. A key indicator of local adjustment to climate variability and change is the degree to which people have access to and are able to apply knowledge about their environment in their livelihood activities (Grainger-Jones, 2013). In this context, climate services, which involve the production, translation, transfer, and use of climate information, are increasingly important for effective preparedness and response to climate-related impacts. This makes climate services particularly important for countries like Bangladesh, because of increasing exposures to climate related risks.

While the entire country is exposed to various climate stresses, the densely inhabited coastal Bangladesh along the Bay of Bengal constitute a vulnerability "frontline" (Dasgupta, 2015; O'Donnell & Wodon, 2015). Climate change in the region is experienced in the form of cyclones, coastal flooding, and storm surges that endanger local lives and livelihoods. Local farmers adjust to increasing climate pressures by altering their livelihood decisions regarding the mobilization and allocation of available household resources. They also look to external sources of support. One such external source is information on climate variability which is provided through either locally or through the national climate services. This information in Bangladesh has traditionally been appeared in the form of early warning systems and short-term weather forecasts. More sophisticated climate services are being developed that provided longer-term forecasts, flood forecasts, indications on when monsoon will begin, and other information. However, it is not known if, in the context of climate change pressures, these services are consistent with local climate information needs. **Focusing on coastal Bangladesh, I conducted research on the intersection of the demands for climate information on the part of local farmers and the climate information (services) produced and disseminated by the national meteorological department.** I asked whether climate information, appropriately communicated, can improve the adaptation decisions of local farmers, who are highly vulnerable to climate related risks.

Climate change as a global phenomenon will increasingly demand innovative adaptation measures in order to reduce the negative consequences of such changes on society, economy, and environment (Adger et al., 2009). Since the efforts to tackle the causes of climate change (mitigation) have been slow, cumbersome, and often involve lot of political disagreement, the threat of climate change is increasingly severe and complex. Adaptations, particularly in most vulnerable countries in the developing regions, is becoming increasingly important. In this context, when Bangladesh is ranked one of the most climate vulnerable countries according to the IPCC Fifth Assessment Report (IPCC, 2014), improving adaptation decisions and capacities are more critical than ever before.

It is important to understand that even though climate change is presented as a long-term macro-scale process, the reality is often manifested and experienced as real-time local-level alterations in climate variability. However, these impacts are usually not homogenous (IPCC, 2014; Ruth & Ibarraran, 2009). Poor and marginalized people who are often dependent on climate-sensitive sectors, such as farming and fishing, will be affected by climate change to a larger extent than other population groups (IPCC, 2014). In this study, I focused on communities in coastal Bangladesh, where thousands of poor and marginalized people are at risk of unpredictable rainfall patterns, sea-level rise, saltwater intrusion in land and groundwater, coastal erosion, storm surges, and tropical cyclones (GoB, 2014). I *hypothesized* that an in-depth understanding of the impacts of climate change on local livelihoods and of the strategies local farmers employ to cope with climate pressures could provide the basis for more relevant and beneficial climate services. Drawing on the literature on social vulnerability to climate change and climate services, I asked: **under the condition of climate variability and uncertainties, how can the local farmers in coastal Bangladesh use agro-meteorological information for their improved cropping decisions?**

Despite the importance of the issues affecting thousands, if not millions, in Bangladesh, surprisingly limited empirical knowledge exists in this area. Bangladesh, because of its vulnerability and the efforts to provide climate information and adapt to climate change, is a critical case to gain deeper understanding on adaptation in a more nuanced way. The knowledge ascertained through this research will have valuable implications to multiple other regions that are heavily exposed to climate stresses, particularly in similar social and environmental conditions.

2. Climate Stresses in Coastal Bangladesh:

The long coastal areas are densely populated with almost 35 million people; however, there are also some sparsely populated remote islands (Shamsuddoha and Chowdhury, 2009). The discharge of several rivers, including the Ganges-Brahmputra-Meghna river system, makes coastal Bangladesh one of the most productive ecosystems in the world (Laila, 2013). The region is ecologically rich due to the combination of the world largest mangrove forest, the "Sundarbans", tidal estuaries, productive and fertile farmland along with favorable conditions for shrimp cultivation (Huq, et al., 2015).

Figure 1: Coastal Bangladesh

At Hiron Point, which is near the Sundarbans in southwest coastal region, the average annual rise sea level was already 5.3 mm a year from1977 to 2002 (CEGIS, 2006). IPCC predictions suggest that 15 million people could be affected and 17,000 square km of land could be submerged if there is just 1-meter rise of sea level. The number will increase to 18 million affected people and 22,000 square km of land submerged if the sea level rise increases from 1 meter to 1.5 meters (Church et al., 2013). Most of the climate-sensitive sectors, such as agriculture, fishing are highly vulnerable because of variations of meteorological parameters (e.g. precipitation and temperature), extreme climate events (e.g. tropical cyclones) and various slow onset climatic events (e.g. salt intrusion in land and ground water, droughts) in the region (Hassan and Shaw, 2015).

2. Research Framework:

2.1 Study Site:

The coast of Bangladesh is approximately 47,201 square kilometers, which is 32 percent of country's total landmass (Hossain and Hossain, 2008). It is densely populated; however, there are also some sparsely populated remote islands (Shamsuddoha et al, 2009). Despite its economic and ecological importance, livelihoods in these extremely fragile and low-lying coastal areas are heavily exposed to progressive inundation from sea level rise, cyclones and tropical storms, heightened storm damage, loss of wetlands and biodiversity, and salinity intrusion in land and groundwater (Dasgupta, 2015).

As part of CLIMAS Climate & Society Graduate Fellowship, I worked in Kalapara, which is in the coastal district Patuakhali. Kalapara is approximately 492 sq. kilometers in size with a population of 238,000. Local communities practice a diversity of livelihoods, including farming, fishing, and some forest-dependent activities, such as wood and honey collection, even though small-scale traditional farming (e.g. crops, rice, and vegetables) is the most common livelihood option (Hoque, 2014). These farmers are usually poor, and often cannot afford modern agricultural tools (Ahmed and Cokinos, 2017).

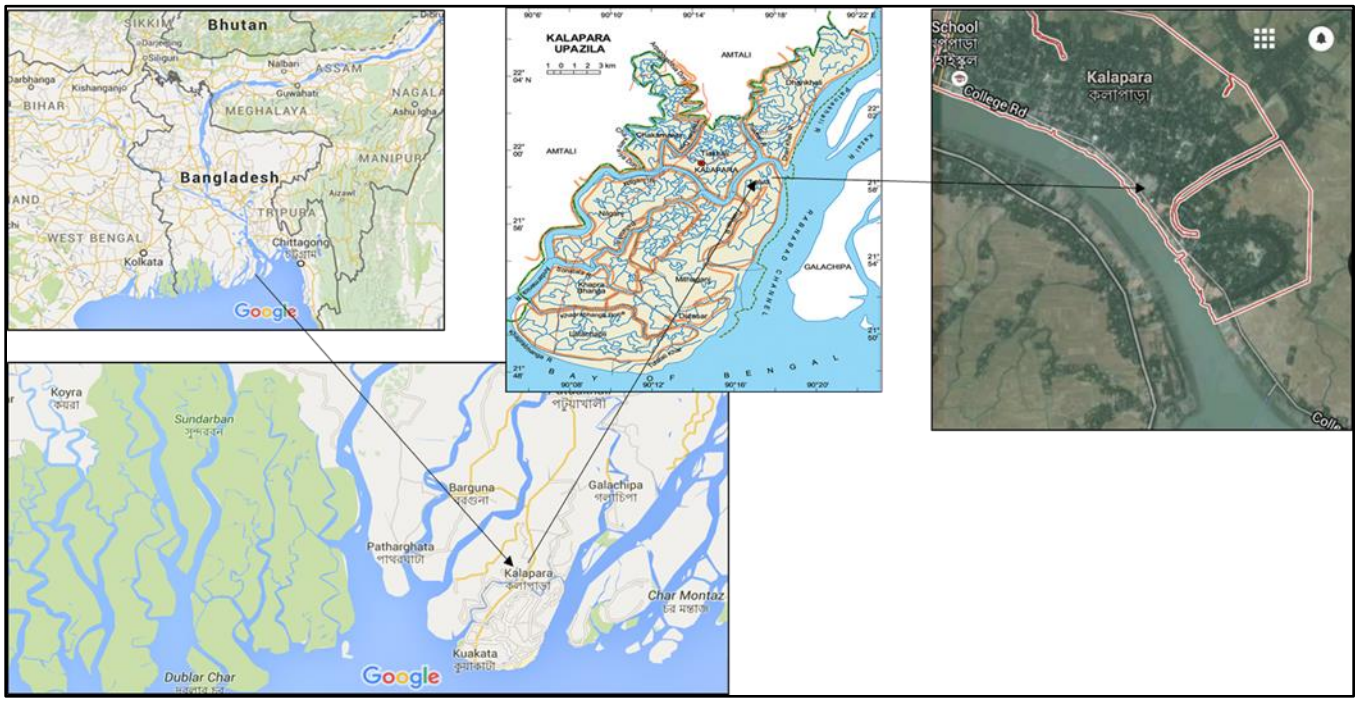

Figure 2: Study Area (Kalapara, Patuakhali, Bangladesh)

However, the use of climate information in their livelihood decisions is also limited. Unfortunately even though they are highly vulnerable, small farmers, who hold small plots of land or lease someone else's land or work as labor, have limited interactions with the local extension agents. The frequency of interactions with local extension agents is often determined by the scale of production, socio-economic status and local political influence of the individual farmer.

2.2 Research Methods:

At first, I conducted key informant interviews (semi-structured), who are involved in the supply chain of climate services delivery in the region. In Kalapara, I interviewed local elders, who are aware of and involved in community affairs; local extension agents, known as Sub-Assistant Agriculture Officers ; local NGO representatives, who are working on issues related to disaster risk reduction and climate change adaptation; local representative from Bangladesh Red Crescent Society, who are very active in disseminating early warning and related information prior to any extreme climate events; local government representatives (e.g. Upazilla Nirbahi [Executive] Officer). I also discussed in very interactive settings with the representatives from Bangladesh Meteorological Department (BMD) /Agromet Division and Department of Agriculture Extension on various aspects of climate services in the country.

Locally, I identified: Muslim households, who are majority; Hindu households, who are minority; households from the local indigenous community; and female-headed households. Male family members from female-headed households are either moved to large cities temporarily for better employment opportunities or passed away in some cases, and therefore, female are the major earning members in female-headed households. Female-headed households can fall under any of the three other population groups; however, for this project, I treated them as another distinct group, since they had different challenges, resources, and needs for adaptation. It was important to realize that race, ethnicity, and gender play a major role in shaping local power structure, which in turn translate to access to various resource and decision-making process. Even though all these four groups of people are primarily farmers, their exposures to climate risks are different depending on their own lifestyles and livelihood patterns. Say for example, indigenous people are at high risk, because of their livelihood dependence on nature in addition to their engagement in traditional farming. The socio-economic backgrounds

of these four groups of people are also different, which ultimately translate to their differential capacities and available resources to cope with any climate stressor. Therefore, their adaptation needs are also different.

I conducted few semi-structured interviews within each of the four groups. I selected respondents within each group to represent a range of characteristics, regarding: (a) dependency on climate-sensitive sectors (e.g. farming); (b) exposures to slow-onset and extreme climate events; (c) limited non-farm income sources; and (d) poor economic status. Here I used the World Bank definition of poor, as those who earn less than US$2 a day. In addition, I selected my first respondent using purposive sampling, which is a deliberate choice of an informant due to the qualities the informant possesses (Tongco, 2007). Once I select, I used snowball sampling, a non-probabilistic sampling technique where existing study subjects recruit subjects from among their acquaintances (Goodman, 1961), to select the other respondents in each social group following similar selection criteria.

3. Climate Services in Bangladesh

3.1 Climate Information Supply:

In general, early warnings before any extreme climate event, such as cyclones, thunderstorms, flashfloods, are relatively more available in Bangladesh than [climate] information about slow onset events, such as sea level rise, salinity intrusion in land and ground water resource (World Bank, 2016). However, the capacity to forecast extreme climate events with sufficient lead time and accuracy is still in question. In reality, climate information plays an important role to understand current climate and weather related risks, recent trends, their causes, and their likely trajectories months to decades into the future.

Currently, there are a number of organizations working on weather forecasting and prediction in Bangladesh. Majority of them are working directly under the supervision of various key ministries/organizations of the Government of Bangladesh: the Planning Commission under the Ministry of Planning; Bangladesh Meteorological Department (BMD) under the Ministry of Defense; Bangladesh Water Development Board (BWDB) and Flood Forecasting and Early Warning Center (FFWC) under the Ministry of Water Resources; Department of Disaster

Management (DDM) under the Ministry of Food and Disaster Management; and Department of Environment and Climate Change Cell under the Ministry of Environment and Forest.

Daily weather forecast has been provided for all the meteorological stations and districts of Bangladesh (Islam et al., 2013). BMD also provides its weekly agro-meteorological information that are useful for people whose livelihoods are dependent on climate-sensitive sectors. BMD recently established 12 agromet data-collection stations across the country. The Department provides three types of weather forecasts that can be useful for local farmers: short-range (up to 48 hours); medium-range (up to 10 days); and long-range (more than 10 days). Each has specific roles to play in local agricultural practices and planning. In theory, BMD also informs farmers about the precautionary actions that they should take as a response to unpredictable weather patterns to minimize their crop and income losses. At present BMD's Agromet Division collects a range of climatic and agromet data with which it prepares advisories and bulletins for both farmers and policy makers. The Division also supports the National Early Warning and Food Information System and Department of Agricultural Extension, thereby improving the supply of timely and reliable information on the national food supply situation (Balaji and Crufurd, 2014).

As a lead meteorological department in the country, BMD issues forecasts on: daily district wise weather forecast; weekly agro-meteorological forecasts; long-range weather forecast for one month; long-range forecast of three months for the Ministry of Agriculture, BARC, DAE and other related departments; heavy rainfall warnings; Kalbaishakhi and other squall warnings; and cold- and heat-wave warnings.

In addition to BMD, FFWC and BWDB, also produces some weather information: daily monsoon bulletin & river situation report; river level forecasts for 24, 48 and 72 hours; current warning messages; special flood situation report; thana inundation status map; flood forecast maps; monthly flood report; dry season bulletin (weekly); annual flood report (Islam, 2013).

In the country, BMD play the major role as the producer of climate science information. In simple words, BMD produced major climate/weather related information or early warning, Department of Agriculture Extension (DAE) gets agriculture or fisheries related information from them, and then those information are channeled through DAE's Agriculture Information Service (AIS) and Field Supervisors. Those field supervisors are previously known as Block Supervisor, and currently named as Sub Assistant Agriculture Officer (SAAO), who are the

frontlines of disseminating agriculture information in the village level. They are trained in such a way, so that they can interpret, synthesize and disseminate relevant climate information and knowledge to the local farmers and fishermen.

However, in the current years the effectiveness of SAAO has raised some questions, which are relating to increasing complexity of climate variability and change as well as individual capacity and intent to work and disseminate climate information in the village level. Usually local people receive climate information from television and radio. In some situation that can be also challenging due to the lack of electricity or remoteness. People get most of their climate related information from local informal networks, e.g. word of mouth. Since numerous NGOs are active all across the country, they can be involved into this process. Already NGOs receive the reputation of disseminating early warning before any extreme weather event. Local people frequently experience absence of an established television and radio channel dedicated for climate information.

In general, majority of the information produced by BMD are focused on early warning before any extreme climate event. There are limited attentions of season to sub-seasonal climate information in the country, which put the farmers or fishermen more challenging situation dealing with climate variability and change.

3.2 Local Need of Climate Information:

Studies suggest, farmers can increase their productivity by 10% if they have access to good weather and climate "agromet" advisories and services (Balaji and Craufurd, 2014). In short period, weather forecasting play critical role in cyclonic and storm surge forecasting, flood forecasting, drought predictions, and heat wave and cold wave forecasting (Islam et al., 2013) that help substantially to minimize human losses and other economic and social damages. Available, accessible, and useful information can help agricultural decision-makers to improve their understanding of the mechanisms and process of climate impacts on agricultural development and food systems and also estimate populations at risk from food insecurity (WMO, 2014). In Bangladesh, the agriculture, forestry and fisheries sectors play a major role in national economy. Approximately 47 percent of its 169 million people are being directly or indirectly engaged in these sectors (Bangladesh Bureau of Statistics, 2010). From food security perspective, the agriculture and fisheries sectors are critical. Currently, fish provides 55 percent

of animal protein intake (FAO, 2015) and rice contributes more than half of the total caloric intake (IRRI, 2015). Climate variability and change are creating various challenges for aquaculture and agriculture, which are likely to jeopardize national efforts to achieve food sufficient. In the country, people are now frequently exposed to unpredictable precipitation patterns, increase in temperatures, sea level rise, increasing intensity and frequency of extreme weather events, salinity intrusions and drought (Huq, 2011). In recent years, farmers and fishers have experienced the shifting patterns of initial monsoon rains, such as previously monsoon used to start in late March or early April and continuing until the end of July, but now starting in July and ending somewhat unpredictably. In rural Bangladesh, rice and fish cultivation are vulnerable to short to long term climate variability and changes. Continuous rains can cause flooding, and floods coupled with increased temperature commonly result in substantial or complete crop losses. Bangladesh is now also exposed to increase temperature and therefore, particularly, on summer months heatwaves are more common than previous. In addition to the impacts on increased human health challenges and even mortality, livelihoods that are dependent on climate-sensitive sectors are also adversely affected. Heatwaves are not food for fish, or agriculture practice. Heatwaves contribute to decrease soil moistures and insects become a problem in agriculture crops.

Local people are more familiar with the early warning system before any extreme weather/climate events. Despite the need, there are very few opportunities for having climate information on slow-onset climate variability. Field evidence suggests that local farmers can be benefitted if they can receive the weather information in appropriate manner, such as, if they are informed at least a week before about the timing and extent of monsoon there can be chances to minimize loss and damage. Some farmers also mention that if they can receive any weather or climate related information one month before, they can enhance their preparedness. In this case, they can harvest early with enough notice as well as raise embankments and/or install nets to prevent fish from escaping. In addition, seasonal to sub-seasonal climate information can help them to decide which crop they should plant under various climate conditions. Such as, for them, it is essential to know the seasonal rainfall forecast (for agriculture and fisheries activities) at a spatial scale of sufficiently fine resolution to enable responses at local scales that are relevant to communities (Islam et al., 2013).

3.3 Climate Prediction Uncertainty:

Weather or climate information often comes with a probabilistic nature. There is no official information available regarding the degree of certainty of the forecast product of BMD. However, the degree of certainty and lead time of forecasting of rainfall needs improvement. Because unpredictability of climate and weather information can be costly for both small and large farmers in the region.

Forecasting from FFWC is reasonably accurate for the very short duration of 3 days. However, the accuracy suffers when lead times increase. In the rural areas, unpredictable nature of weather and climate information can be the reason for local farmers and fishermen not to rely always on forecasting. It is actually not a fault of poor small rural people. They do not realize that climate and weather information come with probabilistic nature. It is critical challenge for BMD and other organization regarding the precision of weather and climate information. Precision of weather and climate information can generate trust on produced science and encourage people to follow the instruction and in turn minimize damage in times of weather and climate crises.

3.4 Climate Information Supply Gap:

At this stage it is challenging to fully capture the climate information supply gap. However, from some rapid assessment from the coastal region, it was apparent, that local people largely do not receive climate information periodically. What they receive is some climate information and climate related awareness bill board in some spots alongside of major highways.

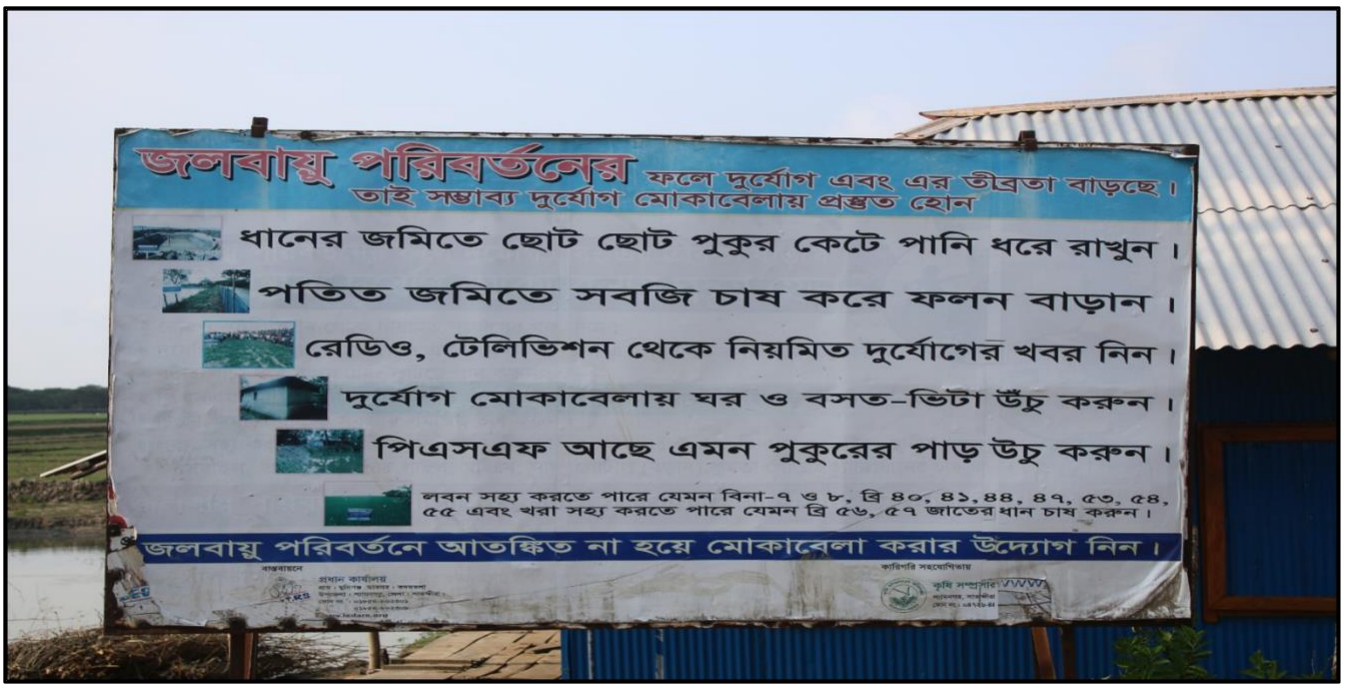

Figure 3: Billboard on climate change alongside the highway

But there are also some local critics about the position of these bill boards. Since they are alongside the major highways, not many villagers go there or see. The people who only visit to local markets or so, they can see this. However, there are also some climate information related billboards were visible near the local government office.

Figure 4: Billboard on early warning next to local government office

In some villages, with supports from national and international development partners, some villagers develop local "*Resource and Risks Map*"**.** However, they are not well-maintained and often difficult to understand the information.

In summary, local people along with the government often confuse themselves early warning with weather and climate information. They understand getting early warning is provision of climate information. However, they do not understand the large spectrum of the provision of climate information and services, and therefore, overlook the important implications of climate information on local adaptation decision-making and resilience.

However, it was clearly understood during the rapid assessment that access to available information is already challenging for the local people. The information they receive in any form from any places are inadequate and often irrelevant. The potentiality to maximize BMD weather and climate information is larger than the present situation. The current processing of information and delivery channels need to improve to reach the large share of population.

In addition, current capability and the provision of weather and climate information do not address the differential needs of weather and climate information, because of people's differential exposure to weather and climate related challenges. It was evident from the rapid

assessment, that local majority (e.g. Muslim), local mainstream minority (e.g. Hindu), female headed households and local indigenous community – all have differential exposures to weather and climate impacts, and their information requirements are also different. Due to their socio-economic and political differences, access to information is also different. So for an inclusive climate services mechanism, these aspects should be taken care of.

3.5 Improving the Delivery System:

Improving the climate information and delivery system requires an in depth understanding and research on the entire process. Locally relevant and socially engaged climate information and services delivery system requires engagement of a wide array of stakeholders. Previous rapid assessments in the coastal Bangladesh suggested that neither state nor science community came to the region to know the local needs on climate services. Local people were neither invited nor part of any development planning or solutions. Traditionally, in the country, most of the development works follow the shadow of colonial practice (e.g. top-down development). Due to this limited engagement of local people into any development process, sometimes development interventions like climate change adaptation address wrong/undesired issues, which end up being maladaptation with negative consequences on peoples' lives and livelihoods.

There is a clear disconnection among the stakeholders of climate services. Users of science (e.g. farmers), producers of science (e.g. Bangladesh Meteorological Department), distributors of science (e.g. local government, weather office), community development enablers (e.g. NGOs), research institutions, government organizations, and other development partners merely interact to advance the benefits of climate information and services. This non-communication offers no opportunity for coproduction of climate knowledge and end up having limited implications on adaptation decision-making and community resilience.

It is important to realize that local farmers are increasingly recognized as the major "clients" of climate information and services. Service delivery mechanism should be farmer (fishermen)-centric. The entire process might require intensive involvement of research, extension, and farmer continuum. Such linkages require special expertise and multiple perspectives (Balaji and Craufurd, 2014). However, a socially engaged and locally-relevant process is not easy, largely due to its practice and history with top-down development approach

as well as limited experiences and opportunities with the coproduction of knowledge. Therefore, it is important to ask and understand the appropriate ways to incorporate both scientists' and stakeholders' *interests, needs, and perspectives* in a project setting. That suggests we need to understand in local context, what would be the mode and approaches to collaboration that can support socially-engaged climate services delivery mechanism.

However, several aspects need to consider for developing a socially engaged and locally relevant climate services delivery mechanism. Now often local community members need to travel several kilometers to reach nearest rural markets, where they receive information. There are many locations where there are no electricity. So for them, going to nearby rural markets is the only option. In addition, if it is not the case of no electricity, local people have more access to mobile phone rather than newspaper or radio/television. However, climate information dissemination using radio and television can be effective for spreading the information in mass level. Sending text message on climate information can be useful.

During the rapid assessment, local farmers mention it will be useful for many of them if they receive climate and weather related information with sufficient lead time. That will allow them to prepare before any major natural hazards. They cannot harvest in the rain. Heavy rainfall forecasting will be helpful for saving crops. There were massive interest for having seasonal climate information (3 months). Participants noted an increase in rain and temperature led to an increase in disease, and also indicated their frustration in government lead projects as they often don't ask communities what they need – they just come in and complete an activity. They also highlighted, there are really only functional early warning for extreme events like cyclones and mentioned that updated climate information would be helpful for day in and day out decisions. It was clearly understandable during the rapid assessment that the dissemination of climate information can be augmented via communication through alternative media, such as sending representatives or volunteers from Government or NGO, mobile phone SMS alerts, etc. However, the quality and accuracy of the early warnings and climate information and services are essential in order to reduce damages.

4. Summary:

The overarching goal in Bangladesh should be to integrate a use-inspired and stakeholder-driven climate services, so that local farmers and other community members can use available climate information to improve their adaptation decisions. Local farming communities would be in better position once they receive tailored climate information that they can combine in their farming practice. Given the large amount of work that has been done in Bangladesh in the area of extreme events and disaster preparedness, the best opportunities are to work on longer timescales including slow-onset monsoon, salinity intrusion, and sea level rise in the region.

Strengthening the national capacity for weather and climate services in Bangladesh has tremendous implications for nations' interests for striving towards climate resilience and improve adaptation decision-making. There have been several projects that aimed to strengthen the capacity of the Government of Bangladesh to deliver weather and climate information in priority sectors and to prepare for climate variability and hydro-meteorological disasters. However, very limited number of them have address the production and delivery cycle of climate information, ranging from science producer, BMD to end science users, farmers. Through this Climate & Society Graduate Fellowship from the CLIMAS, I wanted to address those missing gaps and gain insights on how to maximize the use and implications of climate information and knowledge for advancing society's strive for achieving sustainable development goals by 2030.

A use-inspired climate services has strong implication not just in the region/country, but also in other regions/countries (e.g., Maldives, low-lying Pacific Island Countries) that are facing similar social-environmental challenges. This coastal Bangladesh case study on integrating climate services in adaptation decision-making is therefore an important addition to climate services for adaptation and resilience debate in context of resource-constraint conditions.

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Of Personal Notes:

The experience as a CLIMAS Climate & Society Graduate Fellow 2016 was intellectually stimulating and professionally transformative. It provided me opportunities to think, observe, and test the impacts of use-inspired climate services for improved adaptation decisions in resource-constraint situation. Particularly:

Broader Knowledge on Climate Stresses:

- I travelled across the coastal Bangladesh, and gained how societies and regions are exposed to various climate stresses, such as sea level rise, rainfall variability, and salinity intrusion.
- I also have the opportunities to listen to diverse groups of populations and gain knowledge on their adaptation efforts, and perceived needs.

Dissertation Research:

- During the fieldwork, I selected a specific site for my dissertation fieldwork.
- I also refined my research questions based on local insights and inputs from various local stakeholders.
- I established contacts with:
    - Khulna University
    - Patuakhali University of Science and Technology
    - ADAMS (a local NGO)
    - ICCCAD (International Centre on Climate Change and Development)
    - Bangladesh Meteorological Department
    - Department of Agriculture Extension
    - Local Government Officials in Kalapara
    - Local community members
- All these will be instrumental for my dissertation fieldwork in the region, which is now planned for the Fall, 2017.

Grant Application:

- Based on my CLIMAS fieldwork insights and information, I developed dissertation research proposal, and submitted for the National Science Foundation Doctoral Dissertation Research Improvement Grant (Geography and Spatial Sciences).

Outreach:

- Presented field research findings to:
    - ICCCAD (Dhaka, Bangladesh) in June, 2016
    - USAID Bangladesh Mission (Dhaka, Bangladesh) in June, 2016
    - Department of Agriculture Extension (Dhaka, Bangladesh) in June, 2016

Thank you CLIMAS!