Local responses to weather and climate-related stressors: Adaptation, resilience and transformation in two coastal villages in Bangladesh

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Abstract:

The people of coastal Bangladesh are experiencing the effects of weather and climate-related stressors such as higher temperatures, prolonged drought, increased and more intense rainfall, increased cyclone and storm surges, higher tidal heights, frequent rough sea weather conditions and increased salinity. The paper reports on a recent study of two coastal villages of Bangladesh. It shows a loss over recent years of livelihood opportunities of the poor dependent on natural resources due to cyclones, drought, rising temperatures, intense rainfall and increased salinity. Measures taken to address those stressors by the communities and other actors include improved coastal embankments, rehabilitation and strengthening of houses, improved methods of ensuring a supply of drinking water, new ways of protecting agricultural land and production and changes in fishing methods and practices. These measures fall within the model of adaptation-as-resilience with some evidence of limited movement towards more transformational strategies. (Words 145)

Key words: Adaptation, Bangladesh, climate change, resilience, transformation

Introduction

Adaptation is now a central conceptual tool in climate change research and policy-making. It refers to accommodation to the likely impacts of changes in climate resulting from historical and present-day emissions of Greenhouse Gases (GHG) brought about by a combination of natural and anthropogenic causes. The main global climate change body, the Intergovernmental Panel on Climate Change (IPCC) in its 2014 Assessment Report (AR5) defines adaptation as 'The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.' (IPCC WGII AR5 Summary for Policymakers, 5)

Until recently, academic and policy development has focused on what has been referred to as incremental adaptation within a resilience framework (Pelling, 2010; Kates et al., 2012; Park et al., 2012; Wise et al., 2014). This resilience-as-persistence approach to adaptation derives from an engineering-*cum*-ecological perspective in which a system (household, village, and eco-system) is said to exhibit resilience if it bounces back from a shock or stress. As Folke et al. (2010) put it, resilience is a '… buffer capacity for preserving what we have and recovering to where we were' (Folke et al., 2010, 6). This earlier resilience framework with its focus on restoring societal and ecological equilibrium has more recently undergone modification in an attempt to reflect the more dynamic, non-linear and open-ended nature of change in coupled socio-ecological systems. This shift is recognized by Noble et al. (2014) in the 2014 AR5 (Assessment Report 5, IPCC, 2014) when they comment:

> Incremental adaptation refers to actions where the central aim is to maintain the essence and integrity of the existing technological, institutional, governance, and value systems, such as through adjustments to cropping systems via new varieties, changing planting times, or using more efficient irrigation. In contrast, transformational adaptation seeks to change the fundamental attributes of systems in response to actual or expected climate and its effects, often at a scale and ambition greater than incremental activities. It includes changes in activities, such as changing livelihoods from cropping to livestock or by migrating to take

> up a livelihood elsewhere, and also changes in our perceptions and paradigms about the nature of climate change, adaptation, and their relationship to other natural and human systems (Kates et al., 2012; Park et al., 2012; IPCC SREX, 2012, section 8.6.2.3 and FAQ 8.2; IPCC AR5, section 20.5; Green Climate Fund, 2013b, 3.3). (Noble et al., 2014, 839)

This paper takes up the resilience-transformation debate through an examination of how the people in two coastal Bangladeshi villages understand and deal with local socio-ecological changes linked to climate change, climate variability and associated human-induced and natural hazards. Bangladesh is considered one of the most vulnerable states to climate change and has taken a lead in global action against it (Ali, 1999; GoB, 2009b; MoEF, 2005; Stern, 2006). The paper is organized around four questions. What do coastal peoples see as the most important weather/climate[1] related changes they face? How do their understandings and experiences translate into adaptive strategies? How do local people evaluate the functions of mainstreaming public agencies towards supporting community level adaptation to impacts of changing weather/climate factors? What are the implications of the study findings for current academic and policy debates on the relationship between adaptation as resilience and as transformation?

The paper shows that local people have observed changes over the past several years in normal weather patterns and have responded drawing on traditional techniques and practices conditioned by their occupational and other backgrounds rooted in their everyday and historically shaped material worlds. They have some knowledge and understanding of the abstract notion of climate change but it is not a priority. Their priorities relate to employment, health, education, local politics and dealing with the everyday struggles for survival. Weather and weather-related events and processes are only one component in their efforts to adapt to changes in the social-ecological environment. Adaptation actions taken fall within a relatively conservative resilience framework, which essentially reproduces existing systems of production and reproduction. There is some evidence of a shift to what Pelling calls ‘transitional approaches to adaptation’ (Pelling, 2010: 68-82) but this is in its early stages.

Field work was carried out by Rahman in two villages, Chakbara and Fultala, in Shyamangar upazila (sub-district) under Satkhira district from 2010 to 2013. It included

complete village household surveys, focused group discussions (FGD), key informant interviews (KII), many conversations and observations of the daily lives and activities of local people. People interviewed included rice farmers, shrimp farmers, fishers, fish traders, landless labourers and marginal farmers, local government officials, members of local Non-Governmental Organisations (NGOs), teachers, business people and others. The two villages are spatially close to each other (15 km) but differentially exposed to various hazards and with different occupational and economic profiles. Chakbara has an island-like appearance surrounded by large rivers at the sub-district's southernmost tip and bounded directly by the Sundarban Reserve Forest (SRF) on the south and southwest. Most land is under export-oriented brackishwater shrimp farming and most residents depend on natural resources from rivers and the SRF. It is highly exposed to flooding, storm surges, cyclones, river erosion and soil and water salinity due to its location on the bank of a large tidal river. Cyclone Aila in 2009 severely affected the village and it remained inundated with saline water for over a year. The second village, Fultala, is located on the mainland and relatively less exposed to coastal hazards as it is three km away from a tertiary tidal river protected by embankments. Over 90 percent of village land is devoted to traditional rice farming and salinity is less of a problem than in Chakbara. No villagers relied on the SRF for their livelihoods although the forest is less than 3 kilometers from the village (see Figure 1 for location of villages).

What do coastal peoples see as the most important weather/climate related changes they face?

The two villages have long histories and local historical memories extend to the 19th century. Elderly people recollect many changes to local life during their own life times and those of their parents and grandparents. Of particular importance is the impact of over 50 years of pre-climate change Bangladesh Government and donor agency development interventions that have shaped present-day social, economic and political structures and people's current concerns over changing weather and weather-related events and processes. The most important impacts of such interventions have been infrastructural changes such as new roads, polders and water control structures, conversion of wetlands for agriculture, shrimp farming and other uses, changes in land

and waterscapes and water flow regimes. These changes have affected some groups more than others in both positive and negative ways. The livelihoods of the poorer members of both villages have been negatively affected by reduced freshwater flows, salinity intrusion, the shift to shrimp farming and the appropriation of state-owned land by wealthier and more powerful community members, loss of river navigation, and reduced biodiversity. The origins of some of these changes, such as the construction of the Farraka Barrage in India in 1974, lie outside the present-day borders of the country.

More recently, inhabitants of the two villages have noticed weather and weather-related changes, which have intensified existing conditions of vulnerability[2] rooted in previous social-ecological changes and have affected some village members more than others. Local people have a complex and well-developed vocabulary related to local weather. Most villagers have heard of climate change (jalabayu paribartan) and it has become more commonly used in recent years as a result of observed changes in local weather conditions and the increased activities of government and NGOs in relation to climate change adaptation. However, local people do not often used the term in everyday conversation but speak of changes in weather (abohawya). Generally, by 'weather' they mean particular local weather conditions such as sunlight (rowd), temperature (taap), clouds (megh), rains (bristy) and wind (batash). They refer to days with rains and storms as 'bad weather' (kharap abohawya) and sunny days with clear sky, no storm or strong wind as 'good weather' (bhalo abohawya). In other words, the idea and meaning of weather are embedded in the community vocabulary around local understanding of factors such as rainfall, drought, cold, seasons, tides, which have been integral parts of their lives and livelihoods over generations. Local understandings of weather vary across different occupational groups or people engaged in different economic activities. To understand this better, nine occupational groups were selected for analysis using focused group discussions, survey data and other in-depth conversations with local people. The nine groups are:

1. Fultala rice farmers.

2. Chakbara shrimp farmers. Usually have above average incomes with many switching from rice farming and forest work to shrimp farming.
3. Combined shrimp and rice farmers from Fultala.
4. Chakbara sea-going fishers who had been river fishers or rice farmers and had switched to sea fishing.
5. Chakbara river and forest fishers using small boats to fish in local rivers in and around the SRF.
6. Chakbara crab collectors who had shifted from fishing or shrimp Post Larvae (PL) collection to the more lucrative crab collection.
7. Fultala female rice farmers who assisted male kin.
8. Chakbara female shrimp PL collectors who had previously been farmers or wage labourers
9. Chakbara Mowals (honey collectors) who collect honey seasonally from the SRF and work irregularly in fishing, shrimp PL catching, wage labouring, and shrimp farms.

They identified eight major local weather and weather-related changes during the past five to ten years. These were i) an increase in temperatures especially during summer and monsoon; ii) prolonged drought from more erratic rainfall; iii) more intense rainfall and flooding especially during late monsoon; iv) more frequent rough sea conditions during monsoon and late monsoon; v) cyclones and storm surges post-monsoon and pre-monsoon; vi) heightened water level during high tides especially in late or post monsoon; vii) increasing soil and water salinity extending further inland during the dry season; and viii) shorter and warmer winters together with some intermittent intense cold spells lasting a few days. Figure 2 shows main weather-related stressors and occupational group responses.

Figure 2: Main weather-related stressors and villager adaptation responses

Rice farmers stated irregular rainfall interfered with cropping cycles and had increased the risk of farming. Fishers observed changes in fish migration patterns and more micro-

storms at sea, which necessitated changes in fishing locations and altered fishing effort. Sea going fishers commented that over the past few years, there had been an increase in sudden and instant storm events (hotath jhor) in the sea /lower estuary areas that lasted for around 30 minutes. No warnings were given and some fishers lost nets and floats and in 2009 two fishers died. Shrimp farmers were affected by declines in water quality and by cyclones that washed away shrimp enclosures. Some stated that cyclones were more severe, something partly explained by the advent of two particularly destructive cyclones-Sidr and Aila- in 2007 and 2009. Both men and women said the traditional six Bengali seasons had now reduced to three with longer and warmer summers and shorter and warmer winters.

Many villagers also drew attention to stressors they did not for the most part attribute directly to the weather such as the spread of shrimp viruses, increased numbers of crop pests, reduced fish availability in rivers/mangroves, scarcity of fresh water for drinking, cooking and irrigation, embankment breaching, increased tiger attacks, job scarcity, economic and other barriers in accessing mangroves, siltation, the legal and illegal grabbing of rivers/canals and increased occurrence of banditry in the mangroves. In some instances these stressors were the indirect consequence of weather events and processes and identified as such. For example, increased tiger attacks were partly caused by the decline in tiger prey in the SRF as a result of the devastation caused by the cyclones. Increased pest infestation was attributed partly to changes in weather conditions. Increased soil and water salinity was a result of growing salt water penetration of the coastal land caused by rising water levels, shrimp farming and other factors.

While local people identified various changes in local weather, they differed in what they considered to be the main priorities affecting their livelihoods. Table 1 shows that most priorities were not directly weather-related but in-depth interviews and FGDs revealed that many villagers linked these concerns to weather changes such as sea level rise, droughts and irregular rainfall. These data were drawn from household censuses in the two villages.

Table 1: Main priority problems affecting local livelihoods

What these data suggest is that while local peoples had observed and been affected by changes in local weather in recent times, they were not seen as the main problems they faced but formed part of a wider set of concerns related to previous and on-going development interventions and changes, criminal activities and more broadly-based social-ecological changes. This needs to be kept in mind in the next section, which looks at how local people have adapted to recent weather-related events and processes.

How do local people's understandings and experiences translate into adaptive strategies?

The villagers have learned over decades and centuries ways in which to deal with relatively predictable uncertainties. The more recently observed changes in weather patterns have to some extent simply intensified traditional weather-related uncertainties and villagers have responded by drawing on well-known local practices to deal with them. Table 3 summarises the main weather-related stressors they face and the kinds of responses to those stressors.

Table 2: Weather-related stressors and villager adaptation responses

The table shows that most local actions to deal with weather impacts were largely initiated and carried out by local people themselves using well-known local techniques with NGO and local government support. For example, rising water levels led some villagers, with limited financial support from NGOs and the local government authority, to re-build their homes on stilts, an infrastructural adaptation. Fultala farmers considered salinity of crop fields and intense rain-based flooding (kasthe or akash bonnya) as priority problems. They wanted canals to be returned to their original role as drainage channels to ease flooding and wash out salinity from soils and to act as storage for monsoon rain water in order to expand land devoted to winter rice (boro) and vegetables. They saw these measures as increasing food security and providing employment for the

poor and other villagers. Riverine fishers reported that sand and silt deposits on rivers in the SRF had reduced fish numbers, particularly high-valued species. Some responded by seeking new fishing grounds closer to the Bay of Bengal or shifted to sea-going fishing. The latter exposed them to new and often dangerous conditions as they were forced to seek shelter from bad weather in the Bay. This meant a loss of income and an increased reliance on money lenders to cover occupational and household costs. Increased tiger attacks on local villagers resulting from cyclone-induced prey shortages led some fishers to change their fishing practices by using nets that allowed them to remain on their boats in the forest rather than wading in the tributaries and canals.

The national NGO, Caritas Bangladesh, and the Forest Department (FD) played a more substantial role in a mangrove restoration scheme aimed at protecting the local embankment from tidal erosion in a village close to Fultala. The agencies provided financial and technical support to improve ecosystem functions and provide ecosystems services of various kinds such food, fuel, fodder, and timber, regulatory services such as water flow regulation, erosion control, disaster risk reduction, and carbon sinks, and services such as soil formation, nutrient cycling, and natural habitats. While the mangrove restoration covered only 1.5 km. of coastline and income invested was low, it illustrates the potential for more cross-scalar community-based adaptation schemes (CBA) aimed at giving priority to the needs of local people.

However, most occupational groups focused on what could be done to assist their own work and livelihoods rather than taking a whole community or village approach. In some instances this meant that one group's adaptation strategy was regarded as detrimental to another. For example, while Chakbara shrimp farmers called for raised embankments to protect their shrimp enclosures from cyclones and flooding, non-shrimp farmers were wary of such proposals as shrimp farmers were known for making illegal private sluice gates and pipe culverts in embankments to facilitate water exchange. Such unauthorized structures weakened the dykes and contributed to embankment failure and consequent salt water inundation. While infrastructure changes are important to protect and build up the adaptive capacity of local communities, they can be maladaptive for some community members. More generally, most actions were undertaken at the individual or

household level and were largely reactive, autonomous and incremental (Kates et al., 2012). They were not based on weather vulnerability assessments and lacked any sustainable community-based planning. Some schemes such as pond, shrimp enclosure and canal rehabilitation, mangrove restoration and adaptive agriculture (see below) did adopt some aspects of the ecosystems-based adaptation framework (EbA)[3] and were able to contribute to the enhancement of ecosystem services and community resilience. But most local adaptation actions aimed to achieve short term objectives that at best enhanced levels of resilience and at worst simply allowed individual households to cope, that is, to rely on known methods of accommodation rather than more reflexive practices aimed at longer-term transitional or transformational adaptation (Pelling, 2010). However, there is some evidence of more organized attempts to challenge official and unofficial obstacles to greater local control over their adaptation practices. The next section examines local people's views on their engagement with selected public agencies.

How do local people evaluate the functions of mainstreaming public agencies towards supporting community level adaptation to impacts of changing weather/climate factors?

There have been increasing calls with some policy action at global and national levels to integrate climate change adaptation into development planning[4]. Bangladesh is regarded as a global leader in adaptation planning (Rai et al., 2014) and government and NGOs have been engaged in a variety of adaptation initiatives since the early 1990s (Ayers et al., 2014). These initiatives began to crystallise in the early 2000s into the development of more wide-ranging programmes and policies to make future development planning more climate resilient. Adaptation is now a central component of Bangladesh's official climate policy, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) (GoB, 2009 a., b). In 2010 the government-international donor funded Bangladesh Climate Change Resilience Fund (BCCRF) was established and includes the Community Climate Change Project (CCCP) with a brief to provide funding to NGOs to carry out community-based projects to enhance local resilience.

According to the World Bank:

> At present [2014], PKSF [Palli Karma-Sahayak Foundation (PKSF), the governing council of the BCCRF] has assigned 27 CCCP subprojects to competitively selected local NGOs. The projects include raising homes to prevent daily inundation; repairing roads and planting trees to strengthen road embankments; ensuring access to safe freshwater by rainwater harvesting; excavating ponds and performing desalination in water-scarce villages; and adapting agricultural practices to farm drought-resistant or flood-tolerant crops. The 27 projects include 10 in the high-saline areas, 9 in the flood-affected areas and 8 in the drought-prone areas, with each addressing at least one of the six thematic pillars of the Bangladesh Climate Change Strategic Action Plan (BCCSAP). (http://www.worldbank.org/en/news/feature/2014/07/17/bangladesh-community-driven-attempts-to-build-climate-change-resiliency)

All these projects fall within the adaptation as resilience framework with a number allocated to deal with salinity in the southwest of the country. However, at the time of the field work, there were no CCCP-supported projects in either of the two villages. The Union Parishad (UP), the lowest level of elected government administration funded by the central government, which focused on conventional development activities without specific reference to weather-related concerns. The main development activities in 2010/11 were infrastructural such as road development, earth filling, re-excavation of ponds and canals, construction of culverts/drains, dyke repair, excavation/renovation of drinking water ponds, and school repair. Other agencies such as the Department of Fisheries (DoF) and the Department of Agricultural Extension (DAE) provided limited support to local fishers and farmers and to weather-related concerns. Villagers pointed out that these government actions did not generally reflect their priorities. For example, in Fultala villager priorities were insect pests, lack of freshwater for irrigation, salinity, canal grabbing, drainage congestion and flooding, and a loss of freshwater fish while the local UP's development priorities lay elsewhere. Similarly, Chakbara residents were most concerned with bandits and piracy, harassment by forest officials, tiger attacks, lack of shrimp PL, and lack of freshwater for irrigation and drinking, salinity and embankment failure. None of these were given any priority in the UP development programme.

The lack of direct official engagement with local people in local adaptation actions in the two villages is reflected in table 4. Six of the schemes were small in nature and mostly undertaken by individuals and their families rather than involving greater collective or community level organization and mobilization that extended over wider landscapes. They can be characterized as incremental adaptation (Kates et al., 2012) or adaptation-as-resilience building (Pelling, 2010, 50) in that they were modest in scale, largely dealt with recovering from weather-related shocks using known local measures, fragmented rather than well-planned collective actions, technology driven and took place within the political space defined by the dominant institutions of the society. Whether intentionally or not, they maintained what Pelling (2010, 50) refers to as the functionality of the social-ecological system. Many villagers felt powerless to change both the legal and illegal practices that shaped their lives and they expressed considerable frustration with the activities of some of the relevant government agencies responsible for overall management of coastal resources and disaster risk reduction. However, outright challenges to such activities were uncommon and most people worked within the existing political economic framework to achieve whatever outcomes they could (Mosse, 2005). However, three schemes did show signs of going beyond resilience building towards a more transitional phase of adaptation that worked around and began to challenge 'the rules of the game' that sought to contain development within a largely managerialist, technical and, at times, corrupt (Alam et al., 2011; TIB, 2014) framework. These were the NGO-farmer adaptive agriculture scheme, canal/wetland rehabilitation for freshwater, agriculture and fisheries and the mangrove restoration for erosion control, biodiversity and livelihoods. The next section illustrates in more detail how the NGO-adaptive agriculture scheme moved from a largely resilience-based exercise to one that sought to effect more robust change.

Table 4: Place of adaptation schemes in "Resilience to Transformation" framework

Adaptation, resilience and transformation

The Center for Natural Resource Studies (CNRS), a national NGO, supported by a United Nations Development Programme-Global Environmental Facility (UNDP-GEF) small grants programme titled community based adaptation (CBA) to climate change, began working in 2011 with local Fultala farmers on agriculture based adaptation activities. At that time there had been two weeks of intense heavy rains which damaged 100% of amon rice seedlings and led to forced re-seeding. CNRS brought in a late variety of amon seeds and seedlings from the BRRI (Bangladesh Rice Research Institute) and demonstrated different sowing technologies to farmers. Production was above average and the rice was harvested earlier than other varieties in the area. The demonstration showed that prior to the demonstration, farmers in the area were not aware of the late varieties of amon rice, which indicated a failure of the agriculture extension services and poor dissemination of the outcomes of the BRRI to farmers but that damage to the amon seedbed or newly transplanted seedlings could be reduced through using late varieties and direct sowing. Farmers learned they could increase yields by 15-20% through technical improvements and were keen to adopt the technology and learn more about improved and stress tolerant rice varieties and how they could access them. Other local farmers considered that the locally unavailable new variety was better adapted to flooding even when sown late in the season and so exchanged the rice with the demonstration farmers, which they intended to preserve as seed for the next year. In summary, local farmers sought new and improved varieties of seeds to adapt to changing or irregular weather, which promoted agriculture based adaptation in saline and flood prone areas.

In 2012, CNRS moved to Chakbara village where winter rice farming had not been practiced for 25 years due to high salinity. CNRS assisted farmers to use a saline tolerant variety of boro (winter) rice (BRRI dhan 47), made a digital salinity meter available at the field level, taught farmers how to monitor the water salinity and provided technical support and hands-on training on fertilizing, weeding and pest management, watering and salinity management to improve rice cultivation methods. Post- transplantation, CNRS's field agronomist paid weekly visits and farmers were advised to drain water from fields when salinity was high and to re-water with pond water, which was generally less saline than crop field water. Yields were 6.5 tons/ha which was above the national

average of 6 tons and the demonstration created much enthusiasm among local people. After harvesting in April, some farmers planned for a second crop of summer rice (aus variety) from April to June prior to the next amon rice season in July/August. CNRS supported six farmers to test summer rice as a second crop.

CNRS organized a farmer's field day for people from other villages and for upazila and district level government agriculture officials. During the field day, some community members asked the government officials to take back control of the state owned (khas) canals in the village that had been leased out or illegally appropriated by others. They wanted the canals to be re-excavated to increase storage capacity of monsoon rain water so more farmers could cultivate rice over two seasons. By late 2013, CNRS had approached MMF (Mangroves for Future) project of IUCN-Bangladesh, an international NGO, which provided a grant to a farmers' association to rehabilitate a canal and seven ponds in Dumuria village for Chakbara and Dumuria farmers to cultivate winter crops and provide fish. CNRS also increased its support to over twelve farmers in Chakbara to cultivate high yielding amon rice in the 2012 monsoon season.

Some people attended the field day program at Chakbara from Patakhali village in Poddaypukur Union and approached CNRS for rice farming in shrimp enclosures abandoned after cyclone Aila. Continuous siltation and high soil salinity had combined to prevent rice farming. Several Patakhali farmers who had no cows or power-tillers used in rice farming were assisted by CNRS and the upazila agriculture office to till the abandoned shrimp farm land with shovels and transplanted various amon rice varieties. At first, rice grew better than expected but was then hit by a pest infestation. Repeated application of recommended pesticides did not work and upon inspection it was found that the local pesticide dealer had provided the wrong brand. With advice from agriculture officials, farmers bought the correct pesticides from the regional town and good rice yields were obtained for the first time since shrimp farming began some 25 years before. During harvesting in late November 2012, a mass gathering was organized to open the harvesting season and was attended by the district and upazila level agriculture officials, people from several villages, and the local government representatives.

The example shows that land previously devoted to shrimp farming could be returned to rice cultivation but suffered because of a lack of draft animals and power tillers. In response, CNRS formed two agriculture farmers' associations in Patakhali and Chakbara-Dumuria and provided one power tiller to the Patakhali farmers to start winter rice cultivation and one low lift pump to Chakbara to irrigate the crop fields. The upazila agriculture office also provided one low lift pump to the Chakbara-Dumuria farmers' association for a nominal rent. CNRS sought to return khas lands to rice farming through contacting the district administration responsible for approving canal leases. A district magistrate met with rice farmers and assured them of assistance to free the canals from leasing. The farmers took the opportunity to ask the DAE officials, district administration and NGOs to take action to resolve other issues related to rice farming. In FGD, farmers expressed their concerns about eight specific issues requiring urgent attention to facilitate adaptive farming in the weather stressed coastal zone. These issues included water management, erratic weather factors, enabling markets, pest management, technical backstopping, farm management, land and water use conflicts and quality seeds and inputs.

Of particular importance were land and water use conflicts in the local shrimp farming areas where sluice gates were manipulated by shrimp farmers, canals converted for shrimp and rice farming, drains congested, local populations increasing and crop lands flooded. The rice farmers of Fultala and Kultali villages who shared croplands had been affected by drainage congestion and resultant crop loss for over 12 years because of legal and illegal canal leasing, conversion and restricted access to fresh water in the dry season. The rice farmers had taken legal action but failed because of what they referred to as political interference that favoured the leaseholders and land grabbers. It is important to understand that national government policy states that a khas canal (as flowing canal or river) cannot be leased to any person for the purpose of agriculture, aquaculture and conversion but can only be leased to fishers' groups for fishing. But in reality most of the canals in the area were leased to individuals or illegally grabbed, converted and used for private purposes. The local land leasing authority lies with the upazila and district land administration if the size of land/wetland is less than 20 acres

and with the district authority if the size is over 20 acres. In the study area, two methods were used by influential people to obtain canal leases and to appropriate wetlands. First, in Fultala, in the name of the landless, influential local people obtained leases for up to 99 years and then converted canals to crop lands and settlements or fragmented them for aquaculture. Second, leaseholders in Chakbara converted canals to shrimp enclosures. These actions resulted in conflict between the leaseholders/grabbers and poor people who fished in canals for consumption and sale. There was also conflict between grabbers/leaseholders and rice farmers who used canal water for rice farming. The other institutional actors such as local leaders, land officials, UPs, upazila, district and even central government authorities were generally aligned with the land takers through manipulation of the official leasing system. Local people lacked the legal knowledge and support on state land leasing policies and processes and were unable to organize collective action, which meant the illegal activities went uncontested.

Chakbara farmers joined with the demonstration farmers from Dumuria village to protest formerly to the district land administration authority against land leasing and to restore previous commons land for water use in rice irrigation. Eventually, the upazila (sub-district) administration investigated the contested sites and the farmers' association complained that the leaseholder tried to convince the investigation committee to prepare reports that favoured his continuing control and that the local UP Chairman supported the leaseholder. The farmers asserted that the leaseholder bribed those involved to provide a favourable report. At the time of writing, no resolution had been arrived at.

The case study shows that the NGO-farmer group began with a largely resilience approach based on technical interventions but shifted to questioning and even challenging the wider legal and institutional framework that was used by more powerful agents to appropriate land for their own uses. The action started small with a few farmers of one village who responded successfully to the loss of their amon rice seed beds because of late monsoon intense heavy rain-based flooding by introducing late growing varieties. In the following winter rice season, with the support of CNRS and local agricultural officials, the farmers successfully demonstrated to other farmers that they could cultivate winter rice in saline affected enclosures at a higher production rate than the national average. In the following monsoon, some farmers in other villages

approached the project farmers who demonstrated how rice farming could be successful in abandoned shrimp ghers through proper seed bed preparation, transplantation, fertilizing, pest management, salinity monitoring and water management. Later, groups of farmers established associations to develop local farming strategies and plans to identify available sources of freshwater, which could be stored in canals for use in rice farming. In 2014, with IUCN-MFF project support, CNRS assisted two Dumuria farmers to cultivate wheat using pond water and obtained yields above the national average.

This result was achieved through tripartite negotiations between the local government representatives, leaseholders of canals, shrimp farmers and rice farmers with NGO assistance. The Chakbara-Dumuria farmers' association obtained a low lift pump machine from the upazila agriculture office, local agriculture extension agents paid field visits to support farmers and the NGO provided one power tiller and one low lift pump to two farmers' associations, which had been formed under the program. One factor that worked against more comprehensive collective action was that the main beneficiaries of the farmer actions were smallholder farmers rather than landless labourers who constituted a high proportion of the local population. While some labourers were able to become sharecroppers in rice farming, most were not directly assisted to take up farming.

The issue of how to transfer the leases of state owned canals from shrimp and fish farming to rice farming remained unresolved. This was the most serious political problem facing the farmers as it challenged existing power arrangements in the local area and ultimately the whole system of lease allocation, which traditionally favoured those with political influence up to the highest levels of government. Using Pelling's three fold schema of adaptation, the initial actions of the farmers can be seen as an attempt to build local resilience by '…seeking only change that can allow existing functions and practices to persist and in this way not questioning underlying assumptions or power asymmetries in society' (Pelling, 2010:50). This was followed by attempts to claim what were legitimate legal rights regarding the use of land and water resources with farmers challenging the actions of seed dealers, public officials and ultimately the national government to abide by the law. Pelling refers to this as

'adaptation as transition' as the farmers simply wanted the proper application of the law. In this sense, the challenge by the farmers to the state and its various local agencies to implement the law fairly constituted '…an extension of resilience adaptation to include a greater focus on governance…'(Pelling, 2010:68).

Conclusion

This paper has shown that local communities are responding to different weather related impacts, either on their own initiative or with some support from outsiders such as government agencies and NGOs in the areas of water, aquaculture, fisheries, flooding, agriculture and erosion. Most local adaptation actions were incremental and aimed to achieve short term objectives that at best enhanced levels of resilience and at worst simply allowed individual households to cope, that is, to rely on known methods of accommodation rather than more reflexive practices aimed at longer-term transitional or transformational adaptation. The NGO-farmers joint initiative in adaptive agriculture suggested the growth of more organized attempts to challenge the disjuncture between official policy and its implementation. In contrast, the annual development plans of local government and state agencies illustrated the poor state of local planning to address weather related vulnerabilities of local communities compared with other local concerns. Adaptation beyond resilience building involves multi-sector, multi-agency and cross-scalar institutional and policy actors and takes time, which under conventional short term project initiatives is difficult to achieve.

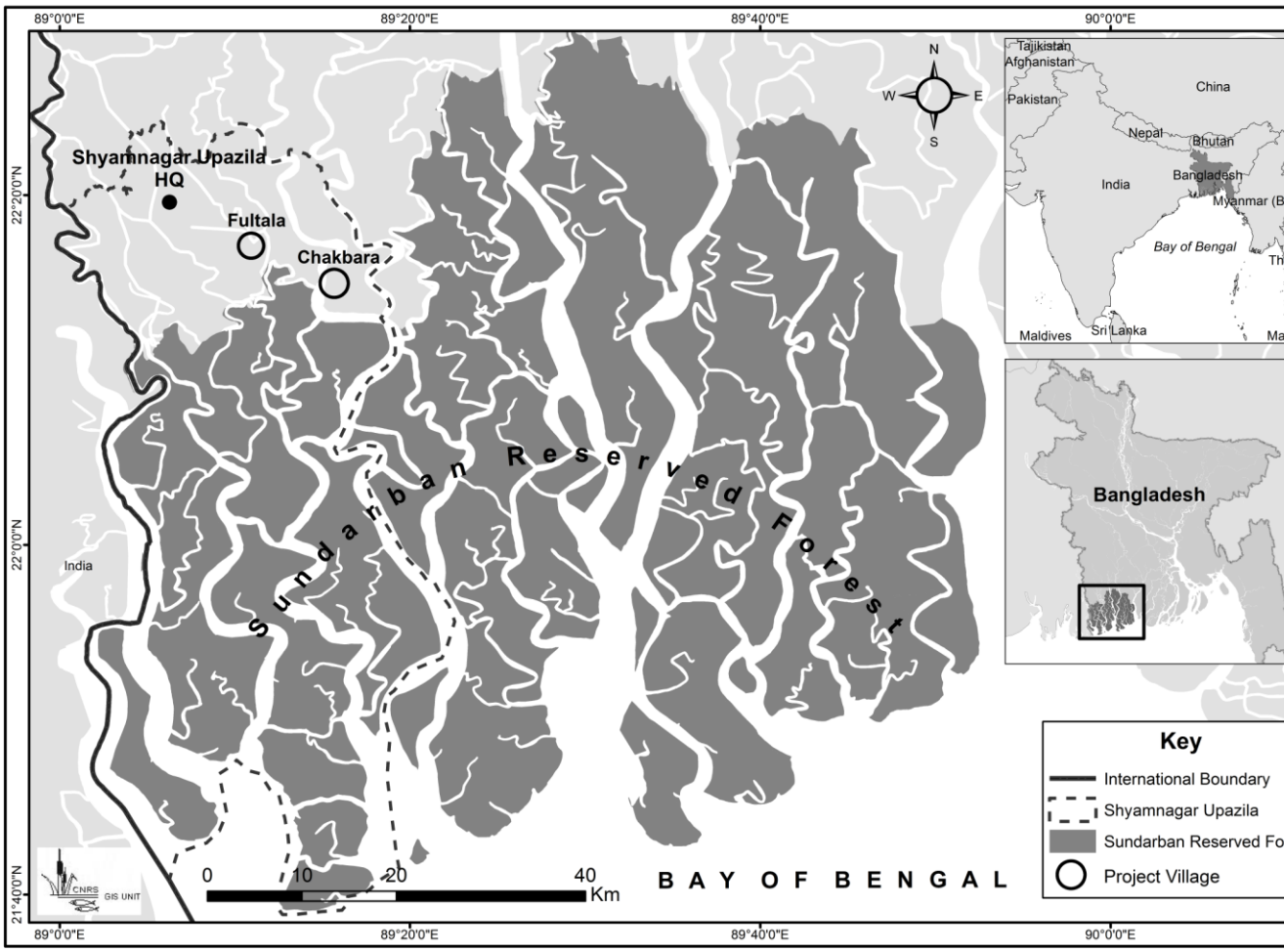

Figure 1: Location of study villages

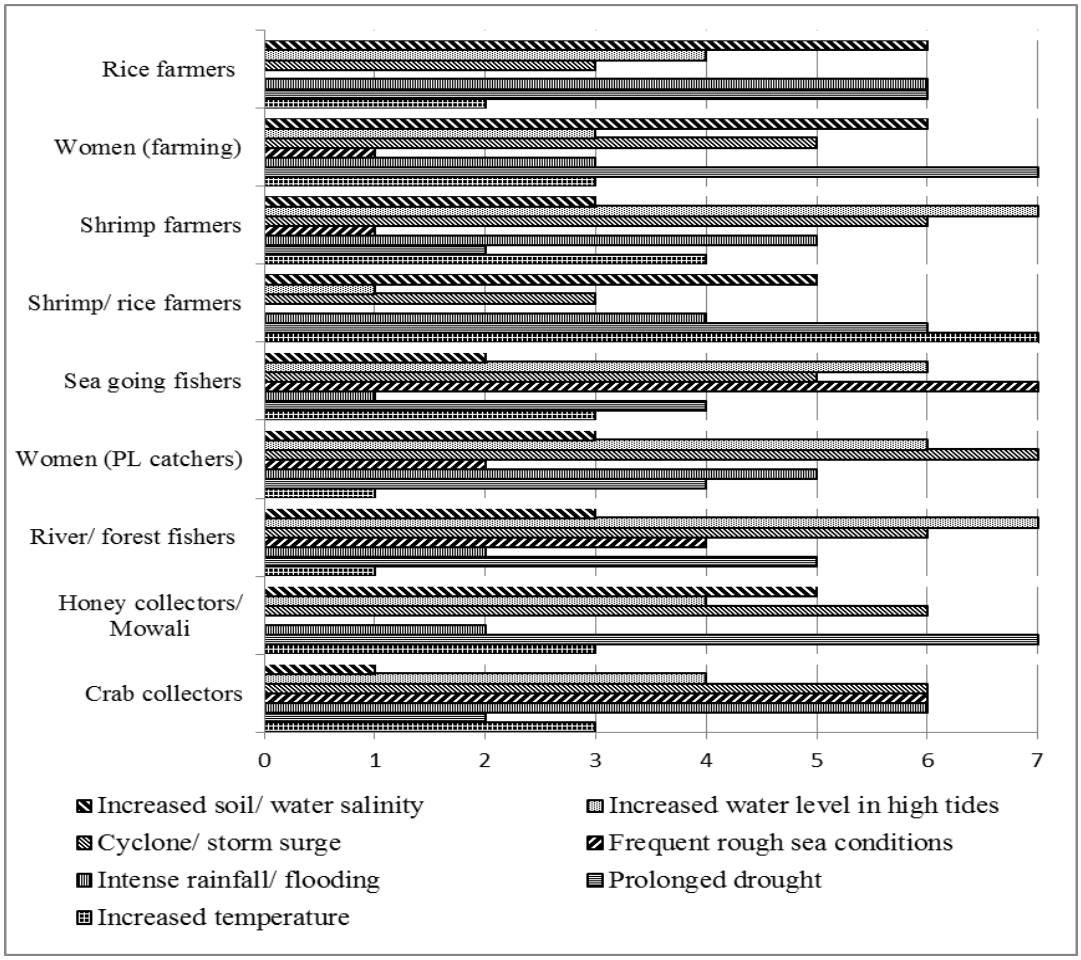

Figure 2: Main weather-related stressors identified by each occupational group

Priority problems of the people of Fultala and Chakbara villages	**Households mentioned (%)**	**Remarks**
Village: Fultala		
1. Increased insect infestation in rice crops	46.2%	Indirect weather-related
2. Salinity of crop fields after cyclone Aila	41.8%	Indirect weather-related
3. Job scarcity in the locality	26.3%	Non-weather related
4. *Akashbonnaya* or *kasthe* (rain-based flooding) affect crops	16.2%	Direct weather but canal grabbing (non-weather) intensifies drainage congestion
5. Poor physical health affecting capacity to earn income	15.8%	Largely non-weather
Village: Chakbara		
1.Dacoits (bandits) in the SRF and lower estuaries	55.6%	Non-weather

2. *Ghus* (bribery) of Forest Officials	52.2%	Non-weather
3. Increased tiger attacks in SRF	26.4%	Indirect weather
4. Poor physical health affecting capacity to earn income	16.9%	Largely non-weather
5. Shrimp farming stopped after Aila	14.6%	Indirect weather-related

Table 1: Main priority problems affecting local livelihoods

Observed weather-related stressors	Adaptation actions	Adaptation type	Comprehensiveness	Remarks
1. Ponds contaminated (unsuitable for use) by cyclone borne-saline water and organic run-off	Renovation of ponds for freshwater and aquaculture	Reactive, mostly autonomous, somewhat planned (cyclone recovery)	Short term, weather vulnerability not assessed	With and without external support, unlikely to be sustained in next cyclone
2. Cyclone induced saline water polluted *ghers* and dykes collapsed	De-contamination of *gher* bottom and dyke raising	Reactive, autonomous, somewhat planned	Short term, weather vulnerability not assessed	Without external support, unlikely to be sustained in next cyclone
3. Flooding of houses	Making houses on raised plinths	Reactive, autonomous, somewhat planned	Short term, somewhat vulnerability assessed	With and without external support, somewhat sustainable
4. Prolonged droughts plus high temperature leading to increased salinity and killing of fish and shrimp	Salinity monitoring, cooling *gher* water by keeping aquatic weeds, deepening of *ghers*	Reactive, autonomous, somewhat planned	Short term, local knowledge-based, somewhat vulnerability assessed	Without external support, unsustainable in further weather stresses
5. Degradation of fishing grounds due to cyclone borne sand depositions	Changes of fishing locations from north to south	Reactive and autonomous, somewhat planned	Short term, local knowledge-based, sharing with peers, vulnerability not assessed,	Without external support unsustainable
6. Killing of prey animals due to cyclones	Changes of fishing gear and locations to avoid tiger attacks	Reactive and autonomous, somewhat	Short term, local knowledge-based, sharing with peers	Without external support, unsustainable

		planned		
7. Frequent rough sea conditions threatening fishers' lives	Abandoning fishing trips	Reactive and autonomous, somewhat planned	Short term, local knowledge, vulnerability not assessed,	Without external support, unsustainable
8. Strong waves at high tides and erosion of dykes and settlements	Mangrove based erosion protection	Reactive mostly planned	Short term, somewhat vulnerability assessed	Partial official support, somewhat sustainable
9. Dry season freshwater scarcity and loss of fisheries and agriculture	Canal rehabilitation	Reactive mostly planned	Short term, somewhat vulnerability assessed	With partial support, somewhat sustainable
10. Higher soil and water salinity	Adaptive agriculture	Reactive, planned, and autonomous	Medium term, involved govt. officials, weather vulnerability assessed	With partial cost sharing, somewhat sustainable

Table 2: Weather-related stressors and villager adaptation responses

Framework	**Resilience**	**Transitional**	**Transformational**
Goal, scope, policy focus and analytical perspectives / **Local adaptation schemes**	***Goal***- *Functional persistence in a changing environment* ***Scope***- *Change in technology, management practice and organization* ***Policy focus***- *Resilience building, e.g., use of new seed varieties* ***Analytical perspectives*** - *Socio-ecological systems and adaptive management*	***Goal***- *Realize full potential through exercise of rights within the established regime* ***Scope***- *Changed governance practices; procedural justice; incremental change in governance systems* ***Policy focus***-*Public & private sector implement legal responsibilities and exercise of legal rights by citizens* ***Analytical perspectives*** - *Governance and regime analysis*	***Goal***- *Reconfigure development* ***Scope***-*Change ove political-economy* ***Policy focus*** - *New discourse redefine distributing securi in society and soci relationships* ***Analytical perspec*** *ethics and politica*
1.Desiltation of ponds to remove cyclone borne run off debris/salinity for household water use	Maintain pond-based water supply system; resilience building, adaptive management	Not claiming rights to have available water for the community, no governance action or regime analyses	Not claiming sustainable freshw system in the area
2. Minor excavation to de-contaminate *gher* bottom and raising of dykes with removed soil	Re-start shrimp farming, short term, renovation cannot protect inundation in heavy rain-based flooding or another cyclone	Not asking compensation nor contesting corruption in protecting local people, no policy focus, governance and regime changes and legal rights	No integrated p farming, water DRR to safeguard other hazards and s
3. Making house on raised plinths to protect flooding	Protect house from flooding, changes in technology, resilience building, adaptive management, adjust to ecosystem changes	Not asking permanent solution, contesting corrupt practice in DRR; not asking legal rights and changes in governance regimes	No policy and a settlements in management and shelters
4.Salinity monitoring, cooling *gher* water by keeping aquatic weeds and deepening of shallow *ghers*	Continue shrimp farming in changing weather; short term; adaptive management	Not asking incentives and technical supports, not seeking improved governance and legal rights	No enabling poli backstopping syste industry from haza
5.Changes of fishing locations in far south of the coast due to degradation of previous fishing grounds by cyclone borne siltation	Continue fishing; resilience building; changing locations; adaptive management, ecosystem based approach	Not asking for compensation, alternative livelihoods or safety net supports; not contesting poor NRM, not seeking improved governance and legal rights	No plan for enha fisheries; no new weather impacts SRF biodiversity
6.Changes of gears and fishing locations to avoid tiger attacks	Continue fishing by changing gears and locations, resilience building, adaptive management	Not asking protection from tiger attacks or for injuries and deaths; not claiming citizens' rights and governance	No policy and pla to reduce human- provide security to
7. Abandoning fishing trips in rough sea weather conditions	Suspend fishing trips, in rough sea conditions, adaptive action, no alternative options	Not asking protection, compensation or alternative livelihoods, or even effective warning systems, no claim for rights	No enabling poli backstopping syste fishers from rough
8. Mangrove afforestation to protect wave erosion	Protect settlements /assets from erosion by mangroves; resilience building, adaptive management, ecosystem based adaptation (EbA)	Not claiming rights to have protection from tidal flooding, nor asking for embankment raising or realignment but community-NGO-local government collaboration added value	No political actions for regula maintenance an sustainable protec settlements
9. Canal rehabilitation to ensure freshwater for irrigation and fisheries	Functional agriculture and fisheries in changing weather, resilience building, adaptive management, EbA	NGO-led activity in one canal but other local canals are grabbed, leased and privatised affecting biodiversity, water farming systems, no claims for rights	No plan to change restoration policy maintain wetlands and community be
10. Stress tolerant rice farming in saline prone gher areas, improved seeds and technologies including capacity building	Continue rice farming in changing weather; new technologies & seeds; form farmers associations for collective actions, resilience building and EbA	Claiming de-leasing of canals to district authorities; got supports from DAE, asking DAE to take action against fake agricultural inputs (pesticide, fertilizer, seeds) sellers; more need to move to better governance, citizen rights	Inform DAE to agriculture practic influence chang economy of co scope of initiativ transformation

[1] (1) very minimum level, temporary, very likely to collapse in next hazard; (2) minimum level, short term, may collapse in next disaster; (3) moderate, medium term, may sustain next hazard with readiness; (4) strong, long term within existing systems, have potential to graduate to next stage; (5) very strong, long term, capable of moving to next stage

Table 3: Place of adaptation schemes in "Resilience to Transformation" framework

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[1] The paper focuses on local people's understandings of weather as distinct from climate. Weather refers to atmospheric conditions at a particular time and place. In Bengali, climate change translates as *jalabayu paribartan*, a phrase with which local people are unfamiliar. For this reason, the term 'weather' is used throughout the paper except when a fuller discussion of climate change is required.

[2] By vulnerability is meant: The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards (UN/ISDR, 2004, 16)

[3] The core idea of EbA is to ensure the capacity of ecosystems to generate essential services for climate change adaptation and requires ecosystems to be managed as components of a larger adaptation landscape of which human activities are a part (Devisscher, 2010).

[4] Integration can take several forms and one of the most common is mainstreaming of climate change adaptation into development planning. For example, the UNDP-UNEP defines this as '…the iterative process of integrating considerations of climate change adaptation into policy-making, budgeting, implementation and monitoring processes at national, sector and subnational levels. It is a multi-year, multi-stakeholder effort grounded in the contribution of climate change adaptation to human well-being, pro-poor economic growth, and achievement of the MDGs. It entails working with a range of government and non-governmental actors, and other actors in the development field.' (UNDP-UNEP, 2011; 3)