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# Adaptation and development: Livelihoods and climate change in Subarnabad, Bangladesh

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This paper explores the relationship between environmental change and development through a vulnerability study of a rural village in southwest Bangladesh. Villagers deal with a variety of pressing stresses, and climate change is not considered separately, if at all. Environmental, political and economic conditions and adjustments in resource use systems, particularly shrimp farming, have changed livelihood opportunities and increased the vulnerabilities of poor villagers to future environmental changes, including climate change. Practical adaptation strategies to reduce vulnerabilities to climate-related stresses reflect the dynamics of people's livelihoods and address the conditions they currently face. In this case, planned adaptations were mainstreamed in the sense that they contributed to the livelihoods of people and made some improvement in their capacity to deal with changes in climate, and they were undertaken via established non-government institutions.

Keywords: adaptation; Asia; Bangladesh; climate change; livelihoods; vulnerability

## 1. Introduction

Climate change and its associated impacts will be experienced through changing temperatures and precipitation, rising sea levels, changes in the frequency and severity of climate extremes and in the dynamics of hazardous conditions (IPCC, 2007). Developing countries are considered to be particularly susceptible to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their limited adaptive capabilities to deal with the effects of hazardous events. Given this limited capacity to adapt, they are considered to be particularly vulnerable to damages associated with climate, just as they are particularly vulnerable to other stresses (Kates, 2000; O'Brien and Leichenko, 2000; Smit and Pilifosova, 2001; Mirza, 2003).

Although there has been progress in studies of climate change impacts and adaptations, as well as an increased recognition of the need for

programmes and policies to implement and facilitate adaptations, to date there are still few practical on-the-ground examples of planned adaptation to climate change that reduce people's vulnerabilities (Huq et al., 2003; Smit and Wandel, 2006). Studies of practical adaptation initiatives have revealed that climate and climate variability are experienced in the context of other changing conditions (environmental, socio-economic, political), and vulnerabilities are rarely to climate change stimuli alone. It is also increasingly recognized that an effective means of ensuring that climate adaptations are undertaken is to mainstream them into development initiatives and existing priorities, such as livelihood enhancement, poverty alleviation, environmental management and sustainable development (Huq et al., 2003; Khan, 2003; Klein and Smith, 2003; Schipper and Pelling, 2006; Smit and Wandel, 2006). The utility of promoting adaptations to climate change by incorporating them into development

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projects has been recognized and acted upon by several development agencies, including the Canadian Development Agency (CIDA), the UK Department for International Development (DFID), the Red Cross/Red Crescent, the World Bank, the Asian Development Bank and others.

This paper draws on the experience of one of these programmes administered by CIDA and implemented by CARE-Canada via CARE-Bangladesh, involving particularly vulnerable communities in southwest Bangladesh. The study uses a generic model of vulnerability to identify and describe the exposures, sensitivities and adaptations to changing conditions among poor households in the village of Subarnabad. The paper provides a review of the field of climate change adaptation and development, as a basis for outlining a generic model of vulnerability. This model provides the structure for the community-based study of vulnerability in Subarnabad village. The paper focuses on outlining the interactions of conditions that people experience and to which they are sensitive. Opportunities for adaptations to climate are sought within the realities of existing environmental, cultural, political and economic conditions.

## 2. Climate change adaptation and development

Until recently, the consideration of adaptation to climate change has been undertaken largely independently of both the literature and practice of development (Swart et al., 2003; Huq et al., 2006). Development programmes to enhance livelihoods were not generally considered in climate change adaptation research, and development programmes rarely recognized risks associated with climate change. Decision-making processes related to development are often dominated by non-climatic stressors that acutely affect people's well-being, such as economic, social, health, equity or other environmental forces. As a result, climate change has tended to go unidentified as a priority vulnerability by communities, governments and development agencies who

are concerned with the reduction of compelling current and not-too-distant future risks, whatever stressors they reflect (Handmer, 2003; Klein and Smith, 2003).

On the other hand, in the climate change field, hypothetical adaptations were often proposed, and sometimes evaluated and ranked, that were specific to distant future climate scenarios, without consideration of other stresses that would influence their effectiveness or adoption, and without consideration of the decision-making processes involved in implementing adaptations.

More recent work has shown that if adaptation processes are in line with development initiatives that reduce existing vulnerabilities and increase people's adaptive capacity in a broad sense, then this will bring both immediate benefits as well as strengthen people's ability to deal with future threats (Burton et al., 2002; Huq et al., 2003; Adger et al., 2007). Initiatives in developing countries that promote economic development, poverty alleviation, improve access to technology, strengthen social networks and institutional arrangements, and improve hazard preparedness are expected also to reduce vulnerability to climate change. For this reason, many have called for the integration of adaptation initiatives into existing or planned development activities (Burton et al., 2002; Huq et al., 2003; Agrawala, 2005; Klein et al., 2007). Often referred to as *mainstreaming*, this practice involves the incorporation of initiatives, measures and strategies to reduce vulnerability to climate change into other existing policies, programmes or management systems so that adaptation to climate change becomes a part of, or consistent with, other well-established decision structures, particularly sustainable development planning.

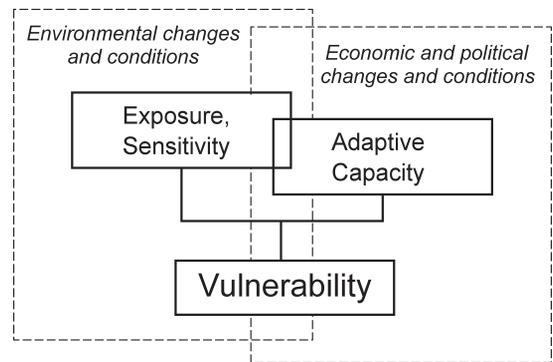
Both the climate change and development fields have emphasized the need for the participation of communities in the formulation and implementation of disaster avoidance and poverty-reduction measures. This 'bottom-up' practice has been termed *Community-Based Adaptation* (CBA), in which the participation and engagement of community members themselves is viewed as vital in determining the factors that

render them vulnerable and the needs and opportunities for reducing these vulnerabilities (Brooks, 2003; Polsky et al., 2003; Smit and Wandel, 2006; Huq and Reid, 2007). Instead of applying predetermined stimuli and theoretical responses to climate change adaptation, CBA places an emphasis on understanding community experiences of vulnerability and the adaptation strategies that are employed (Huq and Reid, 2007). In this way, adaptation initiatives are relevant to the beneficiaries, and effective in complementing development efforts aimed at poverty reduction or livelihood enhancement.

While the CBA approach has advantages relating to practicality and implementability, two other features are noteworthy. First, because adaptations are incorporated into development initiatives, perhaps relating to livelihoods, food security, income, potable water, etc., they do not appear as initiatives specifically or exclusively designed to address climate change. They are rarely, if at all, discrete and separable climate change adaptations. Rather they are management systems or production adjustments or resource use strategies into which climate change has been factored or considered. Second, the focus in CBA on conditions already experienced can mean that conditions expected with climate change, but beyond the experience of people, may not be considered. This issue is explicitly addressed in some recent approaches to vulnerability assessment (Smit and Wandel, 2006).

### 3. Vulnerability and livelihoods

In the climate change literature, vulnerability is generally seen as a function of a society's exposure to stresses to which it is sensitive and its ability to adapt, both of which reflect broader environmental and socio-economic and political forces (Kelly and Adger, 2000; Leichenko and O'Brien, 2002; Smit and Wandel, 2006). Smit and Pilifosova (2003) conceptualize vulnerability, in its most simple form, as a function of a system's exposure-sensitivity and its adaptive capacity (Figure 1). Exposure (in this case, including sensitivity)



**FIGURE 1** Conceptualization of vulnerability (simplified from Smit and Wandel, 2006)

refers to the degree to which the community experiences a stress, reflecting both the nature of the community and the nature of the stress. Exposure represents the susceptibility of a community to an external stress. For example, villages are exposed and sensitive to flooding to the degree that their homes and fields are located and organized such that floods (frequency, severity) are problematic for them. Adaptive capacity refers to the potential or ability of a community to cope with, adapt to, or recover from the effects of an exposure (Yohe and Tol, 2002; Adger, 2003; Smit and Pilifosova, 2003). For example, of two villages (or groups in a village) equally exposed to flooding, one may have more resources to move materials (house, family), replant and rebuild than the other. The enhancement of adaptive capacity represents a practical means of addressing changes or risks, and may reflect the resilience, stability, robustness, flexibility and other related characteristics of the system (Smit et al., 2000; Turner et al., 2003). This model is consistent with the 'pressure and release' conceptualization of Blaikie et al. (1994) in that people are susceptible to the interaction of their living conditions and physical hazards, and the determinants of vulnerability reflect both local conditions and root causes (Smit and Wandel, 2006). The contribution of the vulnerability model employed here is that it differentiates the conditions related to exposure from the conditions that influence the ability to deal with exposures.

This model of vulnerability recognizes that vulnerability can vary within a community, and is context specific, reflecting the characteristics of the location of the system in question, as well as dynamic, recognizing changes that occur over time in the forces affecting exposure and adaptive capacity. Exposures and adaptive capacity are not considered independently of each other, but may be influenced by many of the same issues or conditions, both at the local levels as well as through broader forces, such as regional, national or international socio-economic conditions. In this dynamic process, feedbacks are likely to occur; for example, when an adaptive response to one stress alters the exposure or adaptability to another stress (Turner et al., 2003; Belliveau et al., 2006; McLeman and Smit, 2006). The framework is presented in its skeletal form, without including the particular factors, variables, linkages, etc. in the components, because in the Bangladesh case study these details are not assumed a priori, but are identified empirically from the community itself.

Within this framework, individuals' livelihoods represent an integral component of their vulnerability to current problematic conditions and to future change (Chambers and Conway, 1991; Sokona and Denton, 2001; Bacon, 2005). The pursuit or diversification of livelihoods is tempered by wealth disparities and differential access to resources that are often constrained or facilitated by social relations (e.g. gender relations), institutions (e.g. informal codes of behaviour), and organizations (e.g. governments, non-governmental organizations) (Hussein and Nelson, 1998; Scoones, 1998; Carney, 1999; Ellis, 2000). Livelihoods may affect people's exposures, and they represent an important way of adapting to changing conditions in contributing to a person's adaptive capacity. Consequently, an essential part of documenting vulnerabilities (and hence identifying targets for adaptive initiatives) is to understand the ways in which livelihoods are exposed and sensitive to changing conditions. Capacity to deal with stresses is generally considered, all other things being equal, to be enhanced by robust, resilient livelihoods that are

able to recover from stresses and shocks, maintain or enhance current assets or conditions, and provide means for future success. Thus, several development agencies have focused on livelihoods as the key vehicle for improving communities' well-being, and hence their adaptability to climate change.

In order to understand how livelihood processes may help or hinder adaptation, there is a need to first identify the exposures and sensitivities that exist within communities given their particular set of characteristics, needs and contexts. Communities' adaptive capacity can then be assessed, considering availability and access to different types of capital, including those factors (both internal and external) that may act to facilitate or constrain adaptation. Using this approach, it becomes possible to better understand the nature of vulnerability, comprising the relevant forces, conditions and processes. This provides a basis for identifying practical means of improving adaptive capacity, both currently and in light of future climate change. An application of this approach was undertaken in the community of Subarnabad in southwest Bangladesh.

#### **4. Case study of Subarnabad village, Bangladesh**

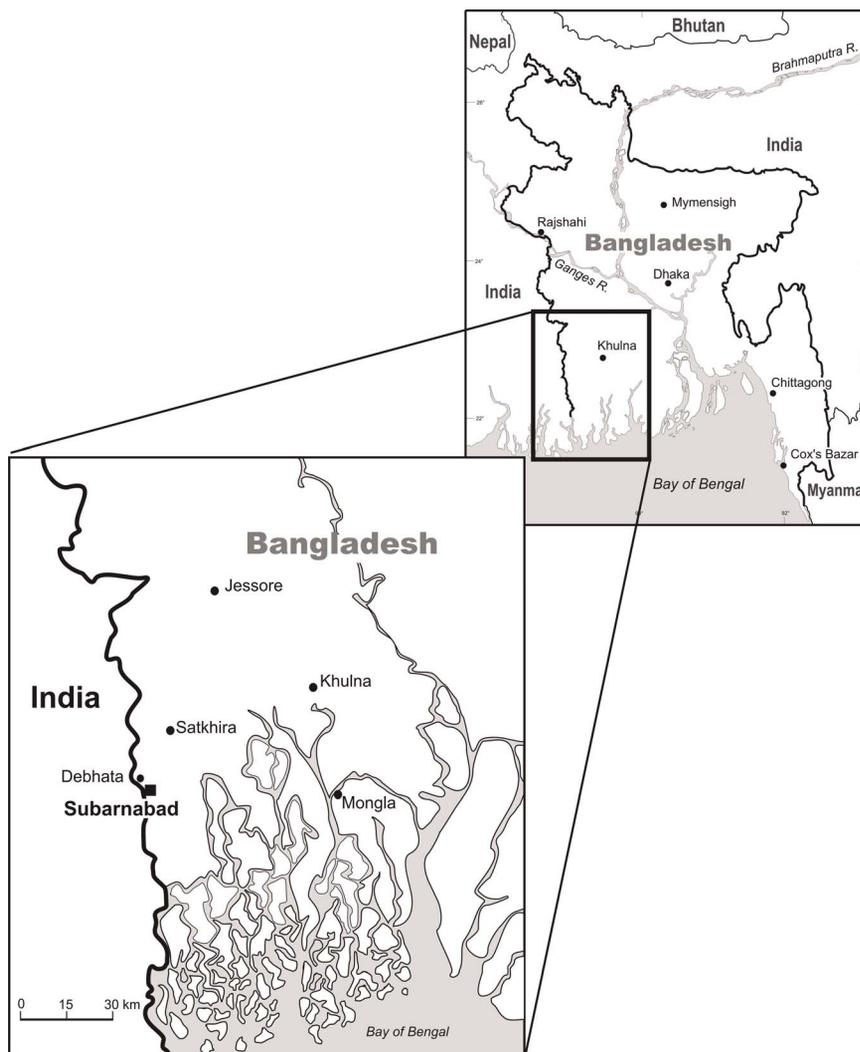
Bangladesh has a very high population density (more than 1000 people per km<sup>2</sup>), with a literacy rate of less than 50%, an infant mortality rate of 48/1000 live births, and 50% of the population below the poverty line (World Bank, 2004). The case study is located in the southwest region of Bangladesh, an area heavily influenced by the tributaries of the Ganges that flow into the Bay of Bengal. Most of the region lies less than 3 m above sea level, and is subject to extreme events such as flooding, cyclones and storm surges (Ali, 1999; Mirza, 2002; UNEP, 2002). Originally a region dominated by farming, over the last 30 years the shrimp industry has grown considerably, driven by a flourishing export market, international donor support, and aided by successive Bangladeshi governments since the 1980s to

liberalize and diversify the economy (Deb, 1998; McLachlan, 2003).

The village of Subarnabad is located in the southwest region near the Indian border (Figure 2), with a population of approximately 2,440 occupying roughly 3.2 km<sup>2</sup>. Water flow within the area is regulated largely by the Isamati River, which is a Ganges-dependent river. The main industry in the village and occupation for the residents is shrimp farming, resulting in the conversion of large portions of the land from crop production to salt water ponds for

shrimp cultivation. Many landless and poor individuals work in these farms for wage incomes, stocking and catching shrimp, building and repairing embankments, and removing weeds from the farm. Subarnabad was a suitable case study because of its high proportion of poor villagers, its exposure to the climate related conditions, the importance of aquaculture in the area, and the cooperation of an NGO with local credibility and contacts.

The research in Subarnabad was undertaken in collaboration with the project Reducing



**FIGURE 2** Location of the village of Subarnabad, Bangladesh

Vulnerability to Climate Change (RVCC), funded by CIDA and implemented by CARE Canada via CARE Bangladesh. The RVCC project operated in six districts in southwest Bangladesh through partnerships with 16 local partner organizations representing local and national NGOs, a community-based organization (CBO) and two research organizations, with the overall goal to increase the capacity of Bangladeshi communities in the southwest to adapt to the adverse effects of climate change (CARE, 2006). Within the study area, the local partner organization was the Institute of Development Education for Advancement of Landless (IDEAL). IDEAL has a long record of participatory development initiatives in the region and has worked with community beneficiaries in Subarnabad village to implement adaptations to climate change.

## 5. Methods and data

The methodology adopted for this research was guided by a bottom-up approach, which starts with an assessment of the vulnerability of the system (in this case the village comprised of households) in terms of who and what are vulnerable, to what stresses or exposures, in what way, and what capacities exist to adapt to changing conditions (Lim and Spanger-Siegfried, 2004; Smit and Wandel, 2006). The research approach does not assume to know a priori the climate factors that matter to the people's livelihoods or the components of vulnerability; these are instead identified over the course of the research, based initially on information provided by the community members themselves. Climate change is considered in the context of these and other changing conditions.

Primary data collection methods were used during 2004 to gather insights into village vulnerability, including living in the area, nine key informant interviews, four focus groups and 21 individual semistructured interviews. The study focused on the poorest individuals of the community, given that people in circumstances of poverty are widely considered to be those least

able to cope with environmental stresses and in greatest need of adaptation (Kates, 2000; Huq et al., 2003; Yamin et al., 2005). Poverty was defined according to the community's categorization of social classes, and the factors they employed (Ellis, 2000; Hulme and Shepherd, 2003). By any standard, most of Subarnabad's residents are very poor, and study households were identified based on wealth and other criteria, including access to resources, occupation type, housing type and household composition.

Observational visits were used to gain an understanding of everyday life in the village in order to complement and prepare for the more structured forms of data collection. Key informant interviews were used to gain insights into the context of Subarnabad village and the nature of vulnerability of its poorest residents. Key informants were identified through consultations with villagers and RVCC and IDEAL staff, and included members of local government, NGO workers, and employees of the Water Development Board and the Ministry of Agriculture. Participants for the focus groups and interviews were chosen purposefully on the basis of poverty and gender, with separate focus groups held separately for men and women, reflective of local social norms.

The insights gained from village respondents were crosschecked with other villagers and with other sources of information, including documents, records and the experience of RVCC and IDEAL personnel. RVCC had conducted a district wide initial assessment of vulnerability based on 78 focus groups in 57 villages (Table 1). This assessment showed that people were concerned about conditions that directly affected their lives and livelihoods (income, food, safe drinking water, housing and health), and that climate mattered to them indirectly via salinity, floods and waterlogging (Table 1). The aim of the Subarnabad study was not to score or rate climate change stresses or adaptations – most were not separable anyway – but to uncover and describe the interactions of forces and processes that resulted in

**TABLE 1** Summary of the initial vulnerability assessment for Satkhira District

Main indicators of well-being/insecurity	
income	
food	
safe drinking water	
housing and safety of property	
health and personal safety	
Main climate related hazards/exposures	
salinity	
flooding	
waterlogged conditions	

(CARE, 2003).

the exposures in order to identify practical entry points for improving adaptability.

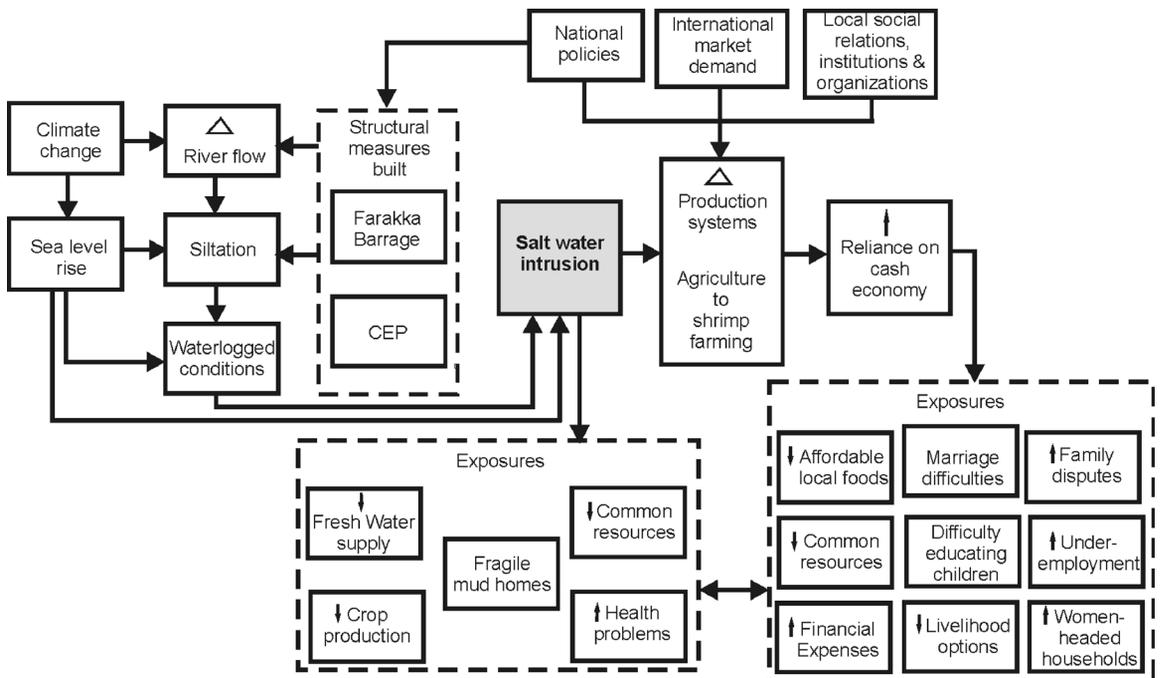
**6. Exposures to changing conditions**

The poorest villagers of Subarnabad identified a variety of problematic conditions or exposures

related principally to income generation and overall poverty. The bulk of villagers’ concerns were directly or indirectly related to (a) environmental changes associated with salt water intrusion, and (b) the changes in production systems from rice and other land-based crops to salt water shrimp farming and subsequent shifts in livelihoods.

Water is a main part of life. If the water is saline, how can I lead my life well? It is hard for bathing, you cannot drink it, you feel bad. If the main part of life is saline water, life is obviously worse. (Subarnabad resident)

Key components and interactions underlying the vulnerabilities of Subarnabad residents, based on the participatory field research, are presented in Figure 3. Of course, there are many other interactions and feedbacks beyond those indicated in the diagram. In particular, the various exposures associated with both salt water intrusion and changes in production systems and economy are closely interconnected. The point of Figure 3



**FIGURE 3** Processes of environmental change and exposures (main interactions only are shown; many of the exposures are interrelated)

is to show, from the perspective of villagers, how they are vulnerable to changing conditions, and how various external physical, economic and political factors contribute to local exposures.

The evolution of salt water intrusion in the village can be traced back 30 years to the construction of several mega-projects and their related environmental changes. Over the last three decades, the water resource system in the southwest of Bangladesh has experienced many changes as a result of the construction and poor maintenance of the Coastal Embankment Project (CEP) along the coast of Bangladesh; the construction of the Farakka Barrage (dam) in India; local water diversions; sea level rise and storm surges (Figure 3). The result of these has been the siltation, sedimentation and rising waters of Ganges-dependent rivers, which has complicated drainage and essentially turned lands protected by polders (structures designed to protect shoreline communities from flooding, surges and saline water intrusion) into lakes, particularly during the monsoon season. This has occurred in the village of Subarnabad, where the base level of the neighbouring Isamati River has risen considerably, preventing effective drainage, and creating severely waterlogged conditions (Figure 3).

Waterlogging, increasing salinity, an absence of any effective government water management programmes and the attractive market for shrimp, together have prompted an increase in shrimp farming and other types of aquaculture by larger land owners, replacing the land-based crops within the polders. Though few villagers were initially interested in shrimp farming, the difficulty of sustaining subsistence and commercial crops under the increasing salinity as neighbouring areas were converted to saline ponds for shrimp gave farmers with clear land title little choice but to lease or sell their land to shrimp producers or start shrimp farming themselves. Subsistence farmers without clear title had little means to resist the conversion of land to shrimp ponds managed by the wealthy. They were forced off the land. Shrimp farms now surround the village of Subarnabad, with a few small home-  
stead gardens remaining in which attempts to

grow crops in increasingly saline soils are still made, with predictably poor outputs.

My decision would not be for the shrimp farm because there is no vegetable, no food for the animals. But the rich started shrimp farming, so this is why we have to live with it. (Subarnabad resident)

Most of the villagers are facing the same problems. The rest of them are the people who own the shrimp farms. The ones who own the shrimp farms are the ones who are making money. If you have no land, you cannot make any money. (Subarnabad resident)

While the economic gain through the proliferation of the shrimp industry is very important for the Bangladesh national economy (Rahman, 2003) and a major benefit for the large shrimp operators, the associated environmental and social changes are becoming issues of growing concern, particularly for poorer residents (Deb, 1998; Crow and Sultana, 2002). The environmental changes due to salt water intrusion in Subarnabad directly influence the exposure of poor villagers to a number of problematic conditions, including a decrease in fresh water supply, the loss of crop production and common resources, an increase in health problems, and an increase in the fragility of mud homes (Figure 3). Villagers of Subarnabad experienced decreased soil and water quality, as the surrounding waters were no longer considered fit for domestic use and consumption, and rendered the soil unsuitable for crop cultivation.

Villagers also experienced decreasing access to common property renewable resources that in the past had provided the rural population with materials for fuel, fodder, building and food. The once ubiquitous rice fields had provided an area for villagers' livestock to graze at no cost during fallow. The inability to sustain rice production has translated into a decrease in fodder and subsequently a decrease in the number of cattle in the village, limiting the dung collected by the villagers for fuel. Common grazing grounds have been converted to shrimp ponds

whose owners do not allow cattle to pass over the embankments for fear of the cows breaking the embankments, thus further restricting the grazing areas. Straw from the rice fields after the harvest used as building materials for villagers' homes has similarly been eliminated, while food sources, such as surplus rice from the harvest that was not used or sold by farmers, homestead gardens or communally used fruit trees, have been lost.

Changes in production systems and the increased reliance on a cash economy have led the poorest villagers to be exposed to a number of economic, social and cultural stresses (Figure 3). In general, there has been a decrease in the diversity of livelihood options for the poorest cohort of the village as a result of the movement away from rice farming and its implications on the availability of local food and employment. Under rice cultivation, much of the land was used for the production of various types of vegetables on both commercial farms and homestead gardens, which were grown on a rotational basis with the rice crops. Land-based livelihoods provided opportunities for subsidiary activities such as cattle rearing and homestead gardening. Villagers were also able to fish in the rice farms at no cost when the rice was ready for harvesting and the water was high enough. Once able to provide their households with food and income from a variety of sources, the livelihoods of both women and men are now increasingly dependent on shrimp production and related activities. While rice production once supplied year-round employment, both men and women are able to find work only sporadically on the shrimp farms, sometimes working only an average of 15 days a month. Raising and tending to livestock is no longer feasible for many of the villagers, nor is homestead farming especially in the dry season due to the high salt content in the soil.

The effect of these changes has had particular significance for women. As underemployment has increased and men have migrated to neighbouring villages in search of work, income from women's productive labour has become

increasingly crucial to families' survival. The accompanying occupational hazards are numerous, as women are more likely to be exploited and exposed to unsafe conditions. Women working outside the home are subject to traditional patriarchal norms on the appropriateness of such work, and may lose respect from their community and family. Difficulties in income generation, underemployment and changing gender roles have apparently led to an increase in domestic disputes as women are drawn into new roles that conflict with cultural expectations.

## 7. Adaptations and adaptive capacity

Villagers in Subarnabad have been resourceful in adapting to changing conditions and have adopted an array of measures, but certain segments of the population appear to be more resilient than others. Though wealthier groups in society were exposed to the same environmental and economic changes, they have had more capacity to take advantage of changes and to shield themselves against stressful conditions. On the other hand, small landowners and other poor and disadvantaged groups have been unable to benefit from the waterlogged conditions, their lack of control over land and the high cost of establishing shrimp farms precluding them from significant use of flooded and saline waters.

The poor have no way of minimizing their shock when one comes. Those without land are even worse. (Subarnabad resident)

As a result, poorer villagers have had to adopt other livelihood strategies in order to cope with the problematic conditions of saline water intrusion and the associated stresses. These strategies were mainly reactive and autonomous (without government or NGO intervention), mostly short-term or tactical, and were largely undertaken by either the individual or the household as a unit. Villagers identified loans (in the form of money or food) as the strategy most widely employed.

Other strategies included selling or leasing a small piece of land or similar assets, such as livestock; increasing the number of family members in the workforce; decreasing the intake of food; working outside the village; raising goats as an alternative to cattle; theft and prostitution.

These adaptations are related to changing conditions, and may have been responses to conditions influenced by climate change, but they were not seen as 'climate change adaptations' by villagers. Nor were they undertaken as discrete measures separable from their day to day coping, and they were not compared or rated, but elements of several were employed as necessary and possible in order to survive in the immediate term. They demonstrate the circumstances into which climate change becomes an additional (and usually indirect) stress, and the circumstances into which any proactive adaptation initiatives would need to be incorporated or 'mainstreamed'.

Adaptations in the longer term have been constrained by the combination of poverty and limited or non-existent access to usable land. Villagers felt that they could not undertake activities perceived as 'risky' such as starting a new business or trying new crops, and the existence of few economic opportunities outside of the shrimp industry limited the pursuit of many alternative livelihoods. As a result, many poor villagers not only missed out on opportunities associated with shrimp farming, but were exposed to problematic conditions to which they had limited capacity to cope or adapt. This limited capacity had to do with the almost non-existent involvement of the poor in the decision-making process regarding land and water use. With no connection to the decision-making elite, poorer villagers have had little ability to influence the processes (judicial, policy, management) through agreement, payment or corruption. Additionally, they have had little or no access or ability to use physical and financial assets, and there have been few institutional structures to support them. Other factors influencing poor villagers' adaptive capacity include family size, competition amongst villagers and specific issues relating to gender.

If I have ducks, I have to feed the ducks, and then I have to wait six months before I will get any eggs from those ducks. Therefore, I have to expend a lot before I see any money ... but I can't even maintain my own food. (Subarnabad resident)

In short, the shift to shrimp farming appears to have been a boon (a successful adaptive strategy) for a powerful few in society, and a bane (compounding exposures) for a larger section of the community. The traditional safety nets of the poor provided by natural resources, social networks and alternative income resources have been seriously eroded, challenging livelihoods in the present and potentially to a greater extent in the future.

## 8. Adapting to future change

Clearly, the future vulnerabilities of people in Subarnabad are related to changes in the political and institutional system, the economic conditions and the social structures as well as conditions related to climate change. Projections from climate change scenarios focus on average temperature and precipitation (Table 2). Apart from the broad spatial scale, the climate-related conditions of importance to villagers are not directly captured in the projections.

However, there is sufficient knowledge of climate change in South Asia to expect Bangladesh to experience increases in temperatures and precipitation, sea level rise, change in river flows, increased intensity of cyclone and storm surges, increased saline water intrusion and changes in coastal geomorphology (World Bank, 2000; McCarthy et al., 2001; GoB, 2002a). These are expected to increase flooding risks (McCarthy et al., 2001; GoB, 2002a; Mirza, 2002), increase soil erosion in coastal zones (Hutton and Haque, 2004), place increased stress on fresh water resources (Alam et al., 1999; GoB, 2002b), increase the intensity of cyclones (Ali, 1999), negatively affect human health (Kausher et al., 1996; Kovats et al., 2003), increase human migration (Ericksen et al., 1996) and disrupt

**TABLE 2** Projected changes in temperature and precipitation for South Asia under climate change scenarios

Season	2010–2039		2040–2069		2070–2099	
	A1F1	B1	A1F1	B1	A1F1	B1
<i>Projected surface area temperature change (°C) with respect to baseline period 1961–1990</i>						
DJF	1.17	1.11	3.16	1.97	5.44	2.93
MAM	1.18	1.07	2.97	1.81	5.22	2.71
JJA	0.54	0.55	1.71	0.88	3.14	1.56
SON	0.78	0.83	2.41	1.49	4.19	2.17
<i>Projected precipitation change (%) with respect to baseline period 1961–1990</i>						
DJF	–3	4	0	0	–16	–6
MAM	7	8	26	24	31	20
JJA	5	7	13	11	26	15
SON	1	3	8	6	26	10

DJF: December, January, February; MAM: March, April, May; JJA: June, July, August; SON: September, October, November

A1F1 refers to the highest future emission trajectory and B1 refers to the lowest future emission trajectory (Cruz et al., 2007)

agricultural production (Karim et al., 1999; Luo and Lin, 1999). In Subarnabad, these conditions already represent development challenges, likely to be exacerbated by climate change.

The conditions that posed problems for residents of Subarnabad were those that directly affected their well-being and needs for food, income and personal safety. Without prompting, residents did not identify climate change as an important factor for them, and only a few mentioned climate in general. However, many of the exposures that were described as very important to residents are either directly related to, or influenced by climatic conditions, and would likely be affected by climate change. For example, the increased vulnerability experienced by poor villagers associated with the conversion from crop agriculture to shrimp farming and to increases in salinity were driven in part by climatic conditions (e.g. storm surges, cyclones) and their management. Certainly, any future sea level rise and reduction in fresh water flows associated with climate change would intensify saline conditions and likely further reduce adaptive options for poor residents. Climate, and hence climate change, while not directly identified as exposures, have important implications for residents' livelihoods and well-being. Similarly,

several of the vulnerabilities of concern to residents are likely to be exacerbated by climate change, including saline intrusion, reduction in fresh water, reduction in food production capacity, loss of livelihoods and reduced access to common resources.

As part of the CARE-RVCC Project, IDEAL initiated activities to increase the capacity of people to adapt to the vulnerabilities associated with climate change. This represented 'mainstreaming' in two senses. First, climate change was not considered separately, but as one of several forces to which adaptive strategies were needed. Second, the adaptive activities were undertaken collaboratively by a development agency (CIDA), an NGO with experience in promoting livelihoods in Bangladesh (CARE-Bangladesh), a local NGO with familiarity and credibility in the community (IDEAL) and the local residents. Other climate change mainstreaming initiatives target government agencies, and this may be necessary for major transformations in such areas as economic policies, institutional effectiveness and equity, and water management infrastructure and operating guidelines. However, to date there has been little evidence of government programmes addressing the vulnerability of villages such as Subarnabad,

and there is evidence that programmes of NGOs have had success in Bangladesh.

In Subarnabad, villagers' ability to access IDEAL and become an NGO beneficiary was found to be an important factor in mediating a person's ability to access adaptation measures and adopt new livelihood activities. Via the NGO, villagers were provided with training and technical support to embark upon new livelihood strategies, as well as access to loans and a savings bank. The initiatives promoted in Subarnabad for income generation and food production included livelihood activities such as goat and fowl rearing, crab fattening, tree planting, halophytic (salt water-tolerant) vegetable gardens and handicraft production (Table 3).

The most widely adopted strategy was household gardening with saline tolerant crops. Goat raising and chicken and egg production were also popular, and duck raising and crab fattening were slightly less widely adopted. The success of these livelihood strategies lay in the minimal need for land requirements, as in animal rearing or crab farming, or in the use of salt-tolerant plants for both consumption and marketing of food products or handicrafts. Practices were adopted with technical and financial assistance from IDEAL, and were maintained when they proved to be successful and self-sustaining. The independent adoption of innovations by those who were not direct beneficiaries of a project indicated the applicability or utility of adaptive development initiatives. IDEAL's strategies were found to meet immediate needs for food and income, as well as enhance householders' capacity to address other stresses by improving their financial assets.

From the point of view of Subarnabad villagers, these strategies were not exclusively, nor even primarily, directed at future climate change. Rather, the represented initiatives which would help them adapt to their immediate and future realities, including conditions related to climate, economy and politics. Nor were the adaptive strategies systematically compared or rated. Rather, in those situations where one type of an option, and often several options, made sense and could be afforded, then they were tried. The

**TABLE 3** NGO (IDEAL) aided adaptation strategies

Adaptation strategy	Description
Goat rearing	Goats are purchased and used for milk, meat, and as a type of savings bank where, in times of need, they can be sold.
Chicken farming	These consisted of small chicken farms (70–100 chickens). Chicks are purchased at the local market, raised, and sold for a profit when fully grown. In these farms, chickens are rarely used as a source of food for the farmer.
Crab fattening	Crab farming involves the collection, rearing and feeding of crabs for 15 days to increase their market value. They are sold for profit in the local market.
Tree planting	Homestead planting of saline-tolerant fruit and timber trees (e.g. kewra, guava) for longer-term income and fuel generation, as well as a source of food.
Saline tolerant vegetable gardens	The promotion of saline-tolerant crops such as chilli and potato for consumption or for sale.
Duck rearing	Ducks are raised for meat and eggs, for consumption or for sale.
Hen egg production	Hens are raised for eggs, for consumption or for sale.
Handicrafts	The production and marketing of mele mats and stools made out of grasses.

success of the mainstreaming process was evident in the flood of applications to IDEAL once the experience of early beneficiaries became evident in the village. Many villagers adopted more than one of the strategies noted in Table 3, and many adapted the initial idea to suit their situation. For example, crab fatteners learnt that they were at a disadvantage selling their fattened crabs individually, so they formed a cooperative to coordinate their marketing, represented by the most effective negotiator, to gain a superior price. A further indicator of effectiveness was in the growing employment of the strategies by villagers operating independently of IDEAL, but learning from neighbours.

## 9. Conclusions

In the climate change vulnerability and adaptation field, it is now widely accepted that enhancing the capacities of societies to deal with present conditions not only serves present and near future needs, but also represents an important contribution to adapting to longer-term climate change. It is also increasingly recognized that adaptations are not likely to be undertaken to climate change alone (Handmer, 2003; Huq et al., 2003; Huq and Reid, 2004; Schipper and Pelling, 2006), but they can be built into development programmes to enhance people's livelihoods and capacities. Climate change may affect development efforts directly when they concern climate dependent activities (such as agriculture and aquaculture), or indirectly, for example, when they relate to socially oriented development activities that operate in climate-sensitive areas. This study illustrates ways in which communities are vulnerable to changing conditions, how climatic conditions play a role, and how climate change adaptation initiatives can be incorporated into development processes.

Vulnerability in Subarnabad is related to people's exposures to problematic conditions and their adaptive capacities, and reflects a mix of dynamic processes and changing external economic, political and environmental conditions that prompt adjustments in livelihoods. The case study of Subarnabad provides an example of actual changes which have been implemented in a community to increase peoples' capacity to respond to the adverse effects of climate change, both autonomously by villagers and as part of a programme to reduce vulnerability. Adaptations have been incorporated or mainstreamed into broader livelihood development initiatives and climate change is considered in the context of multiple stressors and other changing conditions.

Although villagers are resourceful, environmental changes and adjustments in the local production systems have transformed livelihoods of the villagers and reduced adaptation options for

the poorest. The livelihood development activities of IDEAL in Subarnabad represent sustainable development initiatives that address pressing needs in the communities, and also enhance the adaptive capacity of villagers to deal with climate change. The promotion of livelihoods may be seen as 'business-as-usual' in the development field, yet real, practical adaptation initiatives such as those in the village of Subarnabad are still rare in the field of climate change adaptation. There is little evidence that people will (or should) adapt to climate change as a separate stimulus. That climate change becomes incorporated into initiatives designed to improve the sustainable well-being of vulnerable communities in light of multiple dynamic stresses is not a shortcoming of climate change adaptation but a reality, and a necessity if something is to be done.

Of course, the practical, 'do-able' examples in Subarnabad are not sufficient if they focus only on immediate circumstances. Longer term future changes in environmental conditions (sea level, temperature, future storms, river flows, salinity, etc.) may not be appreciated by villagers, yet may have implications for the sustainability of their adaptive strategies and livelihoods, so these risks need to be considered in adaptation programmes. Also, there is, as one reviewer noted, 'an elephant in the corridor' in that there are powerful forces that severely constrain more systemic, widespread and effective adaptations, and are beyond the control of villagers and NGOs. So long as the root causes of poverty remain, involving economic structures, policies and institutions, inequalities and access to resources, the adaptations will be limited, stop-gap efforts.

While more widespread, lasting improvements in the well-being of people will require changes in broader-scale political, economic and cultural systems, as in the case of Subarnabad, enhancing livelihoods provides a practical means of improving people's immediate well-being, and also provides them with increased capacities to deal with future climate change.

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