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Flood proneness and coping strategies: the experiences of two villages in Bangladesh

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This paper explores peoples' indigenous survival strategies and assesses variations in people's ability to cope with floods in two flood-prone villages in Bangladesh. It reveals that people continuously battle against flood vulnerability in accordance with their level of exposure and abilities, with varied strategies employed at different geophysical locations. The paper reports that people in an area with low flooding and with better socioeconomic circumstances are more likely to cope with impacts compared to people in areas with high and sudden flooding. Similarly, households' ability to cope varies depending on people's socioeconomic conditions, such as education, income and occupation. Although floods in Bangladesh generate socioeconomic misery and cause damage to the environment, health and infrastructure, people's indigenous coping strategies have helped them to reduce significantly their vulnerability. Such flood-mitigating strategies should be well recognised and emphasised further via proper dissemination of information through an early-warning system and subsequently external assistance.

Keywords: Bangladesh, coping capacity, coping strategy, flood, indigenous knowledge

Introduction

In Bangladesh, flood is the most frequent natural hazard and is considered to be the main threat. Approximately 60 per cent of the country's land mass is less than six metres above the mean sea level (USAID, 1988; GOB, 1992) and floodwater inundates around 20.5 per cent of the country (3.03 million hectares) every year (Chowdhury, 2000; Mirza et al., 2001). In extreme cases it may cover 70 per cent of the country (Mirza, 2002), with varied effects. Normal floods are seen as a blessing because they bring economic and environmental benefits (Blaikie et al., 1994; Smith, 1996; Handmer, Penning-Rowsell and Tapsell, 1999) whereas high floods are viewed as disastrous (Paul, 1997). For example, normal flooding makes arable land fertile and leads to an augmentation of agricultural production (Brammer, 1990) while high-magnitude events inundate large areas causing widespread damage to crops, human beings, livestock and property as well as devastation to life and livelihoods (Paul, 1984, 1997; Rasid, 1993; Few, 2003). The unique natural setting of Bangladesh on the South Asian subcontinent and its tropical-monsoon climate attract flood hazards to the country (Elahi, 1991). As the majority of the people live in the countryside, their livelihoods are directly or indirectly dependent on the land (BBS, 2003). Therefore, flooding jeopardises the lives and livelihoods of people.

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The term vulnerability refers to the exposure of a group or individual to stress due to social and environmental change, while stress is as unanticipated change in and disruption to livelihoods (Adger, 1999). Vulnerability comprises a set of attributes that circumstance turns into susceptibility to impacts (Lewis, 1999), and centres on the characteristics of a group or an individual in terms of their ability to predict, cope with, resist and recover from the shocks caused by natural hazards (Blaikie et al., 1994). Adger (2000, p.739) suggests that vulnerability is 'the presence or lack of capability to resist shocks and stresses to livelihood'.

A comprehensive and varied literature exists on the concept of vulnerability (see, for instance, Burton, Kates and White, 1993; Cannon, 1994; Moser, 1998; Dercon, 2001, 2002, 2005; Cannon, Twigg and Rowell, 2003; Pelling, 2003). This study, though, takes vulnerability to mean the susceptibility of an individual to the negative impacts of flood hazards. Likewise, there is a wealth of literature on the concept of livelihoods (see, for example, Chambers, 1988, 1995; Chambers and Conway, 1992; Ellis, 1999; Sanderson, 2000; Devereux, 2001). In a livelihoods approach, assets (financial, human, natural and physical) dictate a household's ability to implement strategies to cope with shock events, such as flooding (Moser, 1998; Sanderson, 2000).

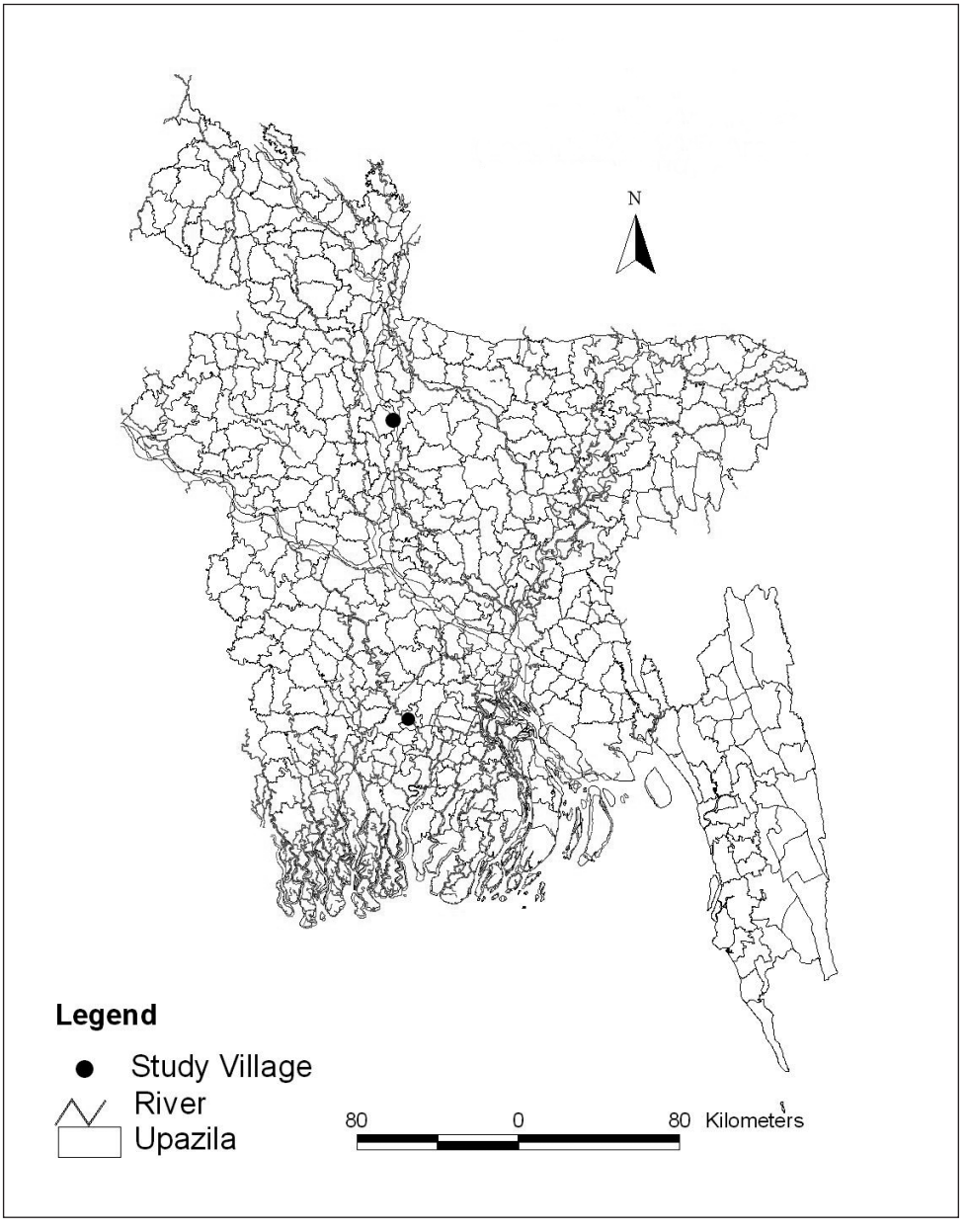
A number of different factors, such as flood characteristics, physical infrastructure, geographic location, geomorphological setting and people's cultural, political and socioeconomic condition (Maskrey, 1999; Alca´ntara-Ayala, 2002; Few, 2003; Hutton and Haque, 2004), condition vulnerability to flooding. However, it requires the combination of these variables with an economically backward country and a socially fragile environment to turn a flood into a flood disaster.

Flood is an unavoidable phenomenon in different parts of Bangladesh. People in a flood-affected locality adopt different measures to minimise the ramifications. Measures taken before the onset of an event are 'preventive', while during- and post-flood measures are 'mitigative'. (Coping and mitigative measures are synonyms and hence this paper employs them interchangeably.) Bangladesh utilises structural (embankment, levee, polder, for instance) and non-structural (awareness raising, flood warning, for example) measures for flood prevention and mitigation (Paul, 1997). Yet, it has become evident in recent years that structural methods are neither economically viable, requiring extensive financial investment, nor environmentally friendly (Custers, 1992; Wescoat and Jacobs, 1993; Haque and Zaman, 1993; Paul, 1997; Hutton and Haque, 2004). Moreover, the country's top-down approaches to planning have repeatedly failed to deliver timely and effective flood mitigation (Ali, 1987; Adnan, 1991; John, 1998; Mirza et al., 2001). Consequently, today, emphasis is being placed increasingly on incorporating local people's indigenous flood-mitigating strategies (Blaikie et al., 1994; Sanderson, 2000) in other public/external efforts to achieve effective flood mitigation (Twigg, Benson and Myers, 2000; Few, 2003). However, there is very limited and narrowly focused literature available on local people's traditional means of coping with floods (Haque and Zaman, 1993; Rasid and Mallik, 1995; Rashid, 2000).

It is important to know how people in remote rural areas survive such a situation without external support given that flooding is quite a regular occurrence. This study

attempts to explore how people in two flood-prone villages in Bangladesh employ different preventive and mitigative measures through different coping strategies. In addition, it evaluates how different enabling attributes, such as education, income and occupation, affect the overall flood-coping strategy and how different measures (preventive and mitigative) help to minimise vulnerability to a flood disaster.

Figure 1 Location of the study areas



Source: author.

The study area and methodology

The study was conducted in the villages of Bannabari and Suvagacha in Tungipara upa-zilla (sub-district), Gopalgonj district, and in Kajipur upa-zilla (sub-district), Sirajgonj district, respectively (see Figure 1). In both villages, the majority of the households are either directly or indirectly dependent on agriculture for their livelihoods. Suvagacha village, located beside the main Jamuna River, is flooded every year and is prone to riverbank erosion. Flooding is sudden and rapid because of the rise of the water level during the rainy season and breaching of the riverside embankment. Running water from the Jamuna River covers the land at a great speed and hence people lack time to evacuate with their belongings. Bannabari village also is flooded regularly but the character of the flooding is different to that of Suvagacha village. Most of the land in Bannabari is marshy and *beel*[2] and floods develop gradually as the water level rises in the *beel* and the Padma river system due to excessive monsoon rainfall. Consequently, people have enough time to protect their possessions.

Primary data were collected through interviews with key informants in Bannabari and Suvagacha, household surveys and unstructured interviews, as well as via focus-group discussions with household members in both villages. Key informants were selected purposively while households were identified using a simple random sampling procedure. The assumption of a 90 per cent confidence interval resulted in an estimated sample size of 94 out of 500 households, and samples from both villages were in proportion (Yamane, 1967).[3] Both descriptive and inferential statistics were used to analyse the data.

Differences in flood-proneness in Bannabari and Suvagacha villages

Both villages experience recurrent flooding, but it is more severe in Suvagacha than in Bannabari. Suvagacha village suffered moderate to high flooding between 1998 and 2005 while Bannabari endured only light to moderate flooding. Over the same period, the average flood duration was between two and three months for Suvagacha village and one month for Bannabari village. With regard to the depth of the floodwater (average floodwater height from the base of the dwelling unit), there was more than five feet of water in almost all households in Suvagacha village compared to one foot in Bannabari. Thus, evidence of flood impacts reveals that Suvagacha is more prone to flooding than is Bannabari. Table 1 lists other attributes pertaining to flood impacts in the study villages.

Indigenous flood prevention and coping strategies

The term coping strategy describes the approaches people employ to deal successfully with a crisis (Davis, 1996). People in both villages developed their own coping strategies to guard against the flooding. One can classify them as either structural

Table 1 Flood impacts in Bannabari and Suvagacha villages, 2005

Flood impacts	Bannabari	Suvagacha
Soil erosion	No soil erosion	Severe soil erosion
Riverbank erosion	Not applicable	Two-thirds of the land area eroded between 1998 and 2005
Soil fertility	Siltation after flood	Sand deposition after flood
Drinking-water pollution	Few tube wells were safe	All tube wells were inundated
Surface-water pollution	Decomposition of human and domestic waste in stagnant water	Decomposition of human and domestic waste together with sand in floodwater
Loss of earning	Average Taka 6,542.85 per year per household	Average Taka 8,677.97 per year per household
Loss of assets	Average Taka 15,279.41 per year per household	Average Taka 20,565.69 per year per household
Food security during floods	62.9 per cent of households	39.0 per cent of households
Access to safe drinking water	85.7 per cent of households	44.1 per cent of households
Common diseases and conditions	Fever, diarrhoea	Cold, fever, skin disease, diarrhoea, stomach problem
Sickness during floods	Average 1.28 times per person	Average 1.62 times per person
Common flood shelter	Unsafe own house	Riverside embankment
Temporary migration of household members	54.3 per cent of households	94.9 per cent of households
Impact on social mobility	High rate of absenteeism from school and job	Very high rate of absenteeism from school and job
Damage to village road	Damage to main road to entrance of the village	Complete destruction (washed away) of main entrance to the village
Bio-diversity status	Bio-diversity not affected	Ecosystem completely changed

Sources: key informant interviews, household survey and interviews with household members, 2005.

or non-structural and indigenous or modern. However, people are used to relying on various indigenous strategies; the adoption of a particular set of strategies depends on people's socioeconomic circumstances and the characteristics of the flood. Our findings suggest that a household response to a flood does not involve the adoption of all strategies but rather sequential implementation of preventative and mitigative initiatives (Corbett, 1988). The sequence associated with preventive strategies includes the placing of barriers around the house, raising the platform of the house, avoidance of construction materials susceptible to flooding, and preparation of *gathua*.[4] Likewise, the sequence associated with mitigative strategies includes using *muchan*[5] and *pataton,*[6] reducing the number of meals and relying on inexpensive food, collecting wild food, depending on relief, taking shelter along an embankment with one's personal belongings, searching for alternative sources of income, selling unproductive assets, and

borrowing, mortgaging and selling land and other productive assets. It is not necessarily the case, though, that all affected households move along this continuum; rather, it depends on their level of vulnerability and their ability to absorb shock. The following subsections discusses overall preventive and mitigative strategies.

Coping techniques to save human lives[7]

Various earlier works suggest that in flood-affected localities, coping starts with efforts to save people's valuable lives, such as raising a homestead before a flood (Thompson and Tod, 1998; Rasid and Paul, 1987). What is interesting from the perspective of this study is what accompanying coping measures people introduce to live in greater safety. Given previous experience of flooding, people tend to elevate their bed using bricks or tie the bed to a wooden pillar and then attempt to make a *muchan* out of bamboo or wood. Some use the upper part of the house as a shelter (*pataton*) and/or prepare a *gathua* out of water hyacinth. Of course, in the worst cases, victims take shelter in relatively safer places such as along an embankment or on higher ground—this is especially true in Suvagacha village.

Our survey findings confirm that the preparation of *gathua* and its application during a severe flood are normal practices in Bannabari village, but not in Suvagacha village. The building of *muchan* is common in both villages. Bannabari is situated mostly on low-lying marshy land and there is a vast amount of water hyacinth during the monsoon period. In fact, people can collect easily and freely water hyacinth for use in *gathua*. In Suvagacha, though, there are no water-hyacinth deposits due to the floodwater current. In sum, some strategies are common in both villages while a few are applied in a particular village depending on the nature of the flood.

Coping techniques to save household items

Besides attempting to save human lives, people also try to rescue their assets, such as furniture and household utensils. Initially they keep their assets on a *muchan* or in a *pataton*. However, when floodwater rises, they move them to safer places by boat or any other available means. Techniques to save property also vary between the two villages. In both villages 33.1 per cent of all respondents said that they preferred to build a *muchan* to protect their property, while 30 per cent of respondents in Bannabari stated that *gathua* is a common practice there. Few people in both villages mentioned raising the platform of the house during a low flood to allow them to keep their belongings inside the house. When all such techniques failed, 29.1 per cent of all respondents reported that they moved to safer places with their possessions.

Coping techniques to save shelter

Techniques to protect shelter depend on the risk posed by the flood and erosion. Earlier works mostly found that villagers in flood-prone areas built their dwelling units on raised land or on earthen platforms so that water cannot reach the plinth level in a normal flood (see, for example, Islam, 2001). However, this study finds that

apart from the usual practice of erecting shelter on a raised platform, villagers also try not to utilise any housing materials that are susceptible to flooding, such as a mud wall; rather, they prefer to use bamboo, corrugated iron sheet, thatch and wood, which are easily transferable. Interestingly, people use materials that they can separate part by part in order to transfer the whole house during a severe flood. In addition, sometimes people make barriers out of water hyacinth or place sandbags around the house to guard against the current. It is common to see plantations of water-resistant plants such as banana, *hogla* and *kolmi*[8] around a homestead to protect the house from erosion.

Approximately 32.3 per cent of respondents in Bannabari said that preparation of a water-hyacinth barrier around the house was a common technique to shield it, whereas in Suvagacha nobody reported employing this method because of the higher velocity of floodwater. In Bannabari, as floodwater increases gradually with less current, 42.1 per cent of respondents reported that they had raised the homestead and the floor of the house in light of their experience of floodwater during the previous year. In Suvagacha, people stated that they had raised primarily the floor of the house due to the changing height of floodwater each year. In Suvagacha, 49.6 per cent of respondents mentioned having used transferable construction materials to move the house in pieces as and when required.

Coping techniques to protect crops

People in both areas have adopted different kinds of indigenous coping strategies to protect crops, including the selection of appropriate crop varieties that suit the time frame of floods and the floodwater level as well as the physiographic and soil conditions of the area. Household survey data show that in both villages, significant numbers of farmers used to follow the traditional crop calendar of the country, although the cropping pattern is not similar in the two study villages. In Suvagacha, farmers used to cultivate mustard, potatoes, pulses, spices, sweet potatoes, vegetables and wheat during the *Rabi*[9] (post-flood) season. Due to flooding, many farmers prefer sugarcane and jute to paddy as they survive in high floodwater. In Bannabari, by contrast, farmers cultivate *boro* and other crops during the *Rabi* season and in the *kharif*[10] season, they prefer *gathua* to cultivate different vegetables. Consequently, this study confirms the findings of Rasid and Mallik (1995) regarding agricultural cropping patterns and related strategies.

Coping techniques to protect poultry and livestock

Poultry and livestock are important assets for people with low incomes in both areas. During the initial stage of a flood, people keep their poultry and livestock on a higher part of their homestead. When this becomes impossible, they move them to safer places, such as higher roadsides; often, they sell poultry and livestock to outsiders. Household survey data show that 49.3 per cent of respondents in Bannabari use *gathua* to protect poultry and livestock, while in Suvagacha, 37 per cent of respondents

keep them on a raised part of their homestead. When all such measures fail, 51.5 per cent of respondents in both villages reported moving their poultry and livestock to safer places.

Coping strategies to protect fisheries

People in Bannabari mostly culture fish as a source of income. As Suvagacha is prone to moderate-to-high flooding each year, very few families develop fisheries. Field survey data show that 82 per cent of respondents in both villages use bamboo and a fishing net called *bana*[11] to protect fisheries during flooding. Some 30 per cent of all respondents use water hyacinth to raise pond embankments, a widely used technique in Bannabari. When floodwater is high, though, water hyacinth cannot defend fisheries.

Coping strategies related to food, fuel and potable water

The storing of food, fuel and water is a difficult challenge for victims of a flood. People prefer and use big *motki* (an indigenous earthen pot) and polythene bags to stockpile dry food and seed. One-quarter of total households in both villages prefer aluminium, earthen and plastic pots to transport fuel and water, as they are easier to carry and normally float. In most houses, the storing place is higher than the normal floor; such places remain safe until there is high floodwater. However, when floodwater increases, people usually prepare a *muchan* inside the house and most houses in flood-prone areas have a *pataton* that is used to store food, fuel and water. Approximately 41 per cent of households in both villages have a *muchan* and a *pataton* for the aforementioned purposes. Few people in both villages have raised the basement level of their storerooms. *Gathua* is practiced by 12 per cent of households in Bannabari—a procedure completely absent in Suvagacha. In Suvagacha, people remain prepared to migrate to safer places during a period of high floodwater, and hence a portable stove is common in the village.

Coping strategies related to purified water

Most of the people expressed a dire need for pure drinking water during and immediately after a flood. A common observation is that post-flood diseases spread through the drinking of contaminated water. People are aware of the risk of consuming contaminated water but often they are unable to procure pure water as tube wells are submerged and water-purifying materials are unavailable. It is not possible to boil water frequently as traditional fuel resources (such as bamboo, cow dung cakes and fuel wood) become wet during flood. The most common methods of water purification in both villages are use of potassium alum (55.2 per cent of all respondents) followed by water-purifying tablets (25.6 per cent of all respondents).

Local medicinal practices during and after a flood

Suffering from water-borne diseases and related conditions, such as cold, dysentery, diarrhoea, fever and skin ailments, is common during and after a flood. Interestingly,

many people treat themselves using their knowledge of medicine. In both villages, 87.2 per cent of respondents have taken medicine from a local pharmacy with and without consultation with a doctor. Furthermore, 31.4 per cent of respondents in Bannabari have used indigenous herbal medicine together with other medicine. The most commonly used herbs in Bannabari village are *tulshi* (Ocimum Sanctum),[12] *basak* (Adhatoda Vasica),[13] *thankuni* (Centella Asiatica),[14] *gando vadal* (Gaultheria Fragrantissima), *durba* (Eragrostis Cynosuriodes) and *pudina* (Mentha Arvensis). *Basak* and *tulshi* are used to treat colds and fevers, whereas *durba*, *gando vadal*, *pudina* and *thankuni* are used for stomach problems such as diarrhoea and dysentery.

Changes in eating behaviour

Scarcity of food during and after a flood is a common phenomenon in flood-affected areas. When faced with an insufficient food supply, the household head is primarily responsible for feeding family members, and he or she usually adopts different measures to cope with such a situation, including reducing the number of meals per day and relying on inexpensive foodstuffs such as flattened rice, *ghur*[15] and green jute leaf as a vegetable. The study's findings show that in both villages, skipping a meal is a common coping strategy and that there are variations in dependency on inexpensive food. Approximately 22 per cent of respondents in Bannabari and 78 per cent in Suvagacha had decreased their number of meals and increased their dependency on inexpensive food. However, the situation is more severe in Suvagacha because of the poor economic circumstances of most residents. By contrast, respondents in Bannabari said that they had reduced their number of meals because of wet firewood and because kerosene was expensive during and immediately after the flood. Consequently, they cooked two meals once a day.

Other important coping strategies

Households in both villages employ many other coping methods during a flood. Among households exposed to shocks, for example, borrowing money (mostly after a flood) (Del Ninno and Dorosh, 2003) and disposing of assets are considered very important initiatives. This study found that the most common assets sold in both villages to overcome difficult periods and manage crises are cattle, chicken and trees. In flood-prone areas, people also pursue alternative occupations, such as fishing and operating boats during a flood, in addition to their normal livelihoods linked to agriculture. Moreover, migration is seen as an option when all other measures fail.

Variations in the adoption of coping strategies: selective determinants

Every locality might have some established or traditional coping strategies, but the type of response adopted by people and its effectiveness may vary over time (Corbett, 1988). Many of these coping mechanisms can fail, and not because people's ability

to cope is overwhelmed by the scale of the flooding (Guarnizo, 1992). In fact, changes in the size of the population and the economy, in the local market and the environment, in the source of livelihood of each household and in flood characteristics can make mechanisms outdated (Corbett, 1988; Few, 2003). The study's findings suggest that traditional strategies make a positive contribution to improving people's adaptability to a flood hazard, but as a whole, it is a complex process, linked to other physical and socioeconomic variables. Therefore, the discussion of variations in the adoption of coping strategies considers endogenous factors, such as education, income and occupation, and exogenous factors, such as external assistance, flood characteristics and riverbank erosion.

Household's income level as a determinant of coping strategies

Household's income level has a close link to coping strategies. Households with a higher income or with savings can readily help themselves in a flood event and hence are less vulnerable to flood impacts (Green et al., 1994). Table 2 shows that the income level of households is associated with the availability of food during and after a flood. Food is available to the high and upper-middle income groups during the flooding period, while most of the low and lower-middle income groups do not have sufficient food to overcome the situation. Consequently, ability to cope with flooding in terms of the storage of food is greater among high and upper-middle income groups than it is among low and lower-middle income groups. According to Banerjee (2007), key in this regard is the relatively higher agricultural production of the former groups as they possess more landholdings than smaller farmers, increasing real wages and reducing their vulnerability to a potential shortfall in income in a time of disaster.

In addition, eating behaviour fluctuates among different income groups. Households in low and lower-middle income groups prefer to decrease their number of meals and to rely on inexpensive food—these groups have fewer resources with which to buy and store food for a prolonged period of flooding. Interestingly, the behaviour of higher and upper-middle income groups is quite different. They prefer to reduce the number of daily meals than consume inexpensive food. The reason for this could be that this group is very aware of susceptibility to water-borne diseases during and after a flood.

Some earlier works have found that a fall in the income of workers due to flooding causes a severe decline in their consumption level and increases the incidence of illness and morbidity (see, for example, Del Ninno, Roy and Mukherjee, 1999), but no such evidence was produced in the study area.

Similar contrasting behaviour is evident among various income groups in relation to disposing of or selling productive and non-productive assets. High and upper-middle income groups, for instance, are able to cope with a disaster without selling their assets. Lower-middle income groups are more likely to cope with the situation by disposing of their assets (see Table 2).

Table 2 Relationship between household head's income level and food availability, changes in eating behaviour and the selling of assets

	Level of income of household head									
	Low (0–2000 Taka)		Lower-middle (2,000–4,000 Taka)		Upper-middle (4,000–6,000 Taka)		High (6,000+ Taka)		Total	
Availability of food	**HH**	**%**	**HH**	**%**	**HH**	**%**	**HH**	**%**	**HH**	**%**
Yes	10	43.47	13	30.95	15	68.18	5	71.43	43	45.74
No	13	56.53	29	69.05	7	31.82	2	28.57	51	54.26
Total	**23**	**100.00**	**42**	**100.00**	**22**	**100.00**	**7**	**100.00**	**94**	**100.00**
Chi-square Test: Sig. value = 0.018 with degree of freedom = 3										
Changes in eating behaviour	**HH**	**%**	**HH**	**%**	**HH**	**%**	**HH**	**%**	**HH**	**%**
Reduce number of meals	6	26.10	13	31.00	15	68.20	6	85.70	40	42.60
Reduce meals and rely on less expensive food (both)	17	73.90	29	69.00	7	31.80	1	14.30	54	57.40
Total	**23**	**100.00**	**42**	**100.00**	**22**	**100.00**	**7**	**100.00**	**94**	**100.00**
Chi-square Test: Sig. value = 0.018 with degree of freedom = 3										
Selling of assets	**HH**	**%**	**HH**	**%**	**HH**	**%**	**HH**	**%**	**HH**	**%**
Yes	10	43.48	27	64.28	7	31.82	2	28.57	46	48.93
No	13	56.52	15	35.72	15	68.18	5	71.43	48	51.07
Total	**23**	**100.00**	**42**	**100.00**	**22**	**100.00**	**7**	**100.00**	**94**	**100.00**
Chi-square Test: Sig. value = 0.047 with degree of freedom = 3										

Note: HH = number of households.
Source: household survey, 2005.

Level of education as a determinant of coping strategies

Education is one of the important determinants of coping as well as for adaptation to ensure survival and to enhance one's quality of life (D'Oyley, Blunt and Barnhardt, 1994). Education level is very important in generating awareness of flood forecasting. Flood warnings can reduce the tangible and intangible damage experienced by flood victims (Parker and Tunstall, 1991). However, people's response to a flood depends on appropriate dissemination and reliability of flood-forecasting information.

Similarly, capacity to understand flood forecasting varies among people with different educational levels. Table 3 shows that almost all household heads with undergraduate-level education and some two-thirds with secondary-school-level education are able to capture flood-forecasting information, whereas the numbers gradually decrease among household heads with primary-school-level education and

Table 3 Household head's education level and capacity to capture flood-forecasting information

Capacity to capture flood-forecasting information	Illiterate		Primary school		Secondary school		Undergraduate		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%
Yes	14	40.00	18	60.00	16	76.19	8	100.00	56	59.57
No	21	60.00	12	40.00	5	13.81	0	0.00	38	40.43
Total	**35**	**100.00**	**30**	**100.00**	**21**	**100.00**	**8**	**100.00**	**94**	**100.00**
Chi-square Test: Sig. value = 0.004 with degree of freedom = 3										

Note: HH = number of households.
Source: household survey, 2005.

among those who are illiterate. Hence, the higher the education level, the greater one's capacity to understand flood forecasting and to reduce one's vulnerability to flooding.

Occupation as a determinant of coping strategies

The occupation of the household head is another important variable that influences the adoption of coping strategies. The study found that food was available to a household head engaged in service activities (see Table 4) while farmers, labourers and small vendors had a limited amount of food. The study revealed also that borrowing

Table 4 Occupation of household heads, availability of food and borrowing of money

	Farming		Daily labourers and small vendors		Service activities		Total	
	HH	%	HH	%	HH	%	HH	%
Availability of food								
Yes	28	43.07	7	31.81	6	85.71	41	43.61
No	37	56.92	15	68.19	1	14.29	53	56.38
Total	**65**	**100.00**	**22**	**100.00**	**7**	**100.00**	**94**	**100.00**
χ^2-Test Sig. value = 0.043 df=2								
Loan to meet expenditure								
Yes	38	58.46	14	63.63	3	42.86	55	58.51
No	27	41.54	8	36.37	4	57.14	39	41.49
Total	**65**	**100.00**	**22**	**100.00**	**7**	**100.00**	**94**	**100.00**
Chi-square Test: Sig. value = 0.62 with degree of freedom =2								

Note: HH = number of households.
Source: household survey, 2005.

during and after a flood is highest among labourers and small vendors, followed by farmers and service holders (see Table 4). This is because the labouring class becomes jobless during prolonged flooding and mostly borrows from moneylenders at a high rate of interest to meet food consumption requirements, increasing vulnerability due to a flood disaster.

External assistance as a determinant of coping strategies

External assistance, such as a relief programme, has a significant impact on a household's capacity to respond to shock and the timing of relief can play an important role in determining the effectiveness of coping strategies (Corbett, 1988). The study's findings suggest that in addition to food relief, external assistance should include provisions to revive agricultural- and livelihood-related activities as a top priority. Food relief is a necessity but providing food-production assistance is more sensible and can enhance victims' ability to cope (Devereux, 2001). The study identified food and drinking water, temporary shelter and access to health services, among other variables, as important needs during a flood; whereas agricultural inputs, employment, food and drinking water and reconstruction of houses are considered vital needs after a flood. Therefore, providing more relief to those who have experienced greater loss or who are poorer post disaster according to their exact requirements can help to create an enabling environment for their coping strategies. If relief is made available early enough and is based on victim's priorities, this may help households to save at least some of their asset base and avoid selling assets or reaching the final stage of destitution (Corbett, 1988).

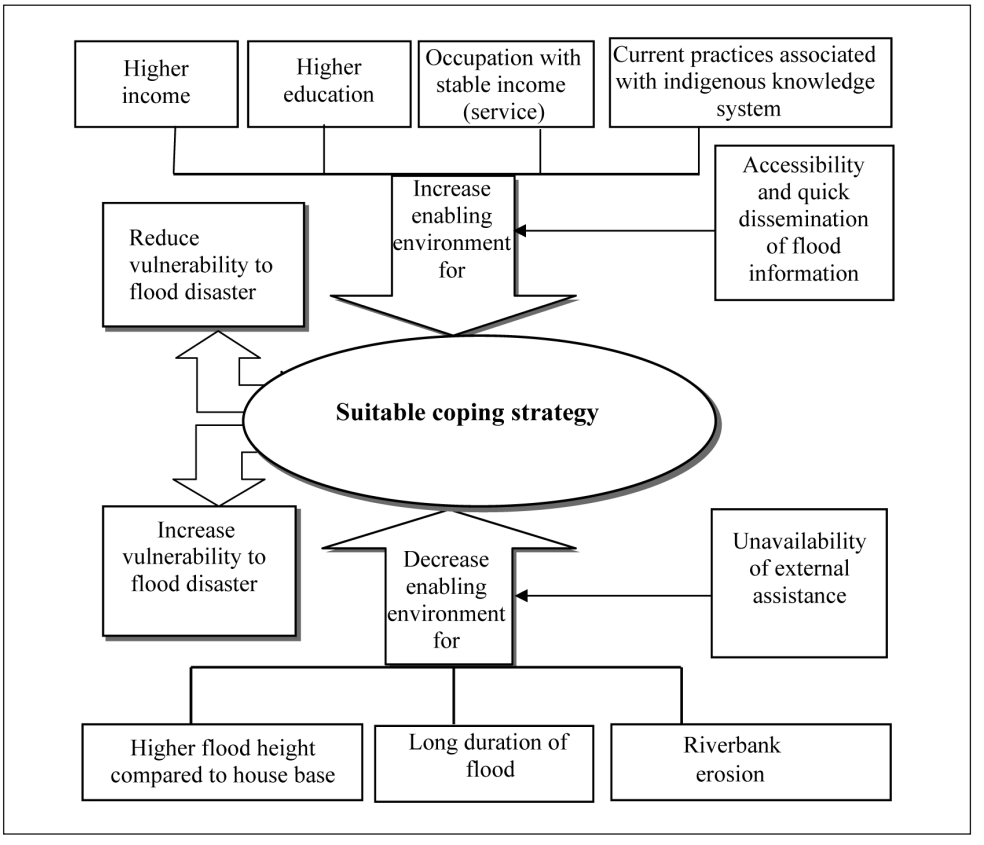
Flood characteristics as a determinant of coping strategies

Flood characteristics, such as the height of floodwater and the frequency and duration of flooding, influence people's adoption of coping strategies. A longer period of stagnating flooding has more severe ramifications than floodwater height. If floodwater remains stagnant for a long time in a locality, the level of total damage rises and hence people's ability to cope with the situation decreases. Similarly, pollution increases if water remains stagnant for a long time and coping strategies fail in relation to health issues. It is also evident in the study that if floodwater stays stagnant for a long time, it causes a disruption to people's food and drinking water supply, reducing the ability to cope and augmenting vulnerability. Thus, there is a direct link between the effectiveness of coping strategies and the nature of flooding and people's socioeconomic conditions, with lower-income people being the most vulnerable.

Distance from riverbank as a determinant of coping strategies

Localities adjacent to a riverbank are more prone to a flood hazard. A great volume of floodwater first enters open land along the river, damaging cropland and homesteads, and subsequently the interiors of houses. People far away from the river are not as vulnerable to flood risk of a similar intensity. Suvagacha village is located beside the River Jamuna, which is prone to riverbank erosion, with the severity of erosion

Figure 2 Coping strategy framework



Source: author.

mounting during monsoon flooding. People living in Suvagacha are more vulnerable to flooding than their counterparts in Bannabari, primarily because they fail to come up year on year with a quick adaptive response to a surge of devastating floodwater, often accentuated by riverbank erosion. In fact, usually they try to escape by taking shelter on the roadside embankment instead of building a flood-protection wall using indigenous measures such as a sandbag supported by a bamboo fence. In sum, people's exposure to vulnerability varies according to distance from the riverbank and is related to the nature of the flood. Based on the findings of the study, Figure 2 presents a comprehensive picture of the factors that positively and negatively influence the adoption of coping strategies.

Conclusion

This study finds that flooding has disastrous impacts on people's socioeconomic condition as well as on the environment, which depend not only on the magnitude of the event but also on some other variables such as income, lack of awareness, level

of education, occupational structure and physical location of the area. Thus, the findings confirm the earlier proposition of Haque and Zaman (1993) and Kunii et al. (2002) that the flood problem in Bangladesh is not merely a hydraulic dynamic; rather, it is also linked to issues of demography, ecology, education, settlement pattern, society, socioeconomic status and even culture and politics.

It is evident that in response to a flood, people adopt different indigenous preventive and mitigative measures or coping strategies in a sequential order. The implementation of such strategies may fluctuate due to variations in aforementioned factors. However, the study finds that coping techniques adopted by households fall into three distinct stages: preventive measures, adaptive measures and distress migration. The study finds also that indigenous coping strategies are highly effective only in a normal flood. As Thompson and Tod (1998) warn, these adjustments have limited effect in reducing damage in more extreme cases.

In this study, the adoption of coping strategies reveals an important pattern in how different households respond to a flood with respect to factors such as education, flood characteristics, income, occupation and riverbank erosion. A rising level of household income is accompanied by increased access to food and drinking water, leading to a greater ability to cope with a disaster without relying on inexpensive food items or selling productive or unproductive assets. Similarly, the higher the education level the greater the scope to capture flood-forecasting information that reduces vulnerability to a disaster and enhances a household's ability to cope with a disaster. Occupation also has a similar influence: service-sector households, for instance, have a more stable income than farmers or labourers and thus have a greater ability to procure food and capture flood-forecasting information.

Flood characteristics, meanwhile, have a negative influence on ability to cope when the flood is prolonged and its height increases, coupled with the associated loss and damage that limits access to food and drinking water. Households close to a riverbank are more susceptible to flooding and erosion, increasing their vulnerability and reducing their ability to cope.

External assistance, such as bulk relief at the proper time and appropriate distribution, can play a pivotal role in determining the effectiveness of coping strategies. Haque and Zaman (1993) and Paul (1997) have made a similar argument that external support and assistance along with social capital at the community level significantly contribute to swift recovery from a flood. In fact, it is vital to ensure assistance from governmental and non-governmental organisations during and after a flood to minimise the hardships that confront victims—although complete elimination is not possible—and to help them regain their pre-disaster status. External support combined with social capital can significantly improve the capacity of people and reduce vulnerability to floods.

Finally, this study confirms that although flooding in Bangladesh always generates socioeconomic and health-related hazards and environmental and infrastructural damage, people's indigenous coping strategies can significantly reduce their vulnerability to disaster. However, such strategies are highly effective only in a normal situation:

when floodwaters rise and cross a critical threshold, people have no choice but to migrate to a safer place. A need exists, therefore, for the integration of proactive settlement planning and policy into a disaster-management framework. People's indigenous knowledge systems and flood-mitigating strategies must be complemented by additional inputs from early-warning systems followed by external assistance during and after a flood to enhance victims' ability to cope.

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Endnotes

[1] As of September 2009, Shitangsu K. Paul is conducting a doctoral study in Regional and Rural Development Planning at the School of Environment, Resources and Development, Asian Institute of Technology, Bangkok, Thailand.

[2] *Beel* is low-lying land that is flooded in the rainy season.

[3] The following formula was used to determine sample size: $n = N/(1+Ne^2)$, where $N = 500$ and $e = 10$ per cent.

[4] *Gathua* is a float made out of water hyacinth and thatch. The process usually starts in December or January—during the dry season—with the depositing of unused thatch in open agricultural field. In July–August, when the floodwater begins to rise in open fields, people deposit a thick layer of water hyacinth on the floating thatch, which typically floats on the water throughout the rainy season. When floodwater enters a house and people cannot stay due to its height, they take shelter on the *gathua,* creating a tent using polythene. When floodwater recedes, *gathua* is mixed with the soil, gradually decomposing over two years and serving as organic manure.

[5] *Muchan* is an indigenous structure made out of bamboo or wood that is used as a platform. This platform can be raised using additional bamboo or wooden pillars when floodwater rises. People live on a *muchan* with all of their belongings during a period of flooding.

[6] In flood-affected areas, people build houses with either bamboo or wooden ceiling in the upper part of the shelter where they live. This ceiling is known as *pataton* and they keep food, fuel, water and valuables there during a period of flooding.

[7] Certain measures that are hard to classify as either preventive measures or coping strategies are termed here as coping techniques.

[8] *Hogla* and *Kolmi* are water-resistant plants that swell with an increase in floodwater, protecting houses from normal floodwater currents.

[9] *Rabi* is a short dry season spanning November to February and is characterised by scant or no rainfall, low temperatures and clear sky. Lack of adequate soil moisture limits the cropped area and irrigation plays an important role in cultivation.

[10] *Kharif* is the main cropping season. It starts in March and ends in October, and is characterised by a monsoon climate with high levels of rainfall and high temperatures.

[11] *Bana* is a kind of fence usually made of bamboo. Generally, it is used to protect the pond and to stop stocked fish from escaping into open floodwater.

[12] *Tulshi* (Ocimum Sanctum) is a small plant that grows to a height of between one and three feet, and is found in almost all households of the Hindu religion. The liquid solution prepared from its leaf is bitter to the taste and is commonly used to treat colds and fevers among children. The paste of the leaves is combined with honey and ginger to produce an effective remedy for asthma, bronchitis, cold, coughs and influenza.

[13] *Basak* (Adhatoda Vasica) usually grows in the surroundings of the homesteads and is commonly used to treat cough problem. Two-to-three tablespoons of *basak* juice with honey offers an instant remedy for colds and coughs. Nowadays it is widely used in the homeopathy field in the preparation of pharmaceuticals to treat coughs.

[14] *Thankuni* (Centella Asiatica) is a perennial herb (erect, biennial or short-lived) with a taproot and dark green shiny leaves. The root solution of *thankuni* is an effective remedy for dysentery.

[15] *Ghur* is viscous/hard sweet product of a black/brown/red colour that is made out of sugarcane molasses.

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