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Perception of and Agricultural Adjustment to Floods in Jamuna Floodplain, Bangladesh

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Based on a sample survey collected from randomly selected farmers inhabiting the Jamuna floodplain of Bangladesh, this study deals with the perception of and agricultural adjustments to both normal and abnormal floods. The study found that the respondents' perception of flood is conditioned by the key role played by floods in their lives. The study further observed that the respondents successfully cope with the normal floods. In cases of abnormal floods, they practiced several adjustments to reduce damages.

KEY WORDS: normal and abnormal floods; *bonna*; *barsha*; perception; agricultural adjustments.

INTRODUCTION

Annual flooding in Bangladesh plays an important role in the agriculture of the country. A number of crops grown in the monsoon period, particularly rice and jute, cannot flourish without flood water. It supplies the moisture and fertility (silt) to the soil that are vital to crop production. Over the ages, the farmers of Bangladesh have successfully adapted their lifestyles and agriculture to the annual floodings that commence and recede in due time and attain normal height. Any major fluctuation of floods with regard

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to timing, duration, and magnitude causes widespread damage to crops and properties and sometimes to animal and human lives. The agriculture of Bangladesh is, thus, both flood-dependent and flood-vulnerable.

A government report published by the Bangladesh Bureau of Statistics (1978) showed that over the previous 16-year period (1962-1977) floods caused an average annual loss of rice production of 427,000 tons. Bangladesh, a food-deficient country that has to import 1.5 million tons of food every year (Islam, 1981), cannot sustain this recurrent loss. As a result, flood and flood control have become crucial issues in Bangladesh. Over the last 3 decades, the government has undertaken varied projects to prevent flood damages such as the construction of embankments and dams and the improvement of river channels by dredging. These government projects, however, deal with the problem of flood and flood control at the public level; no attention is paid to what has happened, what is happening, or what will happen at the private level. To date, only two empirical studies (Islam, 1980; Ralph, 1975) have been undertaken in Bangladesh on this aspect by individual initiatives. In order to better assess the complex problem of flood and flood control in Bangladesh, more attention needs to be given to the individual, especially when the level of national flood damages remains enormous in the face of public expenditures for flood control (Islam, 1980). Moreover, an understanding of how individuals have adapted to and are affected by floods may suggest new and less costly ways of reducing flood damages.

This study is an attempt to develop flood hazard research in Bangladesh. It focuses on farmers inhabiting the Jamuna floodplain in Bangladesh, particularly their perceptions of and agricultural adjustments to floods. Before dealing with the findings of the research, the study outlines briefly the cropping season of the study villages as an aid to understanding the relationship between crop and flood.

METHODOLOGY

Four adjacent villages—Poa Kolaha, Kutubpur, Bahadipur, and Pakutia (West)—in the Jamuna floodplain of Ghatail *thana* (smallest administrative unit in Bangladesh), Tangail district (second largest administrative unit), were selected for the present study (Fig. 1). The villages together have 773 households with a total population of 4250 in 1978. Jhinai, a small river, forms the north and western boundary of the villages, and the nearest large river, Jamuna, flows 12 miles west of the

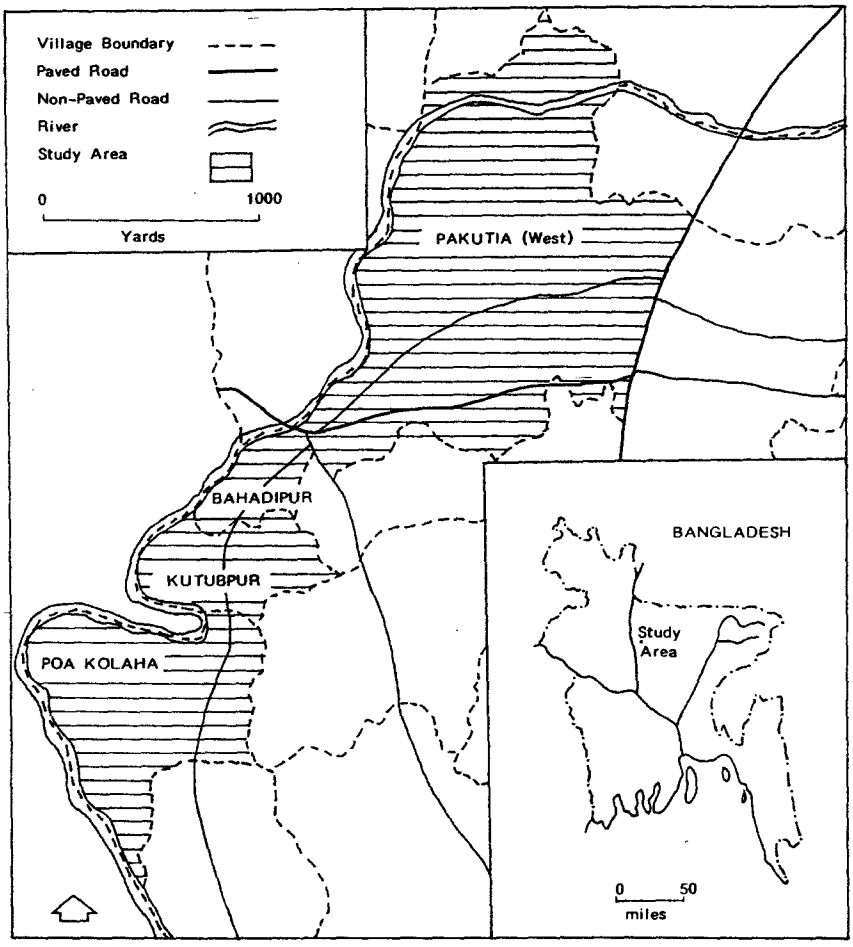

Fig. 1. The study area.

study area. The occurrence and severity of floods in the study villages usually depend on the extent of the rise of water level in the river Jamuna. Due to their distant location from the major river and the relatively moderate local relief, the study villages are subject to moderate annual flooding and thus form part of a medium hazard zone.

Two important considerations led to the selection of the study area. First, the author, native to the locality, has considerable knowledge of floods in the area. Second, the study area was selected from a medium

flood-hazard zone because there has been no systematic study of farmers' perception and range of adjustments to floods in such a zone. Empirical studies done in Bangladesh in the tradition of natural hazards research developed by Burton, Kates, and White (see Parker and Harding, 1979) were based mainly on sample villages located in the high hazard zone. Islam and Khan (1974) and Ralph (1975) suggested the necessity of looking at a number of villages subject to a range of flood experiences. This kind of study, they observed would present a clearer idea of the range of flood perception and adjustment, therefore providing a better basis for understanding the flood problem in Bangladesh.

The present study is based on both field observation and intensive interviews. The former included collection of relevant information through informal group or private discussions. The interviews included a survey conducted in May-June, 1978. For this purpose, 15% (78) of the total heads of the household (518) having cropland were selected randomly and interviewed with the help of a questionnaire.

CROPPING SEASON IN THE STUDY AREA

Agriculture in the study villages, as in most regions of Bangladesh, is crop-oriented. A variety of crops are grown in different agricultural seasons and under different physical conditions (especially rainfall and elevation of land in relation to the flood level). As elsewhere in Bangladesh, three distinct but partly overlapping cropping seasons can be recognized in the study area. The *Rabi* crop season extends from late November or early December to March or April (Fig. 2). Although nearly 15% of the cultivated land is cropped in this season, many crops are grown with or without irrigation. *Boro* rice, both local and high-yielding varieties (HYV), is the principal crop of the season, cultivated mostly in lowlands, which stay wet during the dry season or can be irrigated. This rice accounts for nearly 10% of the total cropland. Other crops— such as pulses, oilseeds, wheat, barely, winter vegetables, potatoes, and tobacco–are also grown in this season. The former four crops are generally cultivated in the lowlands, the latter three in the upper-middle to high land.

The *Bhadai*, or *Kharif,* season begins with scattered rains in late March or early April and lasts until the end of August or early September (Fig. 2). Jute and *aus* rice (local and HYV) are the two important crops grown in this season. They are generally sown in relatively higher lands, since excessive rainfall or flooding is harmful to young *aus* and jute plants.

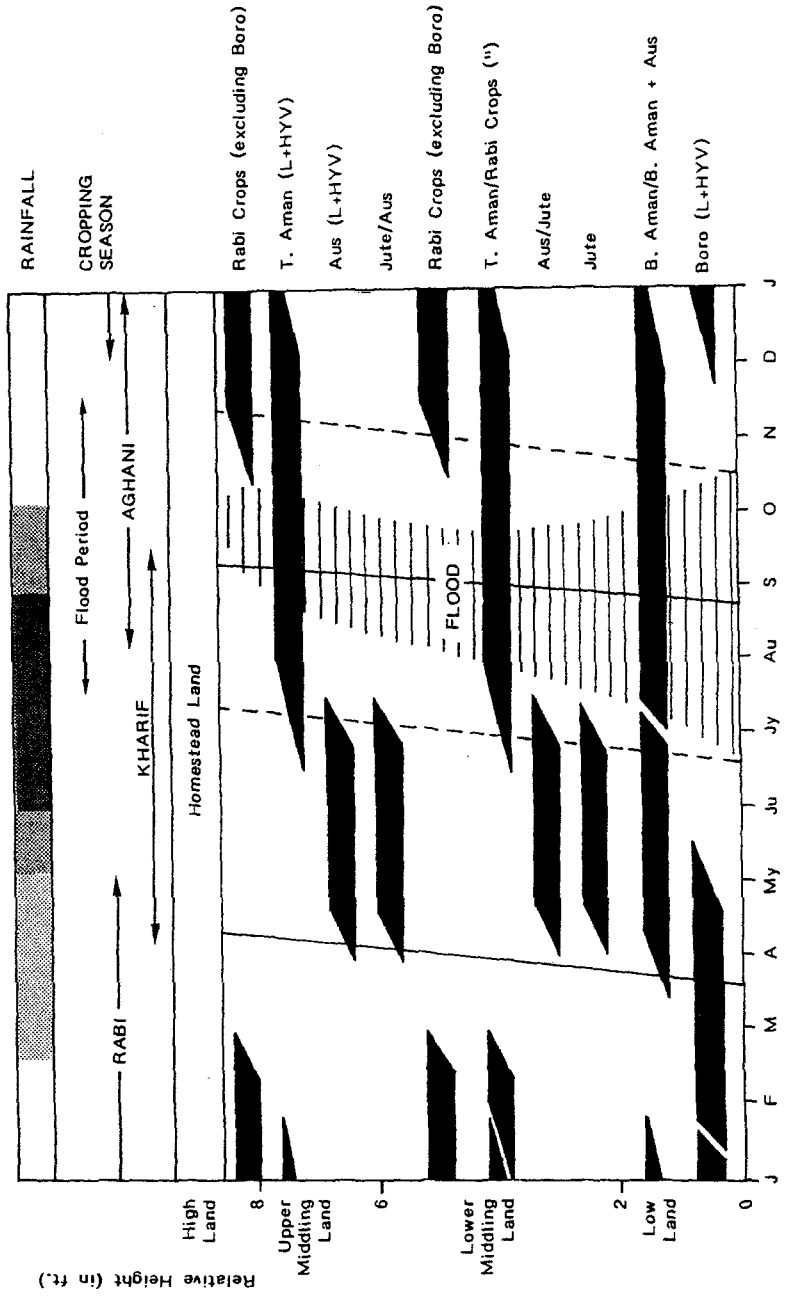

Fig. 2. Crop calendar of the study area. L = local, HYV = high-yielding varieties, T = transplanted, B = broadcast.

The *Aghani,* or *Haimantic* season, which roughly corresponds to the late monsoon period, extends from August to November or December. The main crop of this season is the rain-fed *aman* rice. There are two types of *aman*. The broadcast or floating *aman* is sown in March or April on lowlands that are prone to flooding (Fig. 2). The other type, known as transplanted *aman* (local as well as HYV), is sown densely into nursery beds in early July. Then the seedlings are transplanted into the lower-middle to upper lands at the end of July or early August, and harvested in late November or December.

As indicated earlier, most cultivated land in the study villages is subject to annual flooding. floods usually commence in the months of June and July and last until October; that is, floods extend from the middle of the *Kharif* season to near the end of the *Haimantic* season (Fig. 2). During this time, broadcast *aman* attains its maturity. The early part of the flood season usually corresponds to the harvesting period of *aus* and jute and to the transplantation of *aman*. Hence, any fluctuation in terms of the timing and duration of floods affects the harvest of *aus* and jute, the transplantation of *aman*, and the sowing of *Rabi* crops. If any deviation occurs with respect to the magnitude of floods, all standing field crops are either subject to inundation or their yields are lowered due to lack of sufficient flood water. If there is no flood at all, transplantation of *aman* tends to be hampered, and broadcast *aman* does not thrive well.

The relationships among cropping season, floods in the study area, and local relief shown in Fig. 2 may be generally applicable to most regions of Bangladesh. Some differences may exist since farming activities differ from one region to another because of variations in seasonal rainfall. For the same reason, farming activities may also vary slightly from year to year in a particular locality.

FINDINGS

The samples were drawn from the households having agricultural land. More than two-thirds of the respondents (71%) owned less than 3 acres of farmland. This indicates the subsistence nature of agriculture in the study villages. Most of the respondents were illiterate; only 31% of them had formal schooling. The age of the respondents ranged between 24 and 55 years; 67% of the respondents were 30-45. The overwhelming majority of the respondents had been living in the study area for generations. Only two

respondents migrated into the area in recent times (after 1960), but they came from an area ecologically similar to their present residence.

Perception

Perception of extreme events, albeit subjective in nature, plays an important role in agricultural decision making, especially in hazard-prone areas. In the natural hazards research context, the term *perception* implies the individual organization of stimuli to an extreme event and it is usually revealed in the language people use to describe the event, their ability to remember and describe past events, and their attitude towards its future occurrence (White, 1974).

Description of Floods

It is evident from the field survey that all respondents of the study villages refer to annual flooding either as *barsha* or *bonna.* The former is a normal inundation, which is crucial for production of *aus* and *aman* rice. This type of flood is perceived by the respondents as a benevolent agent providing sustenance to the farmers and, thus, it is an accepted and much-anticipated event. Usually in a year of normal flood, minimal damages to crops occur and farmers are able to harvest all of their *aus* and *aman* rice from the fields.

Floods that rise 8 feet above the broadcast *aman* fields but do not overtop the village mounds or homestead land are called *barsha.* According to all the respondents, the flood of 1977 (the year immediately before the field survey was conducted) was a normal one.

Bonna, or an abnormal flood, on the contrary, is regarded by the respondents as a disastrous and damaging phenomenon. It causes widespread damage to standing crops and properties. While the farmers successfully adjust to normal floods and benefit from them, abnormal floods go beyond their ability to cope and result in considerable hardships. The flood of 1974, which was considered by all respondents to be abnormal, caused nearly 34 times the damage to crops and properties as the flood of 1977 (Table I).

Table I. Extent of Flood Damages of the Respondents[a]

Year	Type of flood	Damages
1977	Normal (*barsha*)	5–10% damages of *aus* paddy for 10 respondents (out of 78) 5–10% damages of jute for 10 respondents (out of 78) Some damages to plinths of two respondents (out of 78) Total damages, Taka 3,000.00[b]
1974	Abnormal (*bonna*)	70% damages of *aus* paddy 65% damages of *aman* nursery beds 60% damages of *aman* paddy 60% damages of jute Total crop damages, Taka 80,000.00 20% structural damages (valued Taka 14,000.00) Damage of storable goods (valued Taka 6,000.00) Total damage, Taka 100,000.00

[a]Based on author's field survey.
[b]One U.S. dollar was equivalent to Taka 18.00 at the official exchange rate of 1978.

The overwhelming majority of the respondents (nearly 94%) described abnormal floods to be those in which the floodwater rises higher than 8 feet above the broadcast *aman* fields and overtops the homestead land. Although abnormal floods are perceived primarily in terms of the height of the floodwater, a small number of respondents (6%) also mentioned other measures of abnormal flooding such as timing and duration of floodwater. This means they consider early or late floods and long-or short-lived floods to be abnormal.

Over the last 4 decades numerous studies have been done on various aspects of flooding in different countries in the tradition of a natural hazards research paradigm (e.g., Harding and Parker, 1974; Kates, 1962; Parker and Harding, 1979; Payne and Pigram, 1981; White, 1945, 1961, 1964). In most of these studies, floods were perceived solely in terms of a damaging phenomenon. But flooding is an intimate part of rural life in the villages of Bangladesh, and it is deeply imbedded in their culture. Only the *bonna* is considered a hazard in the study villages. The *barsha*, which occurs more frequently than *bonna*, is not considered to be a hazard at all, but rather to be necessary for survival. Islam (1980) and Ralph (1975) reported a similar perception among the farmers residing in the Meghna floodplain of Bangladesh.

It appears, then, that floods are considered to be beneficial (i.e., perceived to be a resource) only during a given time or duration, and given a particular magnitude. If flooding occurs either earlier or later than the normal time (June-July), if it stays for a longer or a shorter period than the

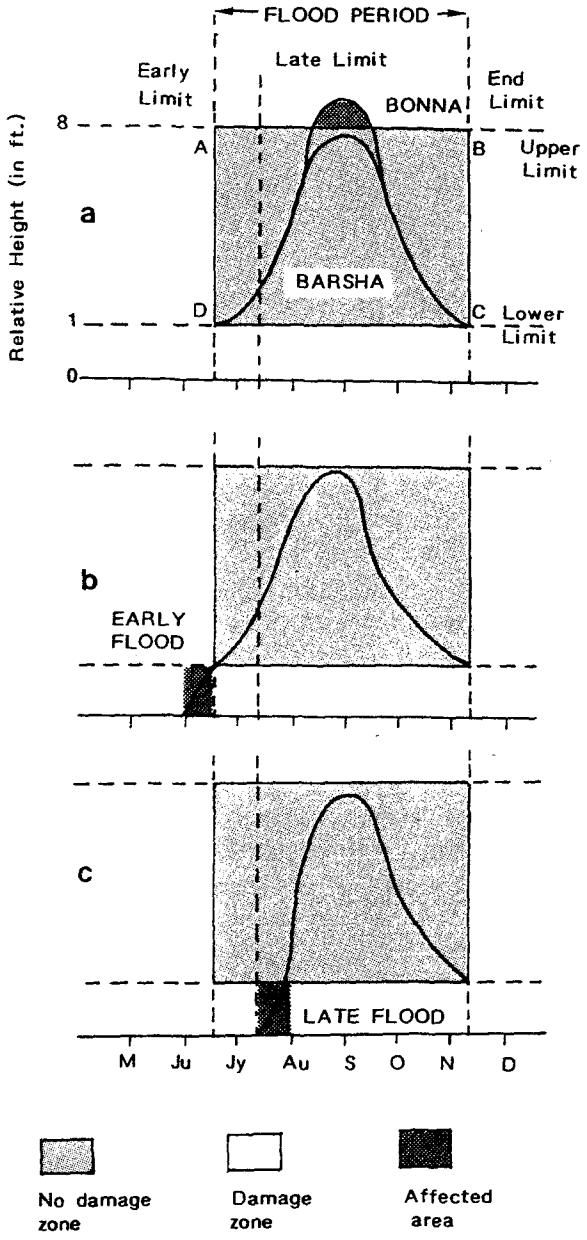

Fig. 3. Physical characteristics of floods.

Table II. Types of Flood in the Study Villages[a]

	Timing			Magnitude			Duration		
	Early	*Usual*	*Late*	*Below*	Normal	Above normal	*Shorter*	Normal	Longer than normal
Normal flood		x			x			x	
Abnormal flood Type:									
I		x			x		x		
II		x			x				x
III		x						x	
IV		x		x			x		
V		x		x					x
VI		x		x		x	x		
VII		x				x		x	
VIII		x				x			x
IX	x			x			x		
X	x			x				x	
XI	x			x					x
XII	x				x		x		
XIII	x				x			x	
XIV	x				x				x
XV	x					x	x		
XVI	x					x		x	
XVII	x					x			x
XVIII			x	x			x		
XIX			x	x				x	
XX			x	x					x
XXI			x		x		x		
XXII			x		x			x	
XXIII			x		x				x
XXIV			x			x	x		
XXV			x			x		x	
XXVI			x			x			x

[a]Based on field observations by the author.

usual duration or period (not more than 4 or less than 2 months and not beyond the month of October), or if flood water rises higher or lower than the usual height (not more than 8 feet and less than one foot above the broadcast *aman* fields), it is perceived as abnormal.

The physical characteristics of both normal and abnormal floods may, thus, be represented by vertical (magnitude) and horizontal (timing and duration) thresholds with a view to drawing a distinction between hazards and resources (Fig. 3). In the vertical thresholds, there are both upper and lower limits. The height of homestead land represents the upper limit of vertical threshold; the minimum height of floodwater required by broadcast *aman* plant for its growth (1 foot) determines the lower limit.

Similar to the vertical thresholds are early, late, and end limits in the case of horizontal thresholds (Fig. 3a). The early and end limits correspond with the flood season and represent, respectively, the onset and close of the season.

The early, late, and end limits occasionally vary from year to year, depending on the variation in sowing of crops. Seasonal patterns of farming activities differ slightly from one year to another on account of dryness in the *Rabi* season or excessive rainfall in the *Haimantic season.*

As can be seen from Fig. 3a, the upper and lower limits and the early and end limits intersect each other to form a rectangle ABCD. As long as floodwater remains within the rectangle, it is useful and is considered a resource. If it exceeds any boundary of the rectangle a flood becomes a damaging phenomenon for that particular area adjacent to the rectangle. In Fig. 3, the areas where floods become hazardous are shown by relatively denser shading. Therefore, the zone lying within the rectangle is the no-damage zone, while the outside area is the damage zone.

Floods, however, may occur during the proper time but exceed the upper or end limits, remain below the lower limit, or stay for shorter periods. These types of floods are harmful.

If floods occur before the usual time, the areas falling outside the early limit will be affected (Fig. 3b). Sometimes these floods may stay for longer times and, thus, areas beyond the end limit may be affected. These types of floods are known as early floods.

Late flooding may also occur. In this case, the area immediately beyond the late limit is likely to be affected due to lack of flood water (Fig. 3c).

The physical characteristics of floods of different regions of Bangladesh may also be expressed in a way similar to the one shown for the study area in Fig. 3. Due to variation in local relief, slight variation may occur from region to region with regard to vertical thresholds. Similarly, horizontal thresholds may differ from one region to another because of variations in the sowing and harvesting of crops.

Based on the above facts, Table II lists 27 possible types of floods. The flood of the study area or any part of Bangladesh in a given year may represent any one of these 27 types.

Past Severe Floods

When the respondents were asked about the previous severe floods, a range of answers was obtained. The flood of 1974 was considered by as many as 50 respondents (64%) to be the most severe flood in their lifetime. This may be partly due to recency of the experience, but it is also grounded in reality. Despite the blunting effect of time, the floods of 1954-1955 stand out clearly in the minds of one-third of the total respondents (21) of the study villages. In fact, the years 1954-1955 and 1974 had the most severe floods in Bangladesh in terms of both damages suffered and area flooded. However, two respondents also listed 1962 and 1966 as most severe flood years.

Future Floods

The study reveals that all the respondents expect abnormal floods within the next 10 years. With respect to occurrence of a severe flood as many as 57 respondents (73%) expect it in their lifetime. Among them, 46 respondents (81%) justified their expectations by saying that Allah/Bhagaban (God) is displeased with people because the majority of them are involved in antireligious activities. For this reason Allah/Bhagaban will give *bonna* as a *gajab* (hazard). Rising of river beds due to deposition of silts was cited by the remaining 11 respondents (19%) as their reason for expecting future floods. Among the above 57 respondents, 37 respondents (65%) were unable to predict the time because, they said, "Allah/Bhagaban is the only one who knows it." Only 20 respondents (35%) expect it soon, the reason being their observation that severe flood usually occurs within a span of 2-4 years.

The ability to predict the future occurrence of a severe flood or the timing of the annual flood reflects the perception of the individual. This is also indicative of his ability to adjust to inundation. Most of the respondents (53) in the study area believed that they are able to predict the timing of the expected annual inundations. An even greater number (57) thought that they could predict how severe the flood would be in a given year. Predictions concerning the severity of floods were based on personal observations of phenomena such as weather, heavy cloud formation, and heavy rainfall, and on the availability of verbal information about the rapid

rise of water level in the Jamuna river or in the nearby small river and about the current of the floodwater.

Agricultural Adjustments

In natural hazards research studies, adjustments are defined as those human activities intended to reduce or minimize negative impact of an extreme event (White, 1974).

It is evident from the field survey that the villagers' responses to floods are of an individual nature that differs according to the type of flood. For the convenience of analysis, the various adjustments adopted by the respondents of the study area are discussed for two important flood types, normal and abnormal.

Barsha [Normal Flood]

Agricultural adjustments to normal floods are reflected in crop selection. since *aus* and jute cannot tolerate excessive amounts of standing water, farmers cultivate these two crops in comparatively higher land. Broadcast *aman,* on the contrary, thrives best in deeply flooded land, hence, lowlands are given over to broadcast *aman*. This crop continues to grow as fast as the flood rises. The *aman* plants usually attain a height of 12-15 feet and keep their heads above the floodwater. But sudden rises of water can overtop the plants, causing damage or destruction. Transplanted *aman*, although requiring flood water, does not grow on deeply flooded land. Farmers generally select poorly drained middle land for cultivation of transplanted *aman*.

Bonna [Abnormal Flood]

Agricultural adjustments to *bonna* in the study village are limited and practiced during the flood time. Among the four adjustments practiced in the years of abnormal flood [*bonna*], only one is related to a crop (Table III). As a protection against strong wind and water currents, farmers who cultivate broadcast *aman* in low-lying areas usually place bamboo sticks a few feet apart in the field to support the growing crop. Out of 35 respondents having broadcast *aman* fields, only 13 (37%) reported that they adapted this adjustment during the 1974 flood.

Table III. Agricultural Adjustments to Flood in the Study Villages[a]

Type of flood (year)	Adjustment	
	Pre-flood	During flood
Normal (1977)	Crop selection method	
Abnormal (1974) *(bonna)*		Placing bamboo sticks for support of *aman* plants (13 respondents out of 35)
		Building of *machan* for draft animals (7 respondents out of 48)
		Moving the draft animals to higher ground or to metalled roads (4 respondents out of 48)
		Keeping the smaller animals on the *chouki* or *shika* (11 respondents out of 23)
Common to both normal and abnormal floods	Interculture of *aman* and *aus*	Protecting *aman* field from water hyacinth and movement of boats by building bamboo fences (16 respondents out of 35 in 1974 and 7 out of 35 in 1977)
		Keeping *aman* field clear by pulling water hyacinth away either by hand or by boat (16 respondents out of 35 in 1974 and 15 out of 35 in 1977)

[a]Based on author's field survey.

families (15%) built *machans* (platforms) for the draft animals using straw, water hyacinth, bamboo, and banana stalks. Although providing safety to the animals in less severe floods, this adjustment is ineffective in cases of very high water. In such a situation, owners of draft animals move their animals to higher grounds, especially the nearby metalled roads. In the severe flood of 1974, only 4 respondents (8%) moved their animals to the road. Smaller animals are usually kept inside the main sleeping structure, on the *chowki* (wooden bed), or hanging in baskets locally called *shika*.

Apart from these, three adjustments are commonly practiced both for normal and abnormal floods. The most widely practiced adjustment is the interculturation of broadcast *aman* and *aus*. The practice of sowing two rice crops in the same field at the same time (March-April) is an agricultural adaptation to the risk of floods. Flood-sensitive *aus* matures much earlier and is harvested in July-August when the cropland is shallowly flooded. Flood-tolerant *aman*, on the other hand, continues to grow with the rising flood water and is harvested after the recession of flood water in October.

Respondents noted that by practicing interculture of *aman* and *aus,* they protect themselves against floods in that they are able to harvest at least one crop. If it is a year of drought and the floodwaters are below normal, the *aus* will survive and the *aman* will wither. If the floods are greater than usual, the *aus* will be destroyed and the *aman* will still flourish. And if it is a normal year, both crops can be harvested.

The remaining two adjustments are related to the flood-borne aquatic weed, water hyacinth, which comes along with floodwater and invades broadcast *aman* fields. To prevent water hyacinth invasion, 45% of the total respondents having broadcast *aman* fields in low-lying areas (35) built bamboo fences around their fields in 1974. The corresponding number was only 20% in 1977. This is also a protective measure against the movement of country boats in the *aman* fields. Another 45% of the respondents kept the *aman* field clear by pulling water hyacinth away either by boat or by hand in 1974. Almost the same number of respondents (15) did this in 1977 (Table III).

CONCLUSION

This study of the perception of farmers inhabiting the Jamuna floodplain of Bangladesh regarding normal and abnormal floods observed how individuals cope with annual inundation and how they respond to abnormal floods. Although the study borrowed heavily from natural hazards research in its working definitions, it differs in one important aspect: flooding is not always a hazard to the farmers. The annual inundation—i.e., normal flooding—is beneficial to and necessary for crop production. Abnormal flooding, in contrast, is considered a negative resource, a hazard. Thus, a good year to the villagers is one in which the flood is normal, enabling the harvesting of both *aus* and *aman* rice, two major subsistence crops of the farmers; a bad year is one in which the timing, duration, or magnitude of the inundation is abnormal, causing widespread destruction to crops and properties.

The respondents of the study villages have been living with floods since their births, and they are fully aware of the phenomenon. This high degree of awareness of flood in the village supports Kates' (1963) contention that in areas of greatest positive or negative certainty concerning the occurrence of floods, floodplain occupants exhibit the least variation in perception. The present study, however, does not support the idea of adjustment through habitation, which states that awareness of environmental problems decreases with length of residence (Preston *et al.*, 1983).

The study observed that respondents cope successfully with the normal floods. In cases of abnormal floods, they practiced a few adjust-

ments. This contradicts the notion that where the hazard is common, many adjustments are made (Sims and Baumann, 1983). However, the adjustments practiced in the study villages concerning both normal and abnormal floods are of traditional types, which have been transmitted through generations. The low level of technology and absence of any public input in the study villages result in folk or preindustrial levels of adjustments (Kates, 1970).

The findings of the present study are consistent with the studies done by Islam (1980) and Ralph (1975), which reported farmers' perceptions of, and range of adjustments to, floods in high flood-hazard zones. This suggests that farmers' perceptions of and agricultural adjustments to floods do not vary considerably from high to medium flood-hazard zones.

Finally, the study emphasizes the need to undertake more research of a similar nature in different regions of Bangladesh having variations in public flood-control measures. Such research will help in ascertaining the impact of existing public measures in reducing flood damages and thus provide a stronger basis for understanding the flood hazard in Bangladesh.

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