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Flood in a Changing Climate: The Impact on Livelihood and How the Rural Poor Cope in Bangladesh

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Academic Editor: Yang Zhang
Received: 10 May 2016; Accepted: 1 December 2016; Published: 21 December 2016

Abstract: It is already documented that climate change will lead to an intensification of the global water cycle with a consequent increase in flood hazards. Bangladesh is also facing an increasing trend of flood disasters. Among the various risks and disasters in Bangladesh, flood is the most common and frequent. Floods make people vulnerable, as they take away their livelihoods at the first instance and leave them with little resources to overcome from the situation. Because of floods, rural poor communities face job loss, and two-thirds of their income is reduced, which limits their capabilities of preparedness, response, and recovery to subsequent floods. People cope with the situation by bearing substantial debts and a loss of productive assets. With an empirical field study in one of the most flood-prone upazilas (sub-districts) of Bangladesh, namely Goalanda Upazilla of the Rajbari district, this study intends to draw a "flood impact tree" of the study area. It also examines the impacts of flood on the livelihood of the rural poor and explores their coping strategies. This paper aims to facilitate an understanding of the impact of floods on their livelihood, especially on the income and occupations of the rural poor. At the same time, it aims to learn from their coping mechanisms.

Keywords: flood impact tree; livelihood; rural poor; climate change

1. Floods in a Changing Climate—A Bangladesh Perspective

Climate change has been one of the most critical concerns in recent decades. Researchers have claimed that global hydrological cycles are expected to accelerate by climate change. Because of increased precipitation and reduced evapotranspiration, river discharge will increase on a global scale, which indicates an increase in the frequency of floods in many regions of the globe. Risk of great floods increased during the 20th century [1]. Floods and droughts projected for the 21st century show significant and large changes from those in the 20th century (i.e., from 1901 to 2000). The authors of a study [2] on large UK Rivers stated that climate change scenarios have caused an increase in the magnitude and frequency of flooding. They noticed that winter flows have generally increased, with higher flows occurring more frequently, and that extreme flood events have increased more (proportionally) than floods with lower return periods.

Projections related to the impacts of climate change warn that developing countries will be the greatest victims of climate change. Since Bangladesh is a low-lying developing country, it is considered one of the countries most vulnerable to climate change [3]. Furthermore, in combination with its geography, population density and extreme poverty make Bangladeshi people highly vulnerable to other natural hazards, which often turn into disasters. Among the various risks and disasters, flood is the most common and frequent [4] and is considered to be one of the principal threats of development [5,6]. About 70% of the people of Bangladesh are at risk of floods [7]. A flood

can engulf between 30% and 70% of the country in each year [8]. In addition to these regular phenomena, it is predicted that climate change will lead to an intensification of the global water cycle with a consequent increase in flood hazards [9]. Flood disasters have already been increasing worldwide over the last 30 years. The number of floods was 150 in 1980–1982 and increased to 550 in 2004–2006 [10]. Bangladesh is also facing this increasing trend of flood disasters in this changing context of climate. Studies using climate models show that the probability of extremely wet Asian monsoon seasons could increase, with severe implications for Bangladesh in terms of flooding [11].

Bangladesh is situated between the foothills of the Himalayas and the Bay of Bengal. Approximately 60% of the country's land mass is less than 6 m above the mean sea level [4]. Further, Bangladesh is located in a low-lying river delta with three major river basins of South Asia, namely Ganges, Brahmaputra, and Meghna (GBM). Hydrology and water resources of the GBM basins are likely to have significant effects due to global warming and climate change, which would change future peak discharges of the GBM basin and could lead to more serious flooding in Bangladesh [12]. Research also warns that various types of floods in Bangladesh could be affected in different ways due to climate change. For instance, more frequent extreme precipitation could increase the possibility of flash floods, and increased precipitation in the GBM basins may increase the magnitude, depth, and spatial extent of riverine and rain floods [13].

Low-lying flat floodplains of three principal rivers and numerous tributaries and distributaries are the main physiographic features of the country. It is estimated that over 230 rivers and tributaries cross Bangladesh. This locational feature has made Bangladesh bound to drain out substantial cross-border monsoon runoff along with its own runoff through this network of rivers. Most of the time, the volume of generated run off exceeds the drainage capacity of this downstream river network, and this makes it one of the most flood-vulnerable countries in the world [12]. Along with the changing climate, this unique natural setting of Bangladesh and its tropical-monsoon climate often cause devastating floods [5].

Climate change is believed to change the nature of floods, and this changing climate influences not only the intensity, but also the duration and magnitude of floods in the world, particularly Bangladesh. The increased volume of rainfall caused by climate change over the past decades has intensified the flood problem. As monsoon precipitation over the basin of the GBM Rivers is the main cause of floods in Bangladesh, future changes in precipitation has four distinct implications with respect to the nature and the extent of floods in Bangladesh [14].

a. The timing of the occurrence of floods may change, with a possible change in the seasonality of the hydrological cycle.

   This implies that the onset and withdrawal of monsoons may be delayed or advanced. Presently, monsoons break in the middle of June and withdraw by the middle of September. A one-month delay in monsoons means that the season will not end until the middle of October, but the duration will remain unchanged.
b. An increase in monsoon precipitation in the GBM basins may increase the magnitude, frequency, depth, extent, and duration of floods.
c. Timing of peaking in the major rivers may also change, which may change the likelihood of synchronisation of the flood peaks of the major rivers.
d. Any increased magnitude, depth, and duration of floods will dramatically change land use patterns in Bangladesh.

These sorts of changes in the nature and extent of floods would cause substantial damage to agriculture, housing and settlements, and infrastructure. Therefore, lives and livelihood would be more vulnerable in such a changing climate. Floods in 1987, 1988, 1998, 2004, 2007, and 2010 all denote changes in the nature and extent in floods and eventually induced severe impacts on lives and livelihood, especially those who live in rural areas.

2. Flood and Rural Poor in Bangladesh

Flooding problems induced by a changing climate would not be faced equally by all strata of society. Scholars claim that disasters have a disproportionate impact on the poor. It has been observed that the poor suffer the most and are more affected by any disaster [15–20]. Therefore, it has been stated that poor people are expected to be hit the hardest by flood disasters, i.e., people who lack adequate means to take protective measures and who also have very little capacity to cope with the loss of property and income [21]. Poverty is a significant contributor to people's vulnerability to flooding, and frequent flood impact leads to increases in poverty and hence vulnerability [22,23].

As the majority of the people in Bangladesh live in rural areas, their lives and livelihoods are directly or indirectly dependent on land and water. Frequent and devastating flooding jeopardizes the lives and livelihoods of these people [3]. Impacts of flood on livelihood are considered a critical issue, especially in rural areas where livelihoods depend on agriculture and aquaculture [23]. It is estimated that, in rural areas, 60% of the population are farmers or fishermen [21]. It has been observed that frequent flooding takes a heavy toll, especially on these poor families in low-lying areas, who either lose their lives or lose what few assets they have carefully accumulated [21]. In Bangladesh, about 40% of the population lives below the poverty line and 82% live on US $2 per day [4]. High population density, poverty, and lack of resources to manage the floods and evacuate people enhance the severity and suffering of the people.

Since land resources are scarce and population density is high in Bangladesh, people, especially the rural poor, are forced to settle in the flood-prone areas. Moreover, as Bangladesh is mainly an agricultural country and since the river basins as well as the floodplains are alluvial, a large number of settlements have been developed along the riverside areas throughout the country. This practice has increased the extent to which people, as well as their shelters and the resources essential for their livelihoods, are exposed to floods.

Floods make people vulnerable, as they take away their livelihoods at the first instance and leave them with little resources to overcome from the situation [23,24]. The impact of floods on the poor, especially those living in flood-prone rural areas, is even greater. The reasons behind this are a lack of assets and inadequate food supplies. Flood not only deteriorates the social lives of people but also the economy as a whole. It causes considerable damage to standing crops, livestock, poultry, houses, transportation and communication systems, educational and institutional buildings, and other social facilities. It also deteriorates the normal functions of life affecting homesteads, agricultural land, daily activities, water supply, sanitation conditions, and economic structure. These combined impacts on society, the economy, and physical infrastructures jeopardize the livelihoods of the rural poor. The poor are constantly struggling to cope with these impacts and manage their livelihoods. Sometimes, coping strategies fail to be effective and only render them more vulnerable.

Knowing the detailed impacts of floods on the livelihood of the rural poor and how they cope with the situation could facilitate the planning and implementation of effective flood risk reduction programs in as climatic conditions change in the future. It would also help to ease the coping mechanisms of the poor and thus to protect them from further vulnerabilities due to flood. Therefore, this research aimed to depict the cause and nature of floods in Goalanda Upazila (sub-district) of the Rajbari district in Bangladesh. At the same time, we examine the impact of flood on the livelihood of the rural poor communities therein and their coping mechanisms.

Livelihoods comprise the assets (natural, physical, human, financial, and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household [25]. Among the different aspects of livelihood, this study focuses on the flood-related impacts and coping mechanisms related to incomes and occupations of the rural poor. Here, the term "coping mechanisms" describes the approaches people employ to deal successfully with crisis [25].

3. Methodological Approach

In order to examine the impacts of flood on the livelihood of the rural poor and to learn about their coping mechanisms, Goalanda Upazilla of the Rajbari district has been selected as the study area, one of the most flood-vulnerable upazilas (sub-districts) of Bangladesh. Key informant discussion was facilitated to identify the most flood-vulnerable upazila (sub-district), union, and villages for this study. The percentage of households, population, and areas affected by previous floods and the total loss and damage were the main indicators when selecting the study area. Key-informant experts and officials from the following organizations were interviewed and consulted at different times throughout the study period: the Disaster Management Bureau, Bangladesh Water Development Board (BWDB), Institute of Water and Flood Management (IWFM), Flood Forecasting and Warning Centre (FFWC), Water Resources Planning Organization (WARPO), Center for Environmental and Geographic Information Services (CEGIS), Ministry of Water Resources, Ministry of Food and Disaster Management, Local Government Engineering Department (LGED), Bangladesh Agricultural Research Institute (BARI), Oxfam-GB, and Rural People Development Songstha (RPDS).

Through empirical study, this research not only examines the impacts of flood on the livelihood of the rural poor but also scrutinizes their coping strategies amid floods. This research relied on intensive field investigation, where sampling was taken from different villages that were the most badly affected by previous floods. For the household questionnaire survey, 120 households from different villages were randomly selected. Since the outcome of this study is part of an undergraduate final grade research, there were both time and financial limitations. Therefore, a statistically sound sampling method that requires a high number of household surveys, was not conducted here. However, the triangulation approach applied in light of key-informant discussion and focused group discussions (FGDs) denotes that these 120 households represent the whole community. The head of the households were the respondents, and 80% of them were male persons within the age of 21 to 58 years. Recalling every year's experiences and especially the experiences of severe floods (in 1998, 2004, and 2007), respondents provided information with respect to impacts and adaptations.

As mentioned, in addition to a structured questionnaire survey, four FGDs were organized in different villages in which people of different professions and strata attended and shared their flood-related experiences and hardships. During the reconnaissance survey, five main professional groups were identified. During the FGD, a proportionate representation of each professional group was attempted. For instance, there were 25 persons in one FGD. Among them, there were nine farmers or agricultural workers, six daylabourers, five businessmen, three poultry farmers, and two servicemen. FGDs were facilitated to develop the flood impact tree for the upazila. Along with the questionnaire survey, these discussions provided a range of views and opinions of people at a grassroots level and enriched the data bank of this research.

4. Goalanda Upazilla and Its Floods

Due to its geographical location and the present pace of climate change, Bangladesh faces normal to extreme floods almost every year [26]. It has already been mentioned that, every year in Bangladesh, 30%–70% of the landmass is flooded, especially the riverside areas [8,27]. The River Padma (part of the Ganges Delta) runs by the northern side of Goalanda Upazilla (Figure 1). It is located in the southwest hydrological region of Bangladesh [28]. Flood is severe in the study area, as the two main rivers, namely the Ganges and the Brahmaputra, join at Goalanda and flow in a wide, straight, trench-like channel, which is called the River Padma. The River Padma is characterized by fine sandy bottoms, flat slopes and substantial meandering. Its bank is susceptible to erosion, and the channel shifts regularly. Due to heavy rainfall and the ice melting of the Himalayas, this river system drains a substantial runoff, which is mainly accountable for the floods. During monsoon and sometimes post-monsoon season, floodwater spills from the rivers and accumulates in the low-lying areas. Heavy and incessant rainfall in the upper catchments of the River Padma increases the discharge

and forces the river to exceed its drainage capacity, and flood eventually occurs. If Brahmaputra and Ganges reach peak-flood levels, the likelihood of a flood increases.

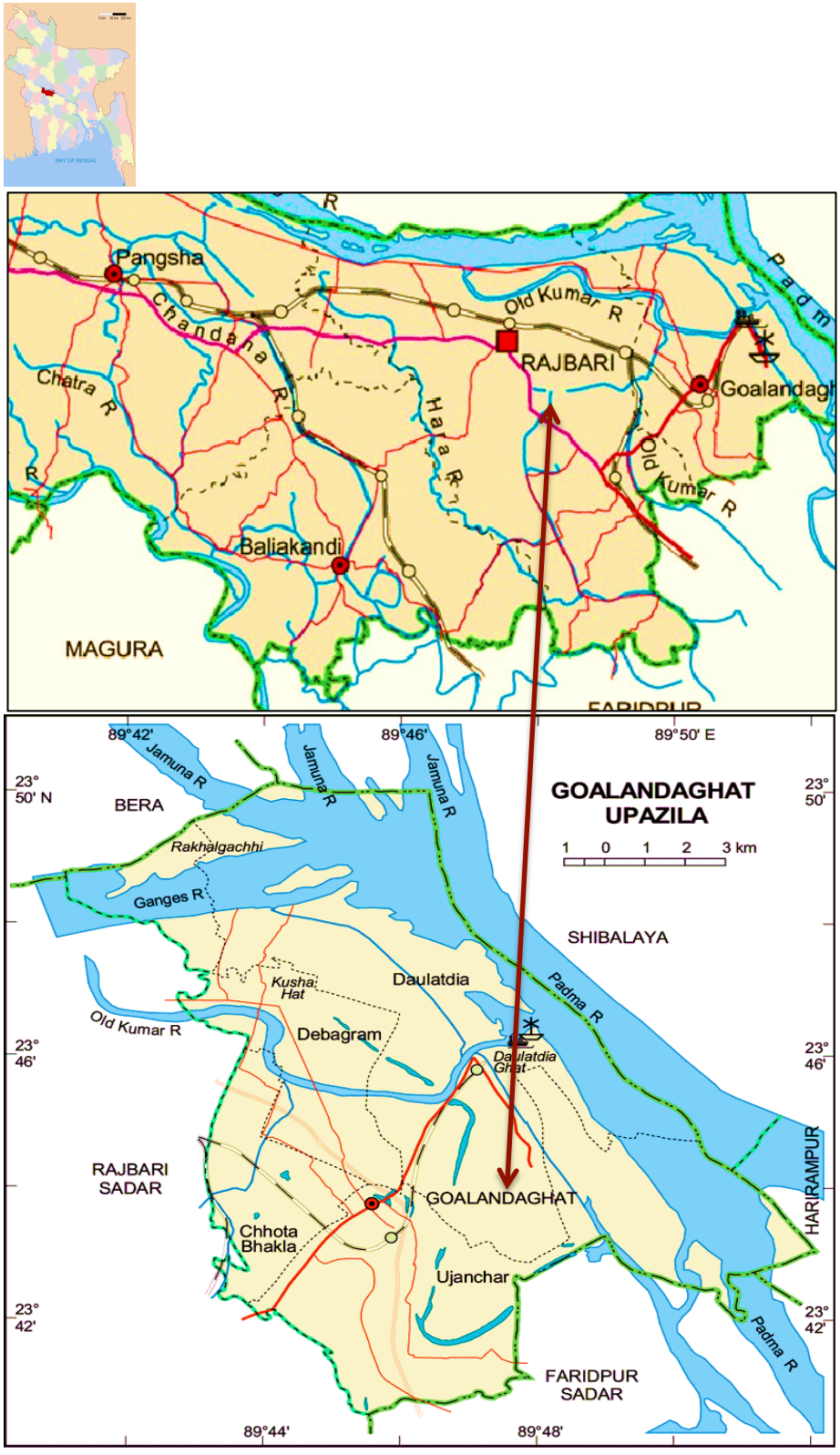

Figure 1. Location map of the study area (https://www.google.co.jp/search?q=Map+of+Goalanda+Upazila,+Rajbari+District,+Bangladesh&bi).

Dwellers of Goalanda Upazila are vulnerable to several natural hazards such as flood, riverbank erosion, drought, and tropical storm. However, flood is considered the most crucial. Almost every year, it is adversely affected by flood. People of Goalanda struggle with flood their whole lives. In spite of this, their livelihood is directly and indirectly dependent on rivers and floods.

According to them, after independence was achieved, the most devastating flood occurred in 1998 (Table 1); the duration of this flood was also the longest—about two months. The second and third most severe flood events occurred in 2004 and 2007, respectively. The 2004 and 2007 floods lasted about three weeks, and the water level was not as high as that of the flood in 1998, but both caused severe damage to houses and crops.

Table 1. Various past floods and their severity.

	1970 to 1980	**1980 to 1990**		**1990 to 2000**	**2000 to 2007**	
	1974	1988	1987	1998	2004	**2007**
Extent of Flood	●●	●●●	●●	●●●●●●	●●●●	●●●●
	●●	●●●	●●	●●●●●●	●●●●	●●●●

Source: field survey. * Number of "●" indicates the severity of flood.

Flood is a regular event for the people of Goalanda Upazila. However, according to the key informants and the locals, the floods of 1974, 1987, 1988, 1998, 2004, and 2007 also had a detrimental impact on the area. Table 1 presents the extent of these devastating floods. In the years 1987, 1988, 1998, 2004, and 2007, the water level was more than 1 m above the danger level. This high water level lasted longer than any other year. These long-lasting high water level floods caused substantial damage to agricultural production, homesteads, and the means of livelihood, especially for the poor. The people in this area have generally had the strength to cope. However, often due to different limitations and poverty, coping mechanisms of the poor have not been effective; all previous floods have rendered the poor more vulnerable.

5. Results

5.1. "Flood Impact Tree" in the Study Area

It is well recognized that flood has a wide range of adverse impacts on lives and livelihood. Further, the poor suffer the most due to their different sorts of vulnerabilities. Before investigating the impact of flood on livelihood, an attempt was made to identify the primary and secondary impacts of flood in the study area by drawing a "flood impact tree" (Figure 2).

It has also been documented that flooding does not only have negative impacts; riverine floods also deposit rich fertile sediments that enrich the nutrients lost through the intensive agricultural practices of deltaic farmers living downstream. However, these fertility benefits derived from flooding are apparently produced mainly by nitrogen-supply algae living in the water [29]. This natural action provides livelihood security for farmers and food security for the people to some extent. The surrounding watershed ecosystem also depends on flooding to enable the development of the life of the surrounding plants and animals. In addition to this, along with relief and rehabilitation programs of different organizations, people have chances to increase their knowledge and awareness of floods and are able to become more prepared for subsequent floods. However, in this study, the questionnaire survey has mostly highlighted their sufferings and the adverse impacts of flood on their livelihood. The majority pointed out the following issues:

(i) A submerged condition of homestead and agricultural land;
(ii) unavailability and increased price of food items and daily necessities;
(iii) unemployment or a decrease in income and hence the non-affordability to pay for daily necessities and cope with floods;

(iv) transportation and communication problems;
(v) problems regarding water supply, sanitation, and diseases.

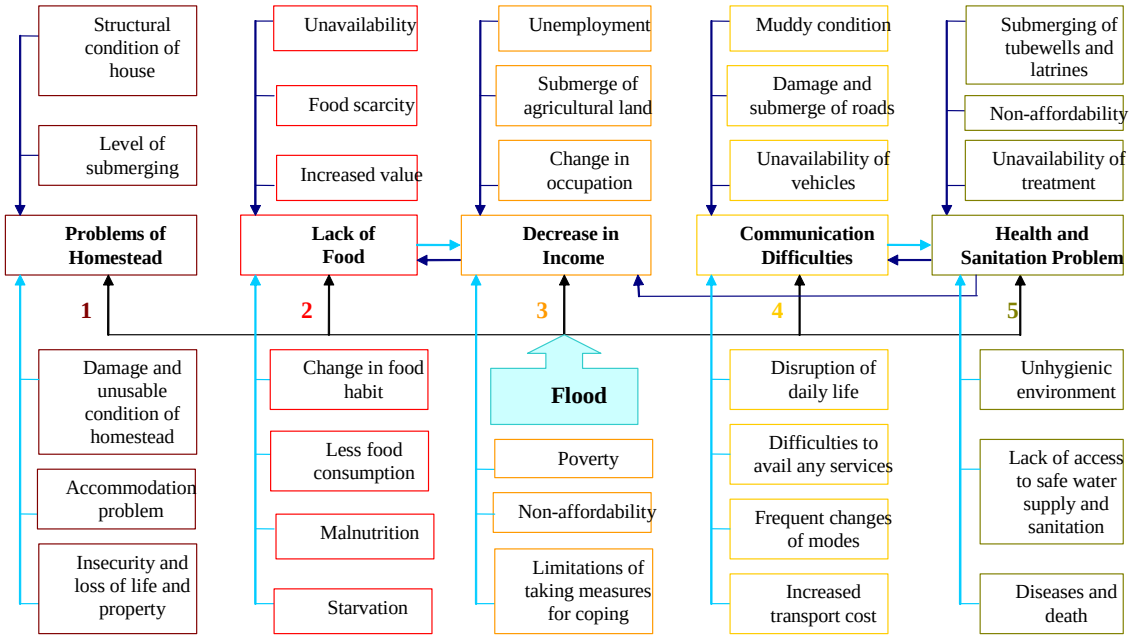

Figure 2. Shifting of occupation due to flood. Source: field survey.

In the study area, the direct effects or primary impacts of flood include the submerging of houses, the loss and damage of physical assets, damage to standing crops in fields, and the dangers associated with the rise in water level. Indirect effects are many, and these include the loss of wage laboring opportunities caused by the lack of demand for daily labor and the inability to work when water levels are raised. Nonetheless, the poor incur extra expenses to respond to flood emergencies and to survive and recover from floods. Most households experience a loss of assets, especially livestock and poultry. Some livestock and poultry are sold at a lower price or consumed when floods occur. The poor often face a scarcity of money amid a flood due to a lack of income, a loss and damage of assets, and sometimes sickness during and after a flood. To overcome this crisis, they need to borrow money, mostly from money lenders at high interest rates. Consequently, most households need to spend the rest of the year repaying those loans. This vicious cycle acts as a driver towards sluggish or thwarted development. Another study claims that relief and rehabilitation support these people receive cannot return them to their original economic level and fail to lift them out of poverty [30]. Moreover, their lack of awareness pushes them away to a more vulnerable condition. Figure 2 summarizes flood-induced problems (primary impacts) and their effects (secondary impacts) on the livelihood of the rural community in the study area.

5.2. Impacts of Floods on Livelihood and People's Coping Strategies

One scholar claims that Bangladesh is perhaps the most flood-prone country worldwide. It has also been said that the geographical distribution of flood risk is heavily concentrated in Bangladesh. Bangladesh has the highest number of people exposed to floods, both in absolute and in relative terms. The highest relative share of population and percentage of economy exposed to floods is found in Cambodia, Bangladesh, and Vietnam [31].

Floodplains of Bangladesh are predominantly where the rural poor live. It has been stated that the community expected to be hit the hardest by flood is the poor, who lack adequate means and have limited capacity to prepare and cope with the loss of income and property [19]. Many studies have

revealed the impacts of flood in a wide range of aspects of life. Households, crops, property, livestock, income, occupation, food, water supply, sanitation, and health are all sectors devastatingly impacted by floods [7,21,32]. Figure 2 also reveals a long list of impacts in the study area. However, rather than addressing a large number of issues, this study focuses on the issues that are directly related to occupation and income: impacts on livelihood and the associated coping mechanisms.

5.2.1. Impact on Occupations and Income

Occurrence of flood is always a serious threat, especially for poor households in Bangladesh. Occupation and income of the poor are the two most important sectors on which flood has significant impacts. According to IPCC 2001 [21], the poor have a limited capacity to cope with the loss of income associated with floods. Further, one scholar argues that crop damage and unemployment caused by floods render an even larger section of the population extremely vulnerable to starvation, malnutrition, and even death [33]. Research conducted by Banerjee finds that, in Bangladesh, agricultural wages decline by 5% in flood-prone areas and by 14% in severely exposed areas during "extreme" floods in the short term [34]. Further, it has been identified that the majority of farmers of Bangladesh is becoming more vulnerable economically; as a consequence, their coping capacity and power to adapt to natural calamities, such as floods, is decreasing significantly [3].

This study area accommodates the most vulnerable population of the Rajbari district. More than half of the population depends on agriculture. According to the respondents, 53% of the households in the study area are engaged in agriculture, 21.7% work as day laborers, and another 21.7% are engaged in business in Goalanda Ferry *Ghat*, which is in close proximity to the study area (Figure 3). More than 80% of the households of the union are poor. The average family size of the union (4.57 persons) is a bit larger than the average family size of the district (4.3 persons). Further, the literacy rate of Goalando Upazila is 40.3%, which is the lowest within the district (a literacy rate of Rajbari is 60.06%) [35]. Poverty, a large family size, and a low level of education aggravate flood vulnerability of the studied households.

Since agriculture is the main economic activity, crop damage, loss of income, and having work to do during flooding are common phenomena in the study area. According to the Goalanda Upazila Parishad, during the flood of 2004, in the Goalando Upazila, 89% of the Aus rice area, 93% of the Aman rice area, and 73% of the jute area were damaged due to flood. Similar levels of loss and damage were faced in other upazilas in almost all previous severe floods.

People have been forced to change their occupation for their livelihood. Due to the flood of 2004, 33.3% of people had become jobless, and 46.5% of people had changed their occupation (Figure 3). Since the majority (53%) in the study area are dependent on agriculture, they have had to face great losses in income and occupation. They were the most vulnerable to floods because of the submerging condition of agricultural lands. In agriculture, 23.3% had become jobless, and others had started working as fishermen, boatmen, day laborers, and rickshaw pullers, as they could not continue their cultivation. Day laborers had decreased to 5% due to floods.

Since most parts of the study area were submerged, 23.4% of people shifted their occupation to become water-oriented, e.g., boatman and fisherman. About 13% of people shifted to rickshaw/van pulling in a nearby city because it was the easiest way to meet immediate needs. Businessmen and day laborers were impacted by flood events mainly due to disruptions in transportation and marketing opportunities, and some of them became jobless. People engaged in the service sector were the least affected during all previous floods (Figure 3).

Floods not only force people to change their occupations but also negatively affect people's income. According to the field survey, the average income before a flood is Tk. 3390 (US $43.64); during a flood, it is reduced to Tk. 1172 (US $15.08). The average amount of decrease in income due to a flood is Tk. 2219. Table 2 presents a comparative picture of household income before and during a flood.

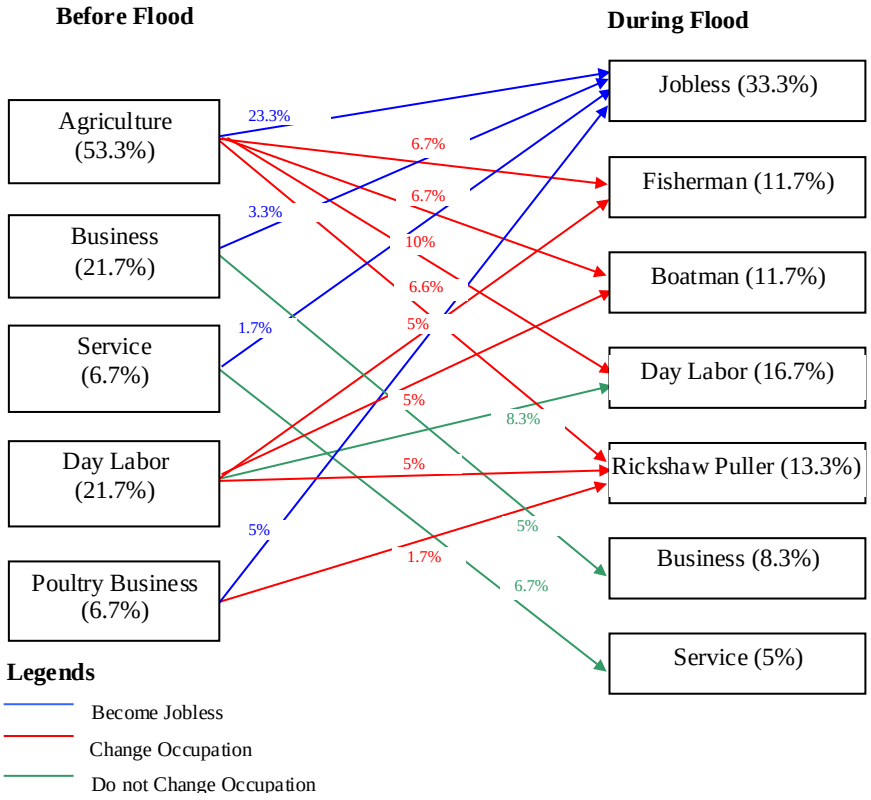

Figure 3. Shifting of occupation due to floods. Source: field survey.

Table 2. Distribution of households according to income.

Before a Flood		During a Flood	
Income Range (Per Month in Tk.)	**Percentage of Household**	**Income Range (Per Month in Tk.)**	**Percentage of Household**
Upto Tk. 2000	15	No Income	33.3
Tk. 2001 to 3000	48.3	Up to Tk. 1000	18.3
Tk. 3001 to 4000	20	Tk. 1001 to 1500	15
Tk. 4001 to 5000	11.7	Tk. 1501 to 2000	21.7
Above Tk. 5000	5	Above Tk. 2000	11.7

Source: field survey.

Table 2 shows that, in the study area, an overwhelming majority of the household incomes fall below the poverty line, which is less than US $1.90 per day per person. About 63.3% of respondents claimed that they normally earn less than Tk. 3000 (US $38.6). Even though this income is not enough to make a living, during a flood, income radically decreased due to a lack of opportunity to work or to continue the previous profession. One-third of the households (33.3%) claimed that they have no income during flooding and are completely dependent on external help, borrowing money, or selling off assets. Only 11.7% of people have had an income above Tk. 2000 during a flood; before a flood, 85% of people earn an income above Tk. 2000. This gives a clear indication of the severe income disruption and vulnerability to flood these people experience.

Using a questionnaire survey, an investigation of the extent of income loss in different occupations was attempted. Survey findings show that almost all households (92%) experience a reduction in their income due to floods. Thirty-five percent of households reported a decrease in income greater than Tk. 1000, while 41.7% see a reduction of more than Tk. 2000 (Figure 4). All who are dependent on agriculture face a reduction in income during floods, while the majority of service holders see no

change in their income. However, the decrease in income is higher among businessmen (petty traders) and poultry farmers, followed by agriculture workers (Figure 5). More than half of the petty traders face an income reduction of more than Tk. 3000 (US $38.6), and two-thirds of the poultry farmers and half of the agriculture workers lose more than Tk. 2000 per month. Thus, income vulnerability during floods renders the livelihood of these people more complicated. The rural poor suffer to a large extent due to income reduction.

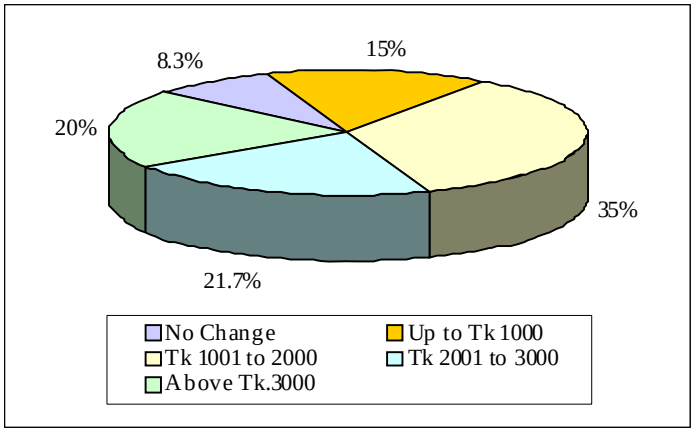

Figure 4. Distribution of households according to income change due to flood. Source: field survey.

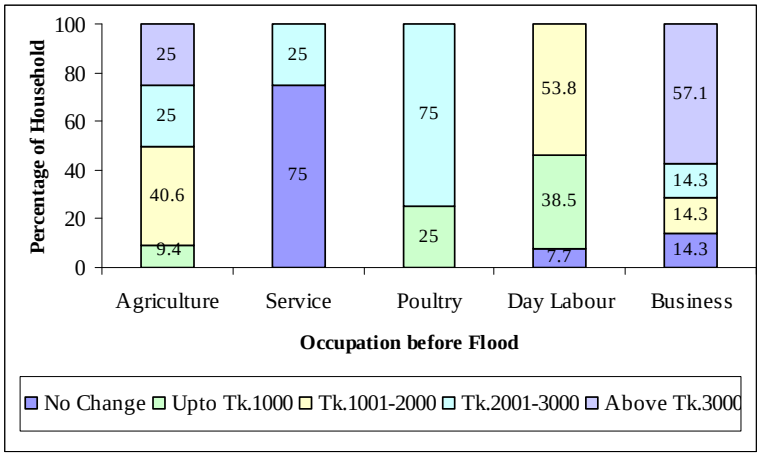

Figure 5. Distribution of households according of occupation before flood and income change (Reduce Income) due to flood. Source: field survey.

5.2.2. Approaches to Financial Coping

In response to the reduction in income due to flood, people in the study area adapt various financial measures, including savings, loans, consumption pattern changes, and the selling and mortgaging of assets (productive, domestic, and liquid assets). These coping strategies have similarities to strategies taken by the poor in Dhaka City during the devastating flood in 1998 [36]. Due to poverty, since not much is saved in normal conditions, these poor people endured severe hardship. During flooding, most families try to cope with income loss by reducing their consumption of food and daily necessities. About 70% of households mentioned that the quantity of food consumption is highly reduced during a flood. It was also observed that, due to reduced incomes owing to asset losses, the flood-affected rural poor experience increased difficulties with food that create substantial health and nutrition problems [37]. Along with the reduction in consumption, various financial measures taken by households to cope with the situation are taken due to devastating floods. These financial coping measures are shown in Table 3.

Table 3. Approaches followed to financially cope.

Type of Financial Coping Approaches	Approach Followed by Majority	Next Best Approach	Least Followed Approach
1. Taking Loan	From Money Lender	From NGO and Bank	From Relatives and Neighbors
2. Selling Productive Asset	Selling Poultry	Selling Livestock	Selling Fish
3. Selling Domestic Asset	Selling Cereals/Rice Stock	Selling Household Items	
4. Selling Liquid Asset	Selling Large Tree	Selling Jewelry	

Source: field survey.

Taking out loans and borrowing rice, salt, oil, and other emergency items were the main financial coping strategies of households in response to floods. The loans were taken to face financial crises, especially for food. In 42% of cases, they borrowed money from moneylenders at high interest rates (12%–25%), since it is not easy to take loans from other sources such as neighbors, relatives, NGOs, and banks. The main reason was the inability of neighbors or relatives to provide loans, as they also had to face the same crisis, and the official formalities and complex procedures of managing loans from banks and NGOs make people bound to take out loans from moneylenders with relatively high interest rates. The disposal of assets in substantial amounts was also noticed. It was found that 58% of total households sold productive assets, and 12% sold household mortgage assets to survive. In addition to the loss of productive assets, the loans taken at high interest rates rendered them more vulnerable. As mentioned earlier, after a flood, many families spend the rest of the year paying back the loans they took during the flood. This situation restricts saving, living a better life, and investing to lift themselves above the poverty line.

Based on the experiences of the previous floods in the area, respondents mentioned that, in addition to their financial coping approaches, different NGOs and government organizations extended support to facilitate their coping mechanisms and to ease their lives during flooding.

Emergency food and medicine supplies were the main supports received by the majority of the households. Besides these, credit supply, material aid, and awareness programs were also offered mostly by the NGOs for their members. According to the Officials of Upazila Parishad, floods affected more that 50% of the households in 2004 and 2007. However, the questionnaire survey reveals that only about 47% of households received emergency food supplies, and the percentage of households availing other institutional supports ranges from 5% to 25% (Figure 6). In some cases, a single household received one or two types of support. However, most of them were not satisfied with what they received.

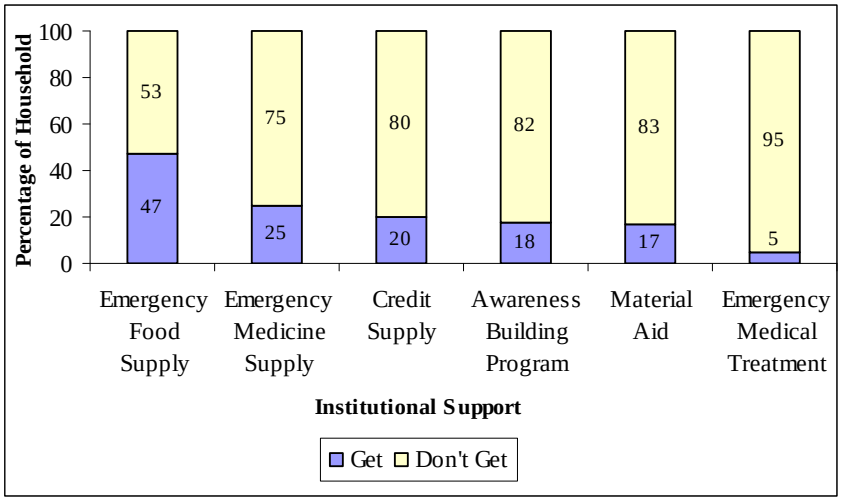

Figure 6. Distribution of households according to availability of supports. Source: field survey.

6. Discussion

With the change in climate, especially temperature, it is projected that a warmer climate will increase flood risks globally [38]. Recent researchers have argued that future levels of flood risk are potentially sensitive to climate change [39]. Bangladesh is already marked as one of the most vulnerable countries due to climate change, and flood risk is also highly concentrated in Bangladesh. Therefore, learning about a flood's impact on the livelihood of the rural poor and about their coping mechanisms is crucial for effective adaptation to the changing climate of Bangladesh.

For the rural poor, their poverty is considered one of the principal contributors to their vulnerability to flooding, and frequent floods lead to increases in poverty and hence vulnerability [23,27]. The First Global Assessment Report [12] on Disaster Risk Reduction, Risk and Poverty in a Changing Climate, shows how different risk drivers, including disasters, are enhancing poverty. Global Assessment Report (GAR), in 2009, recommended that these underlying risk drivers are crucial not only to achieve Millennium Development Goals (MDGs) but also for Sustainable Development and Climate Change Adaptation. At the same time, researchers have claimed that, in developing countries, flood-related problems are far-reaching, affecting the environment and development of the region. The impacts of flood on livelihood have been a major issue, especially in rural areas, where agriculture and aquaculture are the major livelihoods [21]. Loss of income and employment have been identified as one of the major adverse impacts on the livelihood of the rural poor. Therefore, rural development initiatives have started to focus on programs to foster livelihood diversity that includes rural microfinance, cooperative production, and marketing, and to increase the value added to rural production by local skills training. However, in the study area, access to institutional supports, especially credit, material aid, and awareness programs, is only available for a small segment of the community. One scientist argues that the poor, vulnerable communities cannot develop a strong coping mechanism on their own, as they lack institutional supports such as information and skill development options [23]. In fact, access to necessary information is an emergency need for this poor community. This information and skill development would cover a wide range of issues, including flood forecasting and warning, climate change adaptation, disaster risk reduction, and livelihood diversification [40]. Researchers have claimed that the loss of adaptive capacity is the outcome of socioeconomic structures that restrict flexibility in livelihood systems [24]. Therefore, rural development initiatives that focus on programs to foster livelihood diversity by including rural microfinance, cooperative production, and marketing, and to increase the value added to rural production by local skills training, need to be planned and implemented. As is evident from this study, increasing the sources of income of the rural poor and reducing their dependency on individual sources, especially agriculture, that are most affected by floods are endeavors that are urgently needed. Further, building up a strong and diversified asset base, managing their money well, and maintaining access to multiple sources of credit are a foremost requirement. The practice of saving should be ensured for reducing dependency on borrowing money and external help. Further, it is advised that, in this type of flood-vulnerable rural area, hazard assessments or flood assessment maps are incorporated in any sort of infrastructure development, planning, and settlement [41].

It is said that Bangladesh is a fully different country from that which was considered in the formulation of the Flood Action Plan (FAP) 20 years ago. These socio-economic, climatic, and demographic changes need to be recognized in formulating future flood assessment maps and flood control and water management plans. One scholar has advised that, in the absence of effective flood protection interventions, the government must seek to increase both economic returns and employment opportunities in other sectors of the national economy. However, in order to increase industrial production and to flourish service sector investments in education and skill development is foremost requirement [42]. A proper utilization of government grants and of other financial aids must also be ensured. People should be provided with institutional support such that their receptivity is increased, rather than making them fully dependent on external help. The government and other relevant institutions should extend their range of support to protect the rural community

from the disastrous impacts of flood as well as to lead the deprived community towards sustainable development through the efficient management of floods.

7. Conclusions

Flood is a part of the lives of the people of Goalondo. Floods of different magnitudes have a major impact on this region. The damaging impacts of floods disrupt the agriculture, infrastructure, employment, and food distribution systems, as well as other aspects of livelihood. People living here have to live their whole lives struggling against flood, and the most interesting thing is that they depend both directly and indirectly on rivers and floods for their livelihood. Hence, the majority of the people are willing to live in this place despite floods. It is also the reality that this poor community cannot leave this flood-prone area. Therefore, this rural poor community live with flood, face it with hunger and food crises, suffer a loss of income and occupation, and cope with the situation by bearing substantial debt with high interest rates and a loss of productive assets. All of these interrelated factors and impacts act as a driving force towards their long-lasting poverty and vulnerabilities, which limit their ability to prepare, respond, and recover from subsequent floods, as well as any other disasters.

In order to achieve the Millennium Development Goals (MDGs) and to face climate change, flood and its impacts on the livelihood of the poor should be a top-priority issue of concern in developing countries where floods are a common phenomenon. Along with the community, government and local institutions need to find effective alternative solution to minimize the adverse impacts of floods on the livelihood of the rural poor and to find suitable coping mechanisms that will not lead to more vulnerability.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Annya Shimi. Chaitee Biswas and Gulsan Parvin conceived and designed the experiments; Annya Shimi and Chaitee Biswas performed the experiments; Annya Shimi, Chitee Biswas and Gulsan Parvin analyzed the data; Rajib Shaw contributed reagents/materials/analysis tools; Gulsan Parvin, Rajib Shaw, Annya Shimi wrote the paper." Authorship must be limited to those who have contributed substantially to the work reported.

Conflicts of Interest: The authors declare no conflict of interest.

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