The International Emergency Management Society
2014 Annual Conference, October 20-23, 2014, Niigata, Japan

Local People Responses to Flood Disasters in Flood Prone Areas of Northeast Bangladesh

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ABSTRACT :
Living adapted with flooding has been practiced in flood prone areas in Bangladesh. That being properties are protected against flooding through villages formulated in fine highlands as natural levees, and lowlands are utilized as agricultural fields during dry season. As a result, it remains to spread flood inundation condition and exempts necessity of strengthening measures against flooding. This study aims to clarify actual status of self- community- and public- assistances against flood disasters in flood prone areas of the Northeast Bangladesh which derived from a questionnaire survey. We extracted similarities and differences of the flood responses by local people through the findings in comparison to a similar study on 2006 flood in the Sendai River Basin, Japan. The effects of preventive flood mitigation measures by selection of house location are quantitatively confirmed that the maximum inundation depth and duration in house is generally reduced approximately 10% of that in agricultural field. It is revealed that both areas have subjects on the evacuation activities but their factors are different.

KEYWORDS:
flood measures, self- community- and public- assistances, questionnaire survey, Northeast Bangladesh, flood prone area

1. INTRODUCTION

After disaster of Great East Japan Earthquake in 2011, reconstruction plans were formulated in damaged prefectures of East Pacific Ocean coast i.e. Iwate, Miyagi, Fukushima Prefectures, and major damaged cities, towns and villages which plans emphasize development of multiple measures for disaster mitigation [1]. The concept includes resettlement of urban areas from lowlands to highlands, inhabited areas heightening, stilt-up housing, construction of evacuation road, and regulation of residential use in potential tsunami inundation areas as well as construction of disaster prevention facilities such as coastal embankment and gate. It is proposed that land development considering with historical land use [2] and conservation/ restoration of good natural environment along coastal areas [1]. Thus, land use with direction of "preventive disaster mitigation measure" has been discussed actively in Japan.

Living adapted with flooding has been practiced in flood prone areas in Bangladesh. That being properties are protected against flooding through village formulated in fine highland as natural levee, and lowlands are utilized as agricultural fields during dry season. As a result, it remains to spread flood inundation condition and exempted necessity of strengthening measures against flood. Quantitative evaluation of wetland functions such as flood and sediment control functions are essential to carry out conservation and appropriate development of wetlands. Especially huge wetlands in developing countries having some potential of developments require assessment of their functions. WWF [3] pointed out that insufficient understandings of the wetland values have caused much degradation. We previously clarified flood mitigation and sedimentation of wetlands in the Kushiyara River Basin, Northeast Bangladesh quantitatively [4]. However, study on awareness structures and flood measures of local people in the wetlands of the Northeast Bangladesh have been lacking.

For study on flood damages and flood measures of local people in Bangladesh, Muramoto et al. [5] studied flood disaster situations in Bangladesh based on survey of a large flood disaster in 1987. In the study, Oda tried to clarify factors of regional difference of human and physical damage caused by flood inundation through

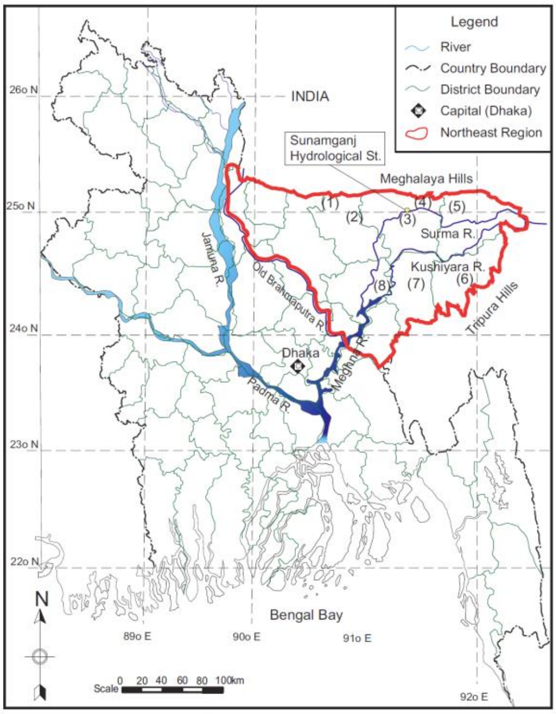


Figure 1 Location Map of the Bangladesh Study

analysis of flood-fighting awareness and activities of local people. Uchida et al. [6] clarified that farmers in Bangladesh have adopted flooding from view point of cultivation techniques for crops and vegetables. The study described floods are rather than for control and/or management it should be "living with" through an example village in the Northeast region. A past study [7] extracted the disaster characteristics in Bangladesh through study on features of the country as background of water related disasters, conditions of damages and their expansions, and analysis on socio-economic structures, evacuation/ damage mitigation system. Islam [8] examined no-agricultural impacts of floods, perception and responses by local people on three differential flood impacts e.g. flash flood, river flood and tidal flood through a questionnaire survey. Sultana et al. [9] studied countermeasures of affected people of 2005 flood disaster through a household interview survey immediately after the disaster on 595 households in four districts extracted by stratified random sampling method. Hoque et al. [10] prepared inundation maps on the Northeast Bangladesh by use of RADARSAT with 50 m x 50 m resolution from 2000 to 2004. Although the study grasp wide range spatial inundation condition, accurate inundation depth and its duration were unknown. As above described, there are several research for flood features and sociological features on response to flood disasters in Bangladesh but study on land use adopted in flood inundation and response to flood disasters in flood prone areas in the Northeast Bangladesh has been lacking.

This study aims to clarify actual status of self- community- and public- assistances against flood disasters in flood prone areas of the Northeast Bangladesh (hereinafter referred to as "the Bangladesh Study Areas") which derived from a questionnaire survey. In addition, the findings are compared with a similar study on 2006 flood in the Sendai River Basin, Japan [11] to extract similarities and differences and we tried to find universality of the flood response by local people.

2. THE BANGLADESH STUDY AREAS

2.1. Geography

As shown in Figure1, the Bangladesh Study Areas located in the Northeast Region of Bangladesh are surrounded by Old Brahmaputra River on Southwest side, Meghalaya Hills in India on North side and Tripura Hills in India on Southeast side, with area of approximately 20,000km^2. A past study report [12] introduced overview of natural conditions on the Northeast Region. Monsoon floods make haor area: a kind of wetland to submerge under flood water during wet season. Approximately 62% of the Northeast Region has inundation depth more than 3.0 m. As a result, rivers and ponds that are independent in dry season leads to continuous water surface, the distance to the opposite shore will be to several ten kilometers. In other areas, plain of 5 to 10 masl is majority except for hilly area of more than 20 masl such as Sylhet city and near the Indian border of the northern and southeastern part.

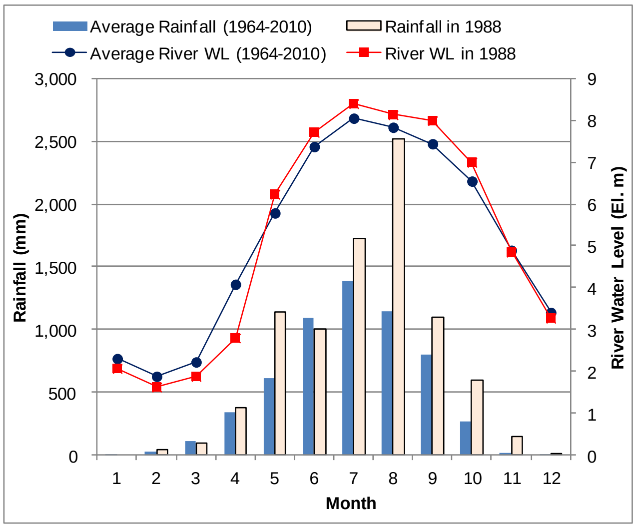


Figure 2 Monthly Rainfall and Monthly Average RWL at Sunamganj Station

2.2. Rainfall

The Northeast Region of Bangladesh is located in subtropical monsoon climate zone and its climate is classified as 1) wet season from April to September: southwest monsoon and 2) dry season from October to March. Seasonal rainfall patterns are governed by onset and withdrawal of the southwest monsoon. Around 80 to 90% of annual rainfall occurs in the wet season. Annual rainfall ranges from 2,200 mm along the western boundary to 5,800 mm in its northeast corner. As shown in the spatial distribution of rainfall over the country in several reports [13-15], rainfall generally increases from south to north within the region. Cherrapunji rainfall station, located in approximately 30 km north from Bangladesh – India boarder, has the world record of annual rainfall with 26,461 mm from August 1860 to July 1861.

Figure 2 shows monthly rainfall and monthly average river water level (RWL) at Sunamganj hydrological station. Annual rainfall at the station in 1988 was recorded as 8,720 mm which is approximately 1.50 times of mean annual rainfall at the station: 5,822 mm observed from 1964 to 2010. Especially, rainfall in August 1988 was recorded as 2,515 mm which is approximately 2.20 times of mean monthly rainfall of August. However, maximum difference between monthly RWL in 1988 and the mean monthly RWL is only 0.55 m in September. There is no significant water level difference as the difference of rainfall, which suggests an extensive flood inundation within flood plains and wetlands.

2.3. Flood

Flood in the Bangladesh Study Areas is classified as pre-monsoon flood mainly from April to May and monsoon flood around June to September. Flash floods, rapidly increase river water level within hours occurs during the whole southwest monsoon season.

Rivers of the region divert a part of their flood discharge to inland wetlands through backwaters to tributaries and distributaries and overflow of embankment unlike Japanese rivers which have been developed in a certain degree. Therefore, it is difficult to grasp flood scale by flow discharge observation at downstream of the region. Past study [16] estimated flood storage volume in the Northeast Region in 1991. According to the study, inflow and outflow volumes are equal over the year, but that peak outflows are considerably damped and delayed. Approximately 25 billion m^3 of flood water was reserved on the wetlands during the wet season in 1991. The peak discharge was reduced roughly two thirds from 22,400 m^3/s to 14,000 m^3.

Table 1 Surveyed Villages

No.	District	Village
1	Netrakona	Kullagora
2	Netrakona	Barkhapan
3	Sunamganj	Laxmanshree
4	Sunamganj	Rangarchar
5	Sylhet	Talikhal
6	Maulvibazar	Munshinbazar
7	Habiganj	Tegharia
8	Kishoreganj	Dhaki

Table 2 Household Annual Income

Unit: BDT

	Nos. of Respondents								
	(1) Kullagora	(2) Barkhapan	(3) Laxmanshree	(4) Rangarchar	(5) Talikhal	(6) Munshinbazar	(7) Tegharia	(8) Dhaki	Total
More than 300,000	3	9	10	1	7	5	5	4	44
120,000 - 300,000	13	17	19	7	20	18	18	20	132
60,000 - 120,000	30	16	16	18	22	25	20	20	167
Below 60,000	4	8	5	24	1	2	7	6	57

3. QUESTIONNAIRE SURVEY

3.1. Methodology

In order to understand characteristics of floods and caused damages, communication of flood disaster information and current situation of flood responses by local people, we carried out a questionnaire survey each 50 households, a total of 400 households in eight villages in the Bangladesh Study Areas which locations and names are shown in Figure 1 and Table 1, respectively. We referred to advice of local agencies of river management to select the villages.

The respondents were randomly selected by visiting interviews in spite of questionnaire mailing method because literacy rate of the country is low. It hired eight survey staffs of Bangladeshi to formulate four survey groups. Each group visited two villages who surveyed over a period of about 50 days. In order to avoid bias in the interview, basically no Japanese was involved in the interview on-site.

The questionnaire survey items comprise four major items on flood responses, including 1) respondents attribute, 2) socio-economic condition, 3) flood damage situation, and 4) evacuation activities. The number of query was 81 items in total.

3.2. Results

3.2.1 Respondents Attribute

The gender proportion of respondents is male: 89.5 %; female: 10.5%; proportion of male is quite larger than that of female. It may be due to 1) householder responded as representative, 2) survey staffs were composed of only male. The generation of respondents is; 10s: 0.5%; 20s: 10.5%; 30s: 21.5%; 40s: 24.5%; 50s: 25.8%; 60s: 12.3%; 70s: 3.8%; more than 80 years old: 1.3%. The proportions of 40s and 50s are slightly larger than that of other generations but it can be said that generally wide range generations were surveyed.

Occupation of respondents is; subsistence farmer: 34.0%, peasant: 11.5%; fisherman: 11.8%; merchant/ small businessman: 9.8%; day labor: 10.8%; others: 22.3%. The survey has received respondents from various occupations. Literacy rate of the whole respondents is 72.5%, which is higher than that of the Northeast Bangladesh with 38.0%. There is a possibility that could not be obtained the cooperation of the answers to the questionnaire from the part of the illiterates.

Residence period of respondents is; below 10 years: 5.3%; 11 – 20 years: 9.3%; 21 – 30 years: 18.0%; 31 – 40 years: 22.3%; 41 – 50 years: 22.3%; more than 51 years: 23.0%. Residence period more than 31 years accounts for 67.5% which means nearly 70% of respondents had experienced the largest flood in Bangladesh occurred in

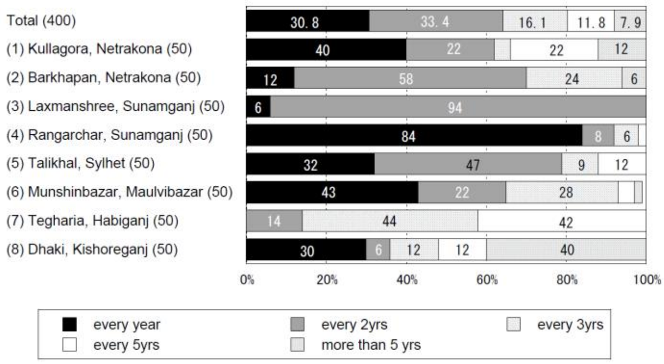


Figure 3 Frequency of Flood Damage

1988 at present houses.

Average household annual income of respondents is approximately 159,000 Bangladesh Taka (BDT) which corresponds approximately 2,060 US dollar. Table 2 shows household annual income in each village. Household annual income of (2) Barkhapan and (3) Laxmanshree are relatively higher than that of others, and (4) Rangarchar located near the northern boundary is relatively lower with 24 household of below 60,000 BDT.

3.2.2 Flood Damage Situation

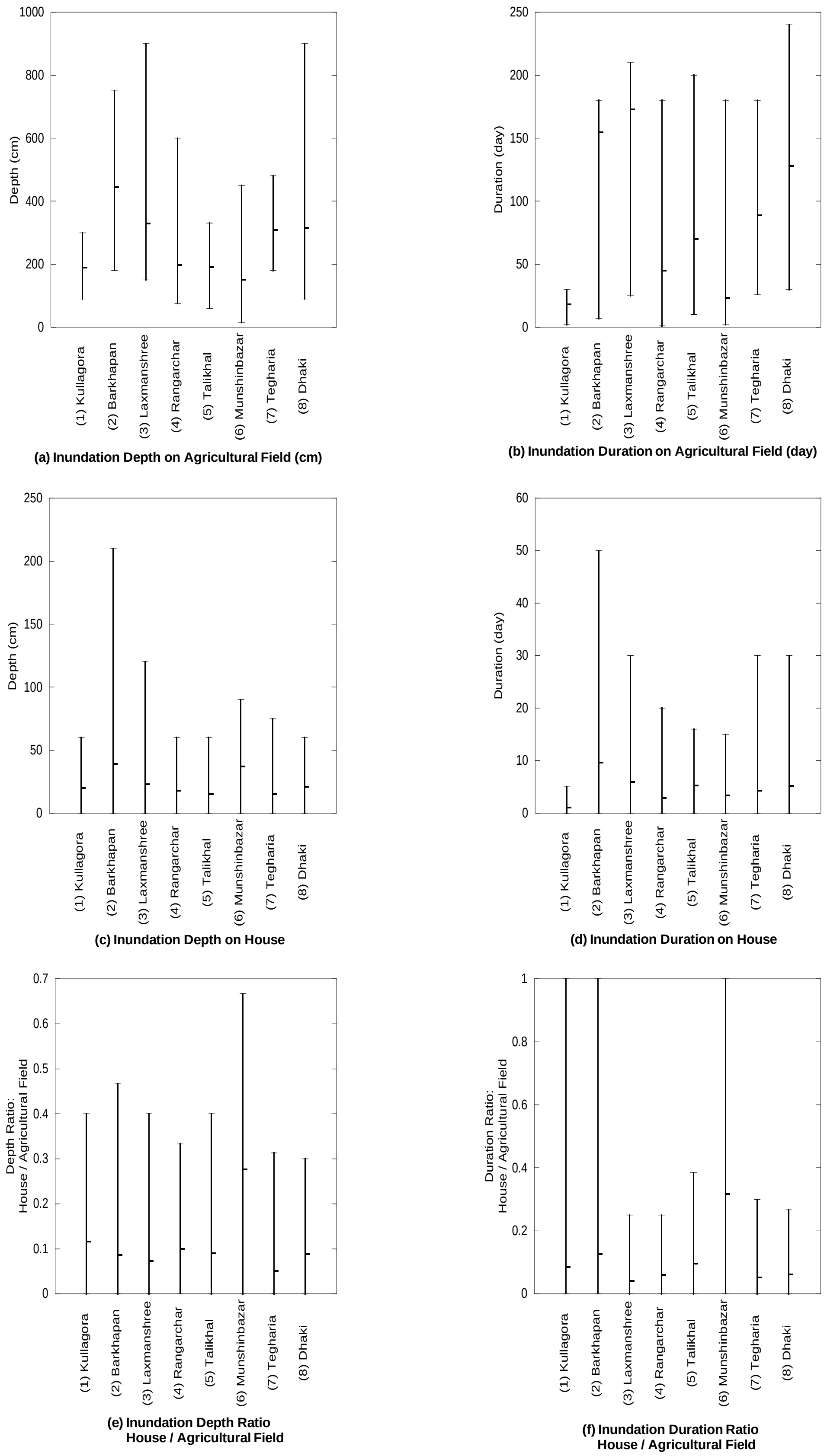
Figure 3 shows frequency of flood damage in the villages. 84% of respondents in (4) Rangarchar replied that flood damages occur every year. However, house damage in the village is relatively insignificant as one totally flushed out and 18 partially flushed out in 50 households under the maximum flood as described later. (7) Tegharia has relatively few frequency of flood damage among the Bangladesh Study Areas that the frequency more than five years accounts for 40%.

For the occurrence year of flooding so far resulted in the most serious damage, 1988 flood accounts for 100% in (7) Tegharia; 98% in (1) Kullagora; 88% in (8) Dhaki; 84% in (4) Rangarchar; 68% in (5) Talikhal. In (3) Laxmanshree and (6) Munshinbazar, 2010 flood occurred in pre- monsoon season accounts for 50% and 44%, respectively. 2009 flood accounts for 48% in (2) Barkhapan. It might be due to memory weathering on 1988 flood because flood damage in 2009 and 2010 is relatively small according to statistical data [17].

Figure 4 shown in the next page indicates the maximum inundation depth and the maximum inundation duration at agricultural field and house during the maximum flood in each village. Ratios of the maximum inundation depth and the maximum inundation duration between agricultural field and house are also indicated in the figure. In the agricultural field located on natural altitude, the maximum inundation depth is in range of 100 cm to 900 cm and 300 cm in average (Figure 4 (a)). For the maximum inundation duration of agriculture, while a respondent in (4) Dhaki has 240 days, (1) Kullagora and (6) Munshinbazar located in relatively steep slope land near mountainous range has relatively shorter duration: 20 days in average (Figure 4 (b)).

Houses usually built in heightened mound on natural levee have the maximum inundation depth below 50 cm and the maximum inundation duration less than 10 days in each village in average basis (Figure 4 (c), (d)). The maximum inundation depth on house exceeding 100 cm can be found only one in (2) Barkhapan and two in (3) Laxmanshree while the case of (2) Barkhapan is exceptional that has above 200 cm inundation depth. 34% of houses have never undergone flood inundation even if other houses have the experience, 52.5% of houses have below 50 cm for the maximum inundation depth. (2) Barkhapan has the deepest inundation depth as 444 cm in agricultural field and 39 cm in house in village average basis.

Figure 4 (e) and (f) indicate dimensionless values of dividing house by agricultural field for the maximum inundation depth and the maximum inundation duration. The maximum inundation depth in house is generally reduced approximately 10% of that in agricultural field. The value in (6) Munshinbazar is relatively larger than others with approximately 0.3 but averaged maximum inundation depth of house in the village is 37 cm which may not cause severe damage. The dimensionless values for the maximum inundation duration are also approximately 0.1. (1) Kullagora, (2) Barkhapan and (6) Munshinbazar have the value of 1.0 but their difference between agricultural field and house is less than one day because these villages have relatively steep slope land and every respondent have relatively shorter inundation duration as less than 9 days. These figures indicate houses located in natural levee or heightened mound can protect properties against flood inundation.



Note: Horizontal bar located in middle of each vertical bar is averaged

FIgure 4 Maximum Inundation Depth and Maximum Inundation Duration at Agricultural Field and House during the Maximum Flood in Each Village and Their Ratios

Table 3 Health Effect of Family by the Maximum Flood

		Nos. of Respondents								
		(1) Kullagora	(2) Barkhapan	(3) Laxmanshree	(4) Rangarchar	(5) Talikhal	(6) Munshinbazar	(7) Tegharia	(8) Dhaki	Total
Physical Damage (Person)	Mortality	0	0	0	0	3	0	1	1	5
	Insury/ Sickness	6	20	39	41	55	10	47	14	232
	None (household)	48	34	35	32	19	42	26	39	275

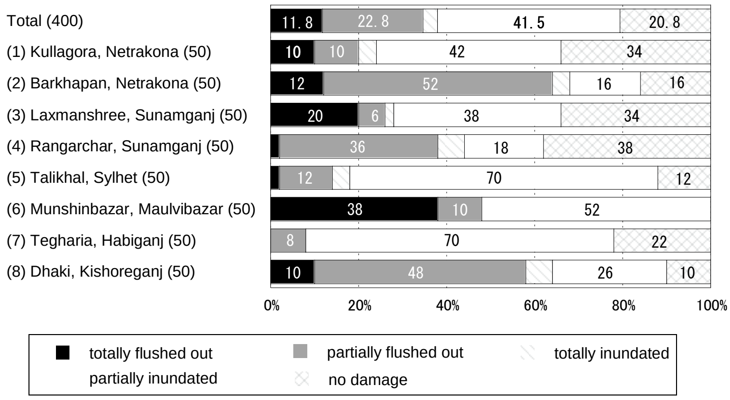


Figure 5 House Damages by Maximum Flood

Table 3 shows health effect of family by the maximum flood in each village. The number of mortality is three in (5) Talikhal and each one in (7) Tegharia and (8) Dhaki. Sickness due to deterioration of sanitary conditions, abnormal outbreak of pests, malnutrition and mental stress associated with flood accounts for more than 90% of the whole health effect. In spite of few house damage in (5) Talikhal and (7) Tegharia, they have mortalities. The causes of mortalities in these villages are unknown but i) worsening of sickness and ii) accidents such as overthrown boat and poisonous snake bite can be considered possible causes. 48 respondents in (1) Kullagora and 42 respondents in (6) Munshinbazar have no health effects and 275 respondents in all of villages do not have too.

Figure 5 shows house damages by the maximum flood in each village. In the whole number of respondents, totally flushed out is 47 (11.8%); partially flushed out is 91 (22.8%); totally inundated is 13 (3.3%); partially inundated in 166 (41.5%); and no damage is 83 (20.8%). (6) Munshinbazar located along the Manu River, suffering from river bank erosion has the largest number of house flush out with 19 respondents. (2) Barkhapan, (4) Rangarchar and (8) Dhaki also have a lot of partial flush out of house. (5) Talikhal and (7) Tegharia have relatively few house damages.

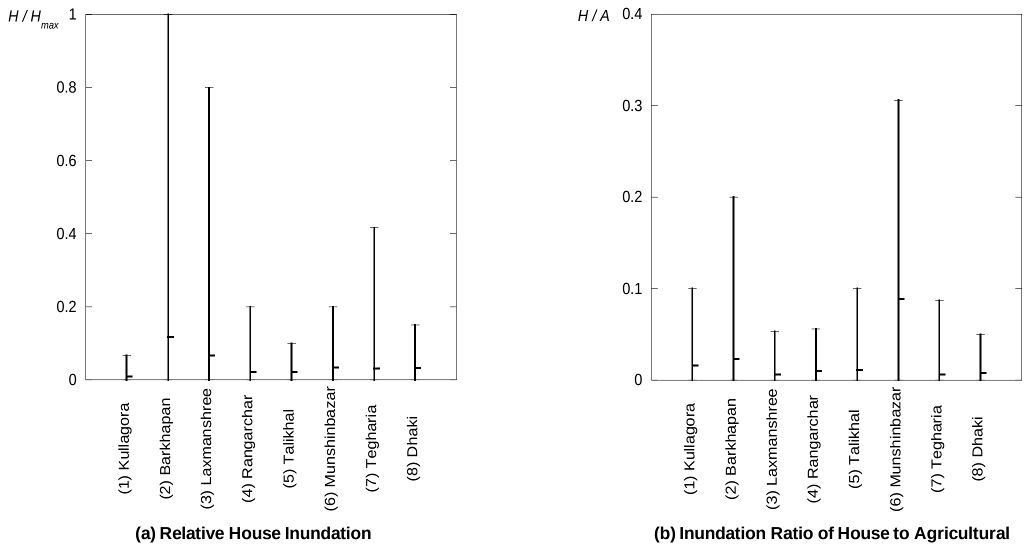
71 households are to be required evacuation against flood forces on house which is determined by based on cross-check of this house damages data and the maximum inundation depth and duration previously discussed.

4. ANALYSES ON LOCAL PEOPLE RESPONSES TO FLOOD DISASTERS

4.1. Preventive Flood Inundation Mitigation by Selection of House Location

This section evaluates selection of house location and stilt-up housing by local people as preventive flood inundation mitigation. The flood inundation damage potential in the maximum flood is simply determined as ‘Maximum Inundation Depth x Maximum Inundation Duration’ and difference of the flood inundation potential between agricultural field and house is considered as flood inundation mitigation effect. Following equations are given for the analysis.

$$H = H_{Dep} \cdot H_{Dur} \tag{4.1}$$



Note: Horizontal bar located in middle of each vertical bar is averaged

Figure 6 Flood Inundation Mitigation Effect by Selection of House Location from View Points of Maximum Inundation Depth Ratio *H/H* **H/H_{max} and H/A**

$$A = A_{Dep} \cdot A_{Dur} \tag{4.2}$$

$$H_{\max} = \left(H_{Dep} \cdot H_{Dur}\right)_{\max} \tag{4.3}$$

where, H_{Dep}: maximum inundation dept at house, H_{Dur}: maximum inundation duration at house, A_{Dep}: maximum inundation dept at agricultural field, A_{Dur}: maximum inundation duration at agricultural field.

Figure 6 (a) and (b) show H/H_{max} and H/A, respectively. H_{max} is in (2) Barkhapan that also have the highest H/H_{max} in village average basis also which indicates (2) Barkhapan comprises relatively large flood inundation damage on house. (3) Laxmanshree and (7) Tegharia have some large values in household basis. Smaller H/A in Figure 6 (b) indicates relative effect of flood inundation mitigation. H/A in (6) Munshinbazar is remarkably larger than others while their H/H_{max} is not so large value which suggests the effect is relatively small. H/A in (2) Barkhapan is slightly larger than others although their H/H_{max} is large value i.e. self-assistance of flood mitigation is insufficient.

It was hypothesized by using equation (1), (2) and (3) in consideration of the fact that some houses flushed out by river bank erosion due to floods, flood mitigation effect of house location selection obtained by the following equation.

$$M_d = 1 - f \cdot \left(\frac{H}{H_{\max}}\right)^{0.5} \cdot \left(1 + \frac{H}{A}\right)^{-1} \tag{4.4}$$

where, M_d: mitigation degree of flood damage on house, f: coefficient of house flush out damage (f=10 if house was totally flushed out).

Estimated mitigation degree of flood damage on house is shown in Figure 7. Household without house damage is M_d=1. For only mitigation effect of flood inundation damage, (2) Barkhapan comprising H_{max} has low degree in village basis and (3) Laxmanshree and (7) Tegharia also has low degree of some households. (6) Munshinbazar with 19 house of totally flushed out has the lowest degree when house flush out damage is counted.

It is said that poor people is the most vulnerable existence against floods in Bangladesh. It is often observed on the sites that land owners built their houses on higher elevation land and poor people live on vulnerable land against flood such as river bank coast and sand bar that was pointed out by Oda [5] also. We attempted preliminary validation of the tendency by study on relationship between mitigation degree of flood damage on house (M_d) obtained in this study and household annual income. As shown in Figure 8, three households with

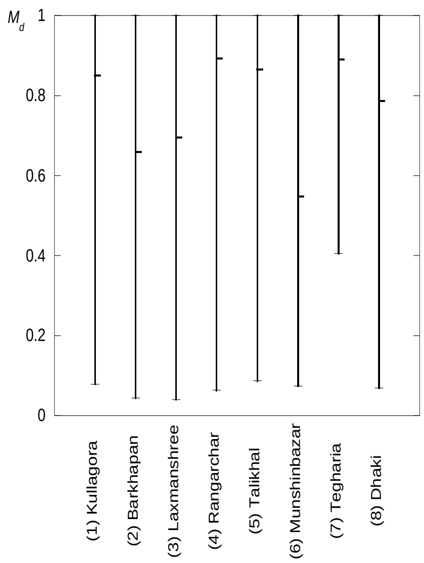


Figure 7 Mitigation Degree of Flood Damage on House M_d

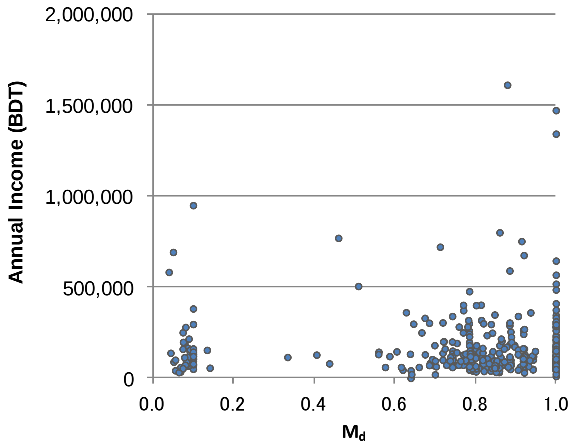
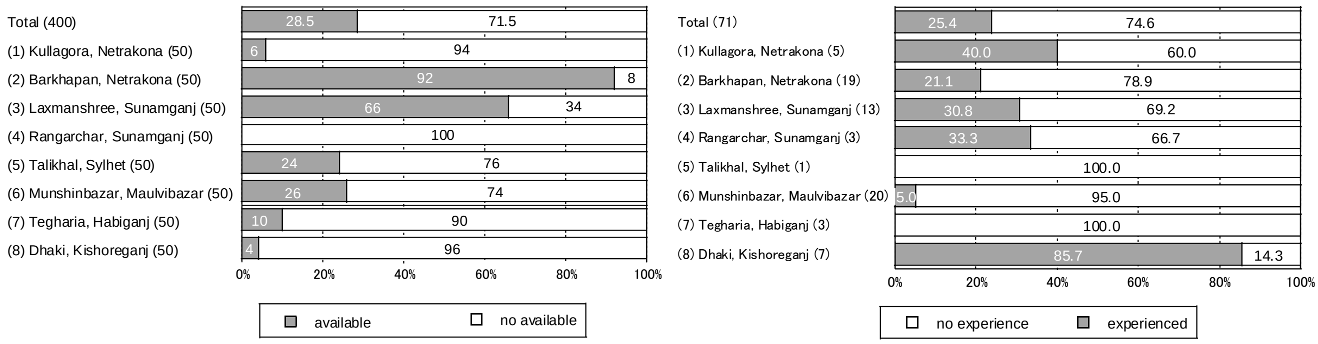


Figure 8 Relationship between Mitigation Degree of Flood Damage on House (M_d) and Household Annual Income

high annual income have high M_d. However, M_d of low annual income households is widely distributed. It is not observed proportional relationship between M_d and the household annual income. It is preliminary revealed that some households mitigate flood damage on their houses even if they have low annual income.
Health effect of flood disaster can increase by outdoor accidents and physical condition of family member even if their house damage is small. Relationship between selection of house location as self-assistance against flood and reduction of health effect cannot be confirmed in this study although it was predicted flood damage mitigation effect by self-assistance would reduce health effects.

4.2. Disaster Information Collection and Evacuation Activities by Local People

Figure 9 (a) shows pre-acquisition condition of flood forecast and warning information of local people. 114 in 400 households replied that they can obtain flood forecast and warning information before flood events. 92% in (2) Barkhapan and 66% in (3) Laxmanshree can obtain the information in advance but more than 70% of respondents in other villages cannot do it. The information sources are, TV/radio: 58; neighbors: 40; community leader: 8; governmental office: 4; others: 4. Main information source is TV or radio but 28 households (56%) in (3) Laxmanshree obtain the information from neighbors which implies some extends of community-assistant against flood disaster in the village. According to a respondent in the village, local people have carried out submersible embankment repair by participatory works every dry season. Another respondent in the village reported that he provided 600 sand bags for a past flood fighting activities. Hence, such regular cooperation on



(a) Pre-acquisition of Flood Forecast & Warning Information **(b) Evacuation of People Living in Seriously Damaged House**

Figure 9 Disaster Information Collection and Evacuation Activities

flood measures has made awareness of flood disaster information which led to the sharing of the information. (2) Barkhapan and (3) Laxmanshree, who are relatively able to obtain the information, receive the information more than one day before flood disaster. It may be long enough time to take evacuation activities.

Households, who have totally flushed out or totally inundated their house are determined to be required evacuation against flood forces on house and then we statistically reveal what factor divide they evacuate or not. Figure 9 (b) shows evacuation experience of local people. Evacuation rate who required evacuation is 25.4% (18) which is almost similar with the evacuation rate of all respondents: 24.5%. Among evacuated respondents who required evacuation, 14 respondents evacuated due to dangerously deep inundation depth that is not preventive disaster mitigation measures but forced evacuation after increasing house damages. Evacuation places who required evacuation order to community assistance: 7 (house of relative: 3; house of neighbors: 4); self-assistance: 6 (highway, embankment and other public facilities); public-assistance: 5 (public evacuation center). In Bangladesh, where frequently have wide flood inundation, highways were heightened to ensure relief activities and logistics during flood disaster. It is confirmed the highways were utilized as temporary evacuation place. Reasons of no-evacuation who required evacuation (53) are; no place to go: 18; flood is frequent events: 15; risk of looting household items: 8; underestimation of flood scale: 7; others: 4; delay of perception of condition: 1. Among respondents who did not evacuation, 43.4% obtained flood disaster information but did not evacuate due to above mentioned reasons.

Only 17 in 400 households had participated in evacuation drill but only two of them are to be required evacuation i.e. the opportunity is not given for really required people. Within two trained respondents, one respondent evacuated against flood.

It is clarified that construction of evacuation facilities and establishment of flood forecast and warning system as soft-measures of public-assistance are insufficient and stilt-up housing as self-assistance is the first choice of flood measures in the Bangladesh Study Areas.

5. COMPARISON OF RESPONSE TO FLOOD DISASTER BY LOCAL PEOPLE BETWEEN THE BANGLADESH STUDY AREAS AND SENDAI RIVER BASIN

In previous chapters, we analyzed land use and responses to flood disaster by local people in flood prone areas of Bangladesh. It is quantitatively clarified to mitigate property damages through high land locations of house and heightening of highways. On the other hand, Hishikari Basin in the Sendai River Basin, which is also a flood prone area in the past, had been developed with land use for flood damage mitigation [18]. The basin was similar as the case of Bangladesh Study Areas in which houses and highways were located on highlands and lowlands were utilized as agricultural field such as paddy field. However, it was pointed out that such “flood damage proof land use” have been changed with progress of flood control dam construction and river improvement project. As the background of this matter, it was also pointed out that local people in Japan recently take a style of relationship that relief is assured from transfer of disasters concern to government experts to be "externalized" in the society of modernization [19].

We previously studied the affected local people by 2006 flood in the Sendai River Basin [11]. The respondents

were categorized evacuated local people and no-evacuated ones. The primary factors to motivate evacuation activities were studied statically by use of the categorized data. In addition, we assessed how functioned self-, community-, and public assistances against flood disaster. This chapter extracts similarities and differences from comparison of responses to flood disaster by local people in the Bangladesh Study Areas and the Sendai River Basin and try to find universality of the flood response by local people.
One difference is that evacuation ratio on household living severely damaged house: to be required evacuation, is 25.4% for the Bangladesh Study Area and 80.2% for the Sendai River Basin, respectively. It is confirmed as its background that construction of evacuation facilities as non-structural measure of public-assistance is insufficient in the Bangladesh Study Area. Local people in the Bangladesh Study Area rely on community- and self-assistances for evacuation place but few opportunities on public facilities. 24.1% of respondents in the Sendai River Basin evacuated based on evacuation drill experiments. On the other hand, only 4.3% of respondents in the Bangladesh Study Area have evacuation drill experiments and one respondent to be required evacuation did it. Opportunities of evacuation drill as public-assistance also one of the differences.
The similarities can be observed households to be required evacuation in both areas. Poor response to flood disaster information is one similarity that no evacuation despite receiving the information in advance is, 43.4 % for the Bangladesh Study Area and 70.0 % for Sendai River Basin, respectively. Their evacuation is not preventive disaster mitigation measure and forced by increased house damages which is observed deep inundation depth for evacuation reason is, 77.8 % for the Bangladesh Study Area and 42.7 % for Sendai River Basin, respectively.

6. CONCLUSIONS

This study aims to clarify actual status of self- community- and public- assistances against flood disasters in flood prone areas of the Bangladesh Study Areas which derived from a questionnaire survey for 400 households and relevant documents. We extracted similarities and differences of the flood responses by local people through the findings in comparison to the similar study on 2006 flood in the Sendai River Basin, Japan. The findings are as follows.

1) The effects of preventive flood mitigation measures by selection of house location are quantitatively confirmed that the maximum inundation depth and duration in house is generally reduced approximately 10% of that in agricultural field.
2) Sickness due to deterioration of sanitary conditions, abnormal occurrence of pests, malnutrition and mental stress associated with flood accounts for more than 90% of the whole health effect. 275 in 400 respondents have no health effects on their family.
3) It is said that poor people is the most vulnerable existence against floods in Bangladesh. However, it is not observed proportional relationship unique to the household annual income and the mitigation degree of flood damage on house. It is preliminary revealed that some households mitigate flood damage on their houses even if they have low annual income.
4) The differences between the Bangladesh Study Area and the Sendai River Basin on local people response to flood disaster are on evacuation rate of households to be required evacuation and opportunity and practice of evacuation drill. The Sendai River Basin has high rate of them based on sufficient provision of non-structural measures as public-assistance.
5) The similarities of two areas are on households to be required evacuation. That is i) many households did not evacuate despite receiving the information in advance, ii) Their evacuation is not preventive disaster mitigation measure and forced by increased house damages.

The Bangladesh Study Area, under development of infrastructures, mainly takes self-assistance against flood disaster such as selection of house location and stilt-up housing. On the other hand, social infrastructure is in place, local people of the Sendai River Basin has gained peace of mind by being "outside" the concern for disasters, do not effectively utilize public-assistance such as evacuation facilities and flood information in the initial phase of exceedence probable floods arrival. Both areas have subjects on the evacuation activities but their factors are different. In other words, the Sendai River Basin, taking flood measures by land use similar with the case of the Bangladesh Study Area in the past, recently enjoy flood measures by public-assistance but the local people take insufficient self-assistance to access the services.

ACKNOWLEDGEMENTS

The questionnaire survey data utilized in this paper was obtained in JICA Preparatory Survey on Cooperation Program for the Disaster Management in The People's Republic of Bangladesh. The data copyrights belong to JICA. The authors sincerely thank JICA to approve using the data. We would like to thank the JICA Study Team Members that beginning with Bangladeshi local investigators who participated in the questionnaire survey.

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