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Social Background of Riverbank Erosion Areas in Bramaptra and Ganges Rivers : Implication for Japanese Hazard Mapping Technology in Bangladesh

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Synopsis

Since Japan and Bangladesh are frequently affected by flood, measures have been developed. Some of Japanese measures are applicable in Bangladesh, if it is adjusted to fit the local condition. In this research, social background in riverbank erosion areas in Bangladesh is analyzed for discussing possible way of transferring hazard mapping technology, which is a Japanese major technology for flood risk reduction. Semi-structured interview and questionnaire survey were conducted in the selected areas for perceiving social background. The results were compared to Japanese flood condition and social back ground. The result shows three major differences: (1) The shapes of rivers and villages change every after flood, which makes difficult to update map. (2) There is enough time to prepare for evacuation (3) People are not able to interpret map. These major results show using hazard map as the same as Japan is impossible in the selected areas, however the map to tell the longer existing area may be useful for the selected areas. Since the hazard mapping technology has possibility to tell the safe / long existing area, different use of hazard mapping technology is expected.

Keywords: Flood, Erosion, Hazard map, Bangladesh, Social background

1. Background

Flood disaster is a critical issue in Bangladesh, with the most severe occurring during July and August. Regular river floods affect 20% of the country, increasing up to 68% in extreme years. After 1987 and 1988 floods, a strategy of “living with the floods” was applied for sustainable agricultural development. After some medium floods occurred in 1990s, 68% of the country was inundated by the flood in 1998. The earthen embankment was unable to protect severe flood in 1998 and even some medium floods. Therefore, institutional development and integrated water resource management took place. In 2004, Bangladesh experienced devastating floods lasted from July to September, and about 38% of the country were inundated (Fig.1).

After this flood, more comprehensive risk reduction was slowly took place. There was a shift from focusing on response and relief to preparedness. In addition, all stakeholders’ participation was also considered to be effective for flood disaster risk reduction, and the needs to improve disaster response and preparedness at local level were also focused. Since Japan also suffers from floods every year, structural and non-structural measures have been developed. As with Bangladesh, measures were shifted from structural measures to comprehensive measures including non-structural measures, such as disaster preparedness and stakeholders’ participation. One of a major non-structural measure is hazard map. It shows possible flood/inundation area and route for

evacuation, and is used for evacuation by local people in Japan. Bangladesh has local strategies, however technology intervention is not common in riverbank erosion area (Fig.2).

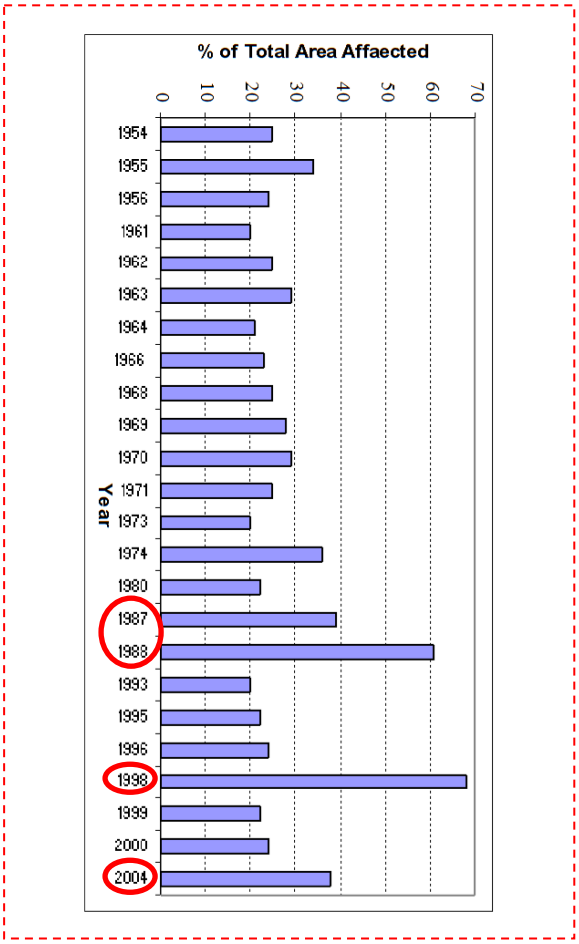

Fig. 1 Major floods and affected area (% of total area of the country) Source: Rahman, 2014

In this research, possibility of transferring Japanese hazard mapping technology to Bangladeshi riverbank erosion areas is analyzed and discussed based on literature review and field research.

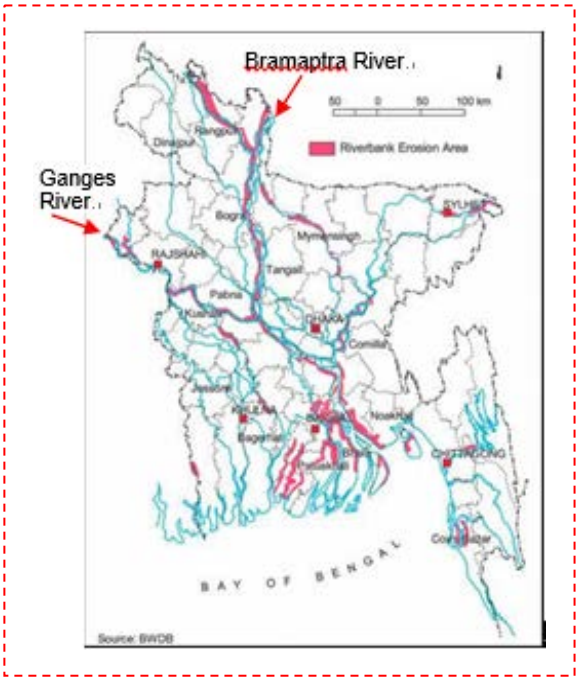

Fig. 2 Riverbank erosion area in Bangladesh (in red) Source: arranged BWDB

2. General issues in riverbank erosion areas

River flood is caused by bank overflow. The most destructive river floods occur when peak discharge of both the Brahmaputra (June/July) and Ganges (August/September) rivers coincide causing downstream devastation.

There are riverbank erosion areas inside and along major rivers, which are called char areas in Bangladesh. 6.5 million people, 5% of total population, are estimated to live on char areas, and 5 million live on the chars in major rivers such as Bramaptra and Ganges Rivers and the rest live on the coastal chars (Kabir 2006). These areas are unstable because they are developed by erosion and accretion. Some of the areas exist several decades but others have short histories.

People on the riverbank erosion areas are mostly farmers. Annual flood-induced fertile soil is utilized for farming in riverbank erosion areas. As a result, their livelihood is affected by environmental conditions such as floods, drought and river erosion. The erosion takes away not only people's homes but also their farming land (Zaman 1989). Most low-lying areas may remain under water for three to four

months during the annual floods from June to September (Younus 2014). As a result, local people have difficulty to find job and often turn out to be poverty and hunger. Summary of general issues in riverbank erosion area is as follows:

- They are vulnerable to environmental conditions such as land erosion, floods, droughts, and storms.
- Physical security is not secured even at home.
- Public and private services are limited, such as education, medical care, information, bank, etc., because of poor transportation networks.
- Employment opportunities are limited.
- They move often for finding safe area to live and job. Frequent moving, mostly by boat, makes them difficult to increase their physical and financial assets.
- Usually, the linkage with the local government is weak, and there is no support for migrants to move and settle to new places, except during emergencies (Martin et al., 2013).

3. Measures for flood

The flood speed in Japan and Bangladesh is different. The flood speed in riverbank erosion areas in Bangladesh is slow and people can live on inundated land as usual for several weeks, however the erosion destroys their land gradually even though their houses are upraised with plinth. The duration of annual common flood in Bangladesh is about a few months. Their indigenous knowledge for the annual common flood is migrating or evacuating to neighboring areas for a few months. Since they have enough time to prepare for moving, they bring their assets as possible as they can. Thus river flood / river erosion in Bangladesh is not dangerous in a short term, however long-term river erosion slowly and gradually affects their livelihood (DMB 2010). People may lose their farm land, working place and food. If the duration is longer than the annual common floods, they have possibility to die because of starvation. Thus flood in Japan and Bangladesh is different, therefore, the measures must be developed differently.

3.1 Structural measures

Indigenous knowledge such as raising / elevating their houses with plinth (Fig.3) and placing sand bags for preventing erosion on the riverbank (Fig.4) is common and effective structural measures for mitigating annual floods.

Fig. 3 Living in elevated houses next to flooded river (Sundarganj, Gaibandha in Aug. 2014)

Fig. 4 Sandbags on the embankment for preventing erosion (Fulcchari, Gaibandha in Dec. 2014)

3.2 Non-strucrual measures

Migration is the major non-structural measure in riverbank erosion areas. Flood is one of the main reasons of migration in Bangladesh (Khatun 2013). It is rare to lose their lives directly because of flood, however erosion and inundation make them difficult to live as farmers. Flood causes low yield of crops and food shortage, as a result, seasonal migration is needed for finding jobs and foods. Usually the villagers evacuate or migrate by themselves since they consider their experience to tell the timing of evacuation is more reliable than any other information. When the flood water levels go down, they come back to their char and repair their

damaged homesteads, plinths, houses, kitchens, toilets, tube-wells, etc. This seasonal / circular migration is an important strategy.

In addition to the seasonal migration, they move several times in their lifetimes. If their land is totally inundated and they lose their place to go back, communities get displaced together to other neighboring erosion areas. If the land-lost farmers are not able to find the new place for farming in neighboring chars, they move to urban cities and often become wage labors. In addition, because of the increasing population and extreme river flood caused by climate change, which scale is bigger and duration is longer than annual flood, people who live along the river / erosion area have more possibility to become food shortage and lose their houses and lands recently. Riverbank erosion displaces 50,000 to 200,000 people in Bangladesh every year (Mehedi 2010), and the number of internal long distance migrants to urban areas is also increasing (Planning Commission 2010). Food shortages are already prevalent in the rural areas, particularly in the riverbank erosion areas, and the poor migrants to Dhaka city generally settle in slum (Afsar, 1999).

Since the people who live on the erosion areas are the poorest people in Bangladesh (Kabir 2006, Ministry of Environment and Forests 2009), they do not have enough money to purchase or borrow stable land. Therefore, they move to another not expensive newly developed or vulnerable erosion areas again. Thus, they are trapped in the vicious cycle of poverty. The poorest dwellers, who cannot pay for land, may live in government provided unstable lands without buying land or paying rent to anyone. Instead of the duty exemption, they may lose opportunity to get official services such as medical care and education.

4. Selected areas for survey

Surveys were implemented at villages along and in Brahmaputra (also called Jamna in Bangladesh) and Ganges (also called Padma) rivers in 2014 for perceiving the social background (Fig. 5). The villages are affected by flood and erosion every year. Questions were asked to 50 respondents in each 6 village (Table 1).

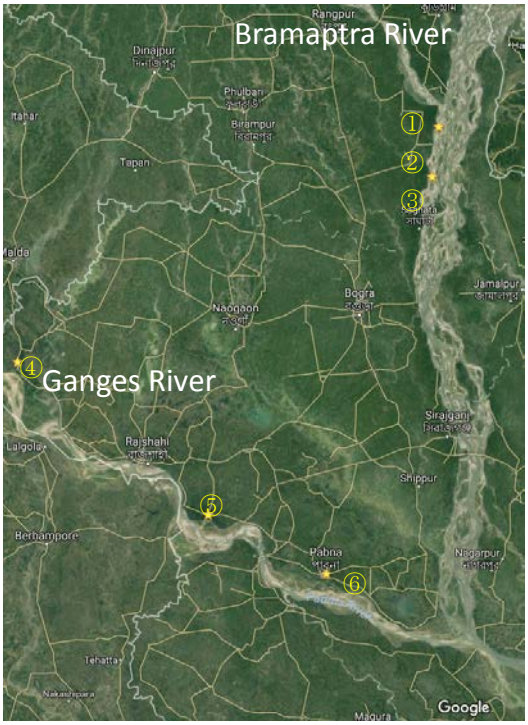

Fig. 5 Selected areas marked with numbers in yellow

Table 1 Selected villages
(6 villages x 50 respondents)

	Village	Upazila (Subdistrict)	Zilla (District)	Division
①	Ratanpur	Sundarganj	Gaibandha	Rangpur
②	Kaziarchar			
③	Lalchamarchar	Fulchhari	Gaibandha	
④	Gorgori	Shibgonj	Chapai Nawabganj	Rajshahi
⑤	Paka/ Durloppur	Bagha	Rajshahi	
⑥	Bharara	Pabna Sadar	Pabna	

4.1 Gaibandha District, Rangpur Division in Brahmaputra River Basin

Selected villages, ① Ratanpur, ② Kaziarchar and ③ Lalchamarchar (Fig. 5, Table 1) are in Gaibandha District. Gaibandha District, Rangpur Division locates in north part of Bangladesh. Gaibandha District is a riparian zone involving Brahmaputra, Tista, and Jamuna rivers. The total population of Gaibandha is 2,117,959, and 641,142

(about 30% in total) live in river erosion areas (Kabir 2006, Union Disaster Management Committee 2012). About 30% of Gaibandha is the river erosion areas.

4.2 Chapai Nawabganj, Rajshahi, and Pubna Districts, Rajshahi Division in Ganges River Basin

Selected villages, ④ Gorgori, ⑤ Paka / Durloppur and ⑥Bharara (Fig. 5, Table 1) locate in the west part of Bangladesh, called Rajshahi Division, along the Ganges River.

④Gorgori village locates in Chapai Nawabganj, the most western district of Bangladesh. The north and west part of Chapai Nawabgan District is bounded by India. Cgaoau Nawabganj District has an area of 1702.55 km^2. Originally, most of this area are plain land with many small ponds and water reservoirs. However, the geography has changed after the construction of Farrakka barrage in India, which was built just before it enter into Bangladesh. It decreased the water level to Ganges River, and created a large area of land full of sand.

⑤ Paka / Durloppur villages are in Rajshahi District. Rajshahi district is bounded by Chapai Nawabganj District to the west and the Ganges River to the south. There are ten rivers in this district, totaling 146 km in length.

⑥Bharara village, Pabna District is in the mid erosion region. Two mighty rivers, Ganges and Bramaptra rivers are flowing next to Pabna. Floods and river erosions regularly strike this district due to its geographical location. Total area is 2376.13 km^2, with land area 2215.97 and riverine area 160.16. The elevation is 8 m and most of the land area is flood plain and marsh land.

5. Methodology and result

Semi-structured interview and questionnaire surveys were implemented in the selected villages. Based on the analysis of semi-structured interview and literature review, 31 questions were prepared asking about demographic information: Q1-Q8, climate change: Q9-Q14, flood, food and health: Q15-Q20 and information system: Q21-Q31. Questionnaire survey were implemented in November to December, 2014. Fig. 6 and 7 are the basic information of the respondents categorized by each river basin, Brahmaptra and Ganges.

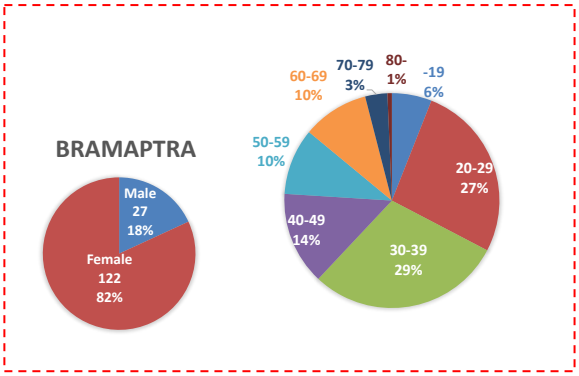

Fig. 6 Gender and age (Brahmaptra)

The number of respondent is 150 (50 in each village) with 18% male and 82% female (Fig. 6). The dominant age ranges are 20s (27%), 30s (29%), and 40s (14%). 75% are illiterate. Regarding education, there are government primary schools, registered primary schools, high schools and colleges in Gaibandha. However, most of them are in far from the erosion areas, which is not affected by erosion. Teachers also live in the areas far from the erosion areas. Due to regular flood many teachers will not travel to the erosion areas for security, therefore it is impossible to have teachers in school regularly, especially during flood season (Kabir 2006). Thus children in erosion area are not able to get even primary education. Regarding the occupation, 73% are farmers.

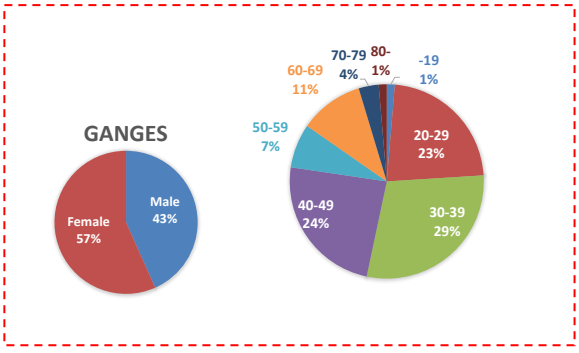

Fig. 7 Gender and age (Ganges)

The number of respondent along / in Ganges River is 150 (50 in each village) with 43% male and 57% female (Fig.7). The dominant age ranges are 20s (23%), 30s (29%), and 40s (24%). 39% are illiterate, and 43% graduated primary school. Though the literacy rate in the selected villages

along / in the Ganges River is higher than the villages along / in Brahmaptra River, they also have difficulties to continue education, especially during floods. Regarding the occupation, 44% are farmers and 12% are laborers.

Though the age range are similar in both areas, the gender and occupation shows the difference.

As it is reviewed that people who live in river erosion areas force to move several times because of flood / erosion induced issues such as losing land, losing job, food shortage etc., the frequency of moving because of floods is asked (Fig. 8).

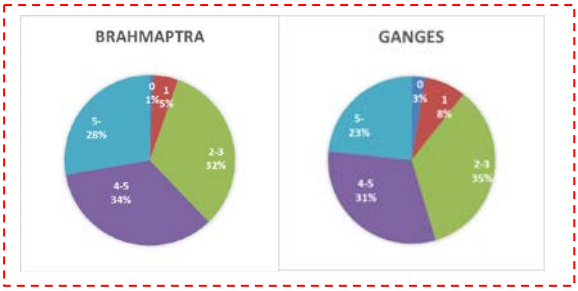

Fig. 8 Frequency of moving since they are born (Brahmaptra and Ganges)

The result is similar (Fig. 8). Most of them experiences moving for several times, 2-3 times: 32%, 4-5 times: 34%, over 5 times: 28% in / along Brahmaptra River, and 2-3 times: 35%, 4-5 times: 31%, over 5 times: 23% in / along Ganges River.

5.1 Challenges to overcome the flood risk reduction

A question asking about the issues due to floods is "Which types of challenges you face to overcome the flood risk reduction in our locality?" and the respondents are able to select two from the following answers.

1. The linkage between community people is very poor
2. No governmental as well as organizational support
3. Very poor economic condition
4. Frequent moving
5. Social unrest
6. Others

"Very poor economic condition" are selected as their major challenges (Fig 9). Then "Frequent moving" is selected. It is considered that since their working places / farmlands are damaged or lost, they are not able to obtain food from their farmlands. As a result, they are forced to move or they need to move for finding living place, food and job. Indeed, most of the respondents experienced moving for several times. There is a little difference for "frequent moving" between the respondents in / along Brahmaptra River and Ganges River. Though the frequency of moving shows the similar result both in Brahmptra and Ganges River in Fig. 8, more respondents in / along Brahmaptra River (Ratanpur, Kaziarchar and Lalchamarchar villages) feel frequent moving is the second major challenge. While more respondents in / along Ganges River (Gorgori, Paka/Dulloppur and Bharara villages) feel no support is the second major challenge. One of the reason may be related to the construction of Farrakka barrage.

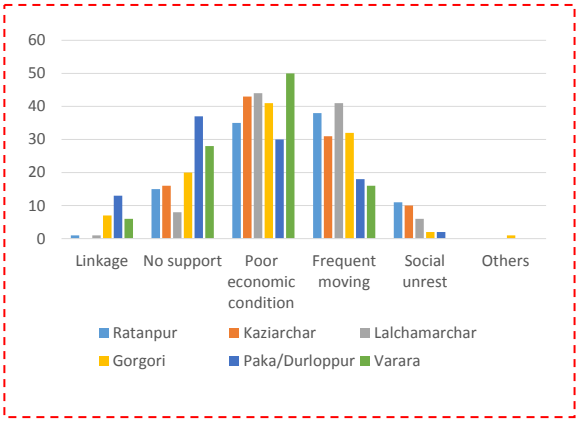

Fig. 9 Challenges to flood risk reduction

5.2 Necessary information during the recent flood

Then necessary information during flood is also asked. The question is "Which information do you need when you evacuate?" and the respondents are able to select two from the following answers.

1. Road condition
2. Warning (timing of evacuation)
3. Medical care
4. Food
5. Safe water
6. Available (safe) area to move
7. Job offer
8. Others

They are interested in “Available safe area to move” and “Food” (Fig 10).

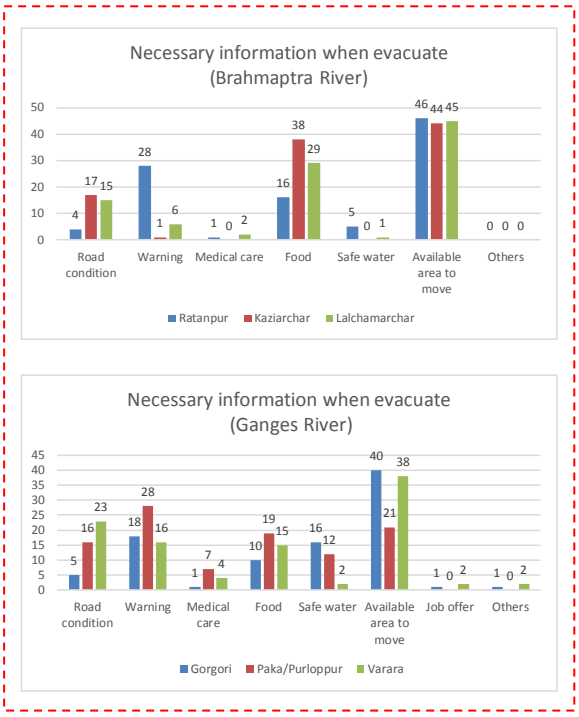

Fig. 10 Necessary information for evacuation

“Available safe area to move” was selected by 147 respondents (Brahmaptra River), which is 98%, and 99 respondents (Ganges River), which is 66%. Though moving is an indigenous knowledge for flood disaster risk reduction, getting information of available safe area to evacuate / migrate is not provided. Providing information about available area to move is effective for them to reduce the frequency of moving and to reduce the opportunity to be poorer by keeping their property and assets.

The second necessary information for respondents in Brahmaptra River is “Food”, and for respondents in Ganges River is “Warning (timing of evacuation)”. The considerable reason of this difference is because of the necessary time for preparing evacuation / migration.

5.3 Days needed for preparing evacuation

As it is answered to the question “How long do you need for preparing for evacuation recently?” (Fig. 11), there is difference of the needed time for evacuation / moving. Respondents in Brahmaptra answered 30 days the most, and the respondents in Ganges answered 7 days the most and 10 days the next. It is analyzed that the respondents in Ganges need to evacuate / move within shorter time, because the speed of flood / erosion in Ganges may be faster or more destructive than in Brahmaptra. Since the combination of early warning and evacuation is supported by the hazard map utilization, there is greater demand of hazard map in selected area of Ganges than in the selected area of Brahmaptra.

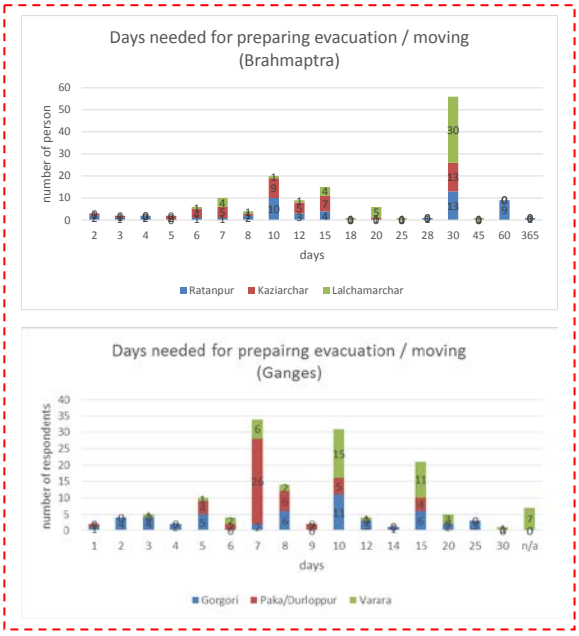

Fig. 11 Days needed for evacuation / moving

Their general issues in the selected areas were almost same as it was reviewed through literature, however there was a gap between needs and demands regarding the area to move. Though the respondents’ most interest during flood is the area to move, the information was not provided. Usually the villagers evacuate / migrate together based on their experiences, because there is no support to find available area to move.

6. Discussion

Not only for annual flood but also for extreme flood, information of evacuation places are important. Knowing the longer existing area and decreasing the number of migration will improve their livelihood and save their lives and improve their livelihood directly or indirectly. Hazard

mapping technology has possibility to tell the safer / longer existing area.

6.1 Comparison of rivers in Bangladesh and Japan

Since the flood phenomena and social background in Japan and Bangladesh is different, the possibility of transferring hazard mapping technology for riverbank erosion areas is analyzed. Floods in Japan are more destructive. Even one flood hit is possible to destroy embankment, buildings, etc. and take people's lives. This is because of the topography. Japan's river has a typical feature. Since the distance from the mountains to coasts is short, generally, rivers are short and steep, resulting in rapid flow. Fig 12 is the comparison of the slop of major rivers in the world.

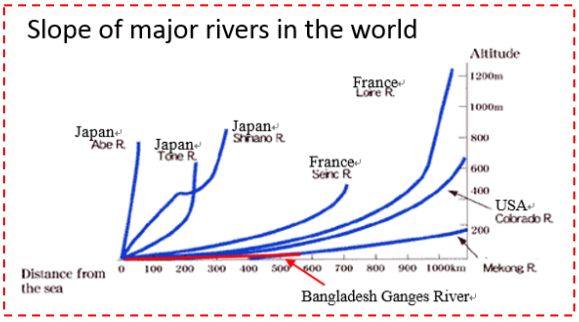

Fig. 12 Slope of major rivers in the world
Source: arranged from (MLIT 2001)

In Japan, if it rains in mountains, water flows to oceans in short time, and there is high risk to occur floods with high velocity. The flood duration is much shorter, within a few days in most cases. On the contrary, Rivers in Bangladesh have gentle slope the river flow is slow. Approximately 80% of the area is within 10 meters above mean sea level. Since flood does not hit buildings, land and people, they are able to live in the inundated place as long as it exist (Fig. 13). Therefore, there is enough time to prepare for evacuate / migrate. However, the erosion affect large area. It deprive people of their farm land and crop resulting starvation.

Fig. 13 Villagers walking flooded path (Sundarganj, Gaibandha in Aug. 2014)

6.2 Comparison of flood measures in Bangladesh and Japan

While the flood in Bangladesh is not destructive in a short time, flood in Japan has possibility to destroy buildings and deprive people's lives. In addition, available flat land to live is limited in Japan because of its mountainous topography. Approximately 66% of the land is covered by mountain. Therefore, people have lived in the flat but flood prone area. As a result, rivers in Japan have structural measures, such as high embankment, for protecting the people's lives, assets, infrastructure and buildings (Fig. 14). Rivers in Bangladesh have few structural measures (Fig. 15). Most of the rivers keep natural condition. This is because the flood is not hit the people directly, and because the people utilize and rely on the flood conveyed fertile soil for agriculture. Because of the few structural measures for rivers in Bangladesh, the shape of rivers change every after monsoon and flood.

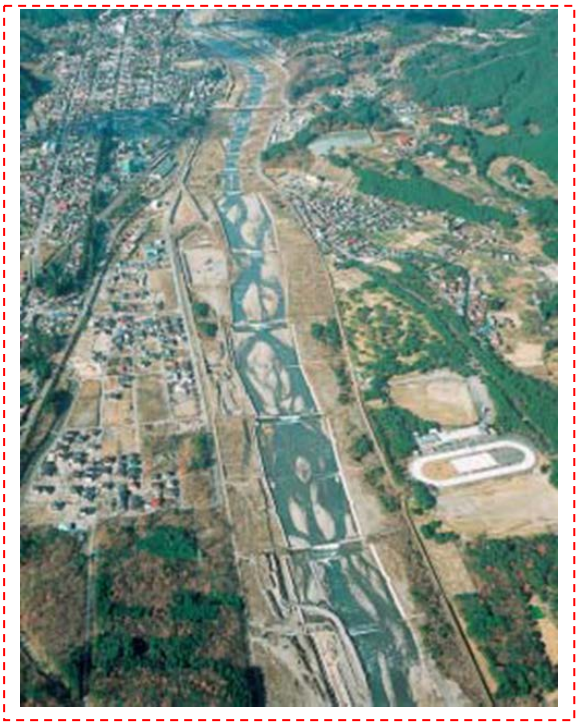

Fig. 14 Japanese river with structural measure
Source: arranged from Sabo in Japan (MLIT)

Fig. 15 Bangladeshi river with few structural measure Source: google map

Though there are structural measures for flood disaster risk reduction In Japan, it is not enough sometimes. Therefore, hazard map has also developed as non-structural measure for protecting people's lives. Hazard map in Japan shows the possible places of flood and tells the evacuation routes and temporary evacuation places. Since map education starts in elementary school in Japan, people are able to interpret their local hazard map. However, interpreting hazard map for the local people is difficult in Bangladesh. Since flood deprive children of access to education for a few month, it is difficult to get even primary education.

7. Result

Though hazard mapping technology is already introduced in Bangladesh, it is not common in the selected riverbank erosion areas. There are three major reasons that the Japanese hazard map is difficult to be used directly.

(1) The rivers and village shapes change often in Bangladesh. Most of the downstream rivers in Japan, where most people live, were fixed with high embankment for protecting people's lives. Since rivers do not change the shape, it makes easy to update maps. Rivers in Bangladesh change the shape every after monsoon, therefore it is difficult to prepare for the updated map.

(2) Local people are not able to interpret maps. One reason which they are not able to interpret is that they do not have opportunity to see local maps. Hazard map is needed to be prepared for the local scale for local peoples use. Though the national map is updated, the local maps, suitable scale for hazard map, are not even prepared. Another reason is the ability of interpreting map. The low literacy rate is related to the education level. Map interpretation skill is usually taught in higher education. The education level in riverbank erosion areas is lower than the average level, and the school dropout rate is higher than other areas. Since most teachers are not able to commute to the schools, and school buildings are inundated or used as evacuation facilities during the flood, children lose opportunity of study for a few months every year. Floods makes difficult for local people to study safely and continuously.

(3) There is enough time to prepare for evacuation. Though they are able to stay inundated area for a few months, they are not able to live as usual by farming. Even though they rely on the fertile soil conveyed

by flood, the situation living in inundated area for a few months is needed to be improved. If the duration living in flood is reduced, it will save their lives from hunger and improve their livelihood.

The hazard mapping technology is considered to be useful also in the research areas. The technology to simulate the possibility of erosion occurrence area is useful to know the longer existing place. As a result, a hazard map in riverbank erosion areas is suitable to be used like land use map, which predict the longer existing areas. For introducing the longer existing areas, support by officials or experts, who are able to interpret the map, is essential.

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