IMPACTS OF POST-DISASTER SLOW REHABILITATION OF A COASTAL POLDER ON COASTAL LIVELIHOODS: A CASE STUDY ON AILA

Tamanna Kabir*[1], Mashfiqus Salehin[2] and Md. Gulam Kibria[3]

[1] *Graduate student, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology , Bangladesh, e-mail: engr.tamannakabir@gmail.com*
[2] *Professor, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: mashfiqussalehin@iwfm.buet.ac.bd*
[3] *Graduate student, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Bangladesh, e-mail: kibriabuet07@gmail.com*

ABSTRACT

Cyclone "Aila" devastated the coast of south-western Bangladesh on May 25, 2009 and caused various socio-economic impacts including loss of lands, damages to infrastructures and loss of coastal resources. The loss and damages were caused by the failure of the coastal polders (enclosed embankments) and continuation of intrusion of saline water. The situation called for accelerated rehabilitation of the coastal polders as the community was suffering extreme immediate loss and damages which were getting even more severe with time. This study is comprised of an evaluation of the implications of embankment failure and delayed rehabilitation of coastal infrastructures to the livelihoods of the coastal communities in a coastal polder of Bangladesh. An interdisciplinary research methodology has been followed throughout the study. The polder breaching locations and the duration of the inundation has been recognized using Participatory Geographical Information System (PGIS). Polder rehabilitation process and impacts on the livelihoods of different vulnerable groups has been investigated through Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). As a result of long term inundation, loss of net cultivable lands was accounted as almost 850 hectares. People lost their access to resources and livelihood bases as a consequence of slower and delayed rehabilitation. Estimated loss of rice production was approximately 29000 tons in the three years after Aila. The day laborers, who used to work in agricultural lands previously, could not manage any work until the agricultural activities were started again. Rehabilitation of shrimp pond and shrimp cultivation was not viable until the polder has been rehabilitated. In such similar storm surge cases, this particular study recommended rapid recovery process instead of conventional rehabilitation program to minimize the rehabilitation time and accelerate livelihood restoration processes.

Keywords: *Storm surge, slow rehabilitation, coastal livelihood, restoration, PGIS*

1. INTRODUCTION

Coastal areas of Bangladesh are vulnerable due to its special geographical settings and susceptibility to different natural hazards. The major disasters in the southwest coastal zone are floods, cyclones, storm surges and riverbank erosion ((Parvin, takahshi and Shaw, 2009). Cyclonic storm surge is the most severe environmental shock faced by coastal community (CCC, 2009). Since distant past, the coastal belt has faced a number of storm surge events of varied intensity. The biophysical changes caused by cyclonic storm surges caused various socio-economic impacts including losses of lands, damages to infrastructures and coastal resources (MOEF, 2009). Low-elevation of coastal areas and their high population density increase their vulnerabilities and sufferings during and after the appearance of a storm surge event. Inundations due to cyclonic storm surges pose threats to lives and properties in the coastal regions of Bangladesh. Bangladesh has 139 polders and most of them were constructed in the 1960s to protect the coast from tidal flooding and to reduce salinity intrusion (Khan, 2014). They reduced the cyclical flooding of the coastal lands during daily high tides and inundations due to other tropical cyclones. When Cyclone Aila devastated the coast of south-western Bangladesh on May 25, 2009 a huge coastal areas were inundated by surge water intrusion due to breaching and overtopping of the coastal polders (UN, 2009). A large coastal area including human settlements and agricultural lands was inundated by massive embankment failures. The major livelihood options in the coastal areas were agriculture, shrimp farming, day labors, golpata and honey collection from Sundarbans, etc. After the cyclone Aila, the livelihood sectors were distorted both immediately and in long term and it severely affected the income opportunities of the coastal communities in long term (Action Aid, 2009). The long term impacts on the coastal livelihoods were the consequences of the delayed rehabilitation of the damaged polders. Until the reconstruction of the broken

embankments, the displaced affected people could not come back to their previous living places and start their traditional livelihood practices. Moreover, the agricultural lands could not be made suitable for further cultivation unless the receding of the salinity from the soil and the water that was deposited during Aila (Rabbani et al., 2013). So the post impacts cyclone Aila demanded the highlighted need for accelerated rehabilitation of the coastal landscape as the communities were experiencing prolonged sufferings from the embankment failure. This study provides an evaluation of the implications of embankment failure and delayed rehabilitation of coastal polder to the livelihoods of the coastal communities.

2. STUDY AREA

Among three polders of Dacope upazila of Khulna district, viz. polder 31, 32 and 33, polder 32 was the most affected polder and hence was selected as the study area. Polder 32 is located in between 89°27′E longitude and 22°37′N latitude, consisting of two unions, namely Kamarkhola and Sutarkhali (Figure 1). The southern part of the area is surrounded by the Sundarbans. The polder 32 has a total area of 7800 ha. It is a tidal floodplain lying under Agro Ecological Zone (AEZ)-13, which is the Ganges tidal floodplain. The landscape of Polder-32 has a combination of plain lands, canals and bevels. The polder is bounded by the Shibsa and the Dhaki (tributary of shibsa) rivers in the west, the Bhadra River in the east and the Dhaki River in the north. All these rivers are fully tidal rivers. These rivers act as both feeding channels and drainage canals for the small river (Nalian) that passes through the polder as well as a number of canals (Gulbonia, Oramukhi, Mistripara, Jaliakhali) within the polder. Major land type of this area is medium high land (flood depth 0.30-0.90 m), followed by medium low land (flood depth 0.90-1.80 m). However, cropping patterns are dominated by aman (monsoon) cropping and fisheries aquaculture in both unions, with a cropping intensity of about 104%, since dry season cropping is severely constrained because of high soil salinity during the dry season. Soil salinity ranges from high to very high (13-30 dS/m) in the dry season. Agriculture dominates the livelihoods of people in both Kamarkhola and Sutarkhali unions, with the distribution of different catagories as: landless farmer- 30%, marginal farmer- 26%, small farmer - 21%, medium farmer - 19% and large farmer- 4% for Kamarkhola union; and landless farmer- 25%, marginal farmer-35 %, small farmer- 17%, medium farmer- 13% and large farmer- 10% for Sutarkhali union (MoL, 2011).

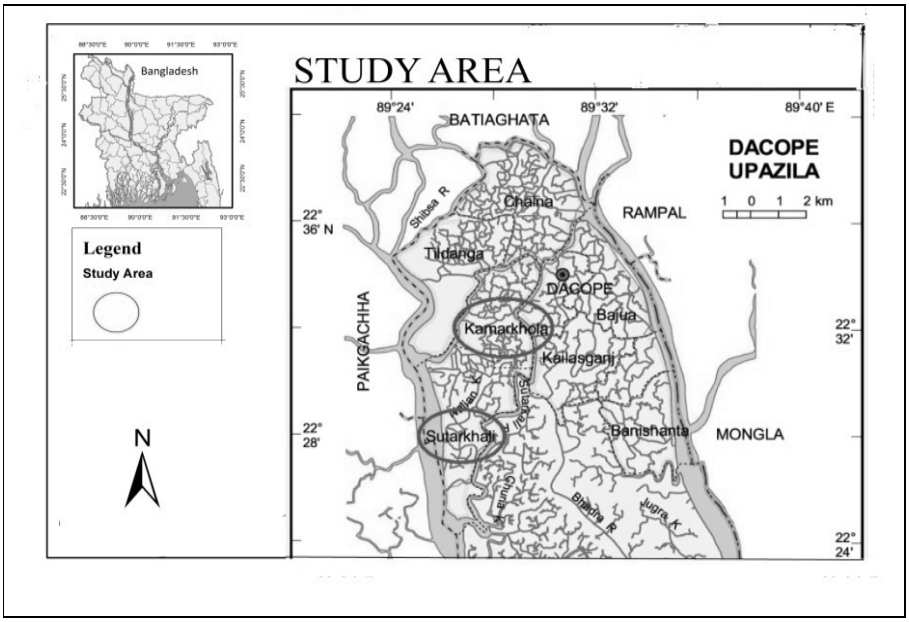

Figure 1: Study area located in the coastal region of Bangladesh (Source: Banglapedia, 2003)

3. METHODOLOGY

Different primary and secondary information have been collected using Participatory Rural Appraisal (PRA) tools which include Focus Group Discussions (FGDs), Key Informant Interviews (KIIs). Participatory Geographical Information (PGIS) system has been used for identification of the breaching locations and information about inundation depth and duration. An interdisciplinary research methodology has been followed throughout the study where four field visits (each of 6 days duration) has been conducted. Polder 32 of Dacope

upazila of Khulna district has been selected as study area as it was the most damaged polder during cyclone Aila. The polder breaching locations and the duration of the inundation have been recognized using participatory geographical information (PGIS) system where some forms of base maps i.e. Google earth images, LGED union maps, canal networks have been used to gather geographical information from local people. Polder rehabilitation process has been explored conducting Key informant interviews (KIIs). Further 15 FGDs with different livelihood groups have been conducted to assess the impacts of rehabilitation time to local livelihoods and long term losses have been linked with the rehabilitation time and process. During impacts analysis a framework has been developed linking rehabilitation time and livelihood resources bases.

4. RESULTS AND DISCUSSIONS

4.1 Damages of Polder at Different Locations

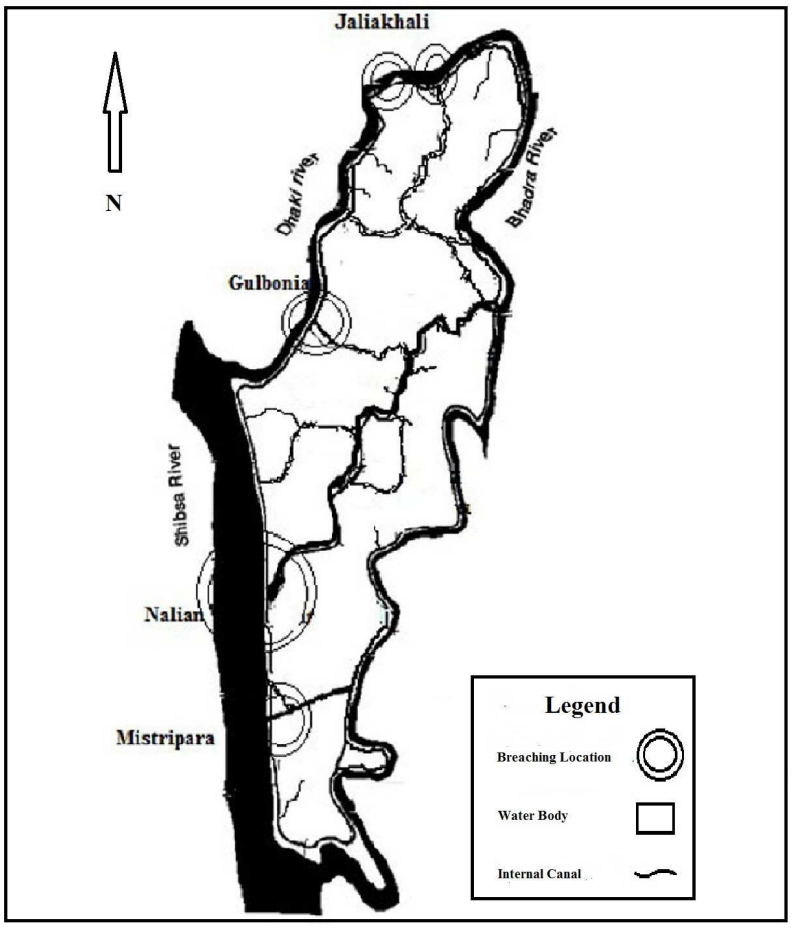

Figure 2: Polder breaching locations

During cyclone Aila, Polder 32 was breached at different locations. Major breaching locations have been shown in PGIS maps (Figure 2). During the study it has been found that, an eight vent regulator was breached at the mouth of the Nalian River, which was previously a channel within the polder. This narrow channel turned into a branch of the Sibsa River after breaching during Aila. It has been found that, two other embankment failures occurred at Polder 32 at tips of former tidal channels. Situation worsened while the scouring at the toe of polder accelerated and deepened at the breaching location during daily high tides and low tides. As the time elapsed, the breaching locations enlarged up to a width of 20 to 22 meters while it was 3 to 4 meters initially. Local people reported about even wider breaching in the study area. Polder was overtopped during Aila in few places which also caused washing out of the embankments and other severe damages.

4.2 Inundation Scenarios

Polder breaching-induced prolonged inundation was the post disaster scenario of storm surge Aila. Immediately after Aila, the whole area remained exposed to continuous inundation by daily tidal actions. As the starting of the rehabilitation and reconstruction work of the polder took more than a year, the area was exposed to regular inundation during daily tides and water was logged in some natural and man-made depressions longer than the anticipated time. Figure 3 shows that the entire area of Polder 32 was completely submerged under saline water for more than first six months. In 2010, water receded from many parts of Kamarkhola union by natural drainage after construction of the closure (reconstruction of the damaged part of polder) in March 2010. As there were a number of natural and man-made depressions in Sutarkhali union, some of the depressed areas were still water logged. In 2011, the Kamarkhola union was fully free of water logging and so was most of the Sutarkhali union unless a small amount of dead storage in some of the natural depressions.

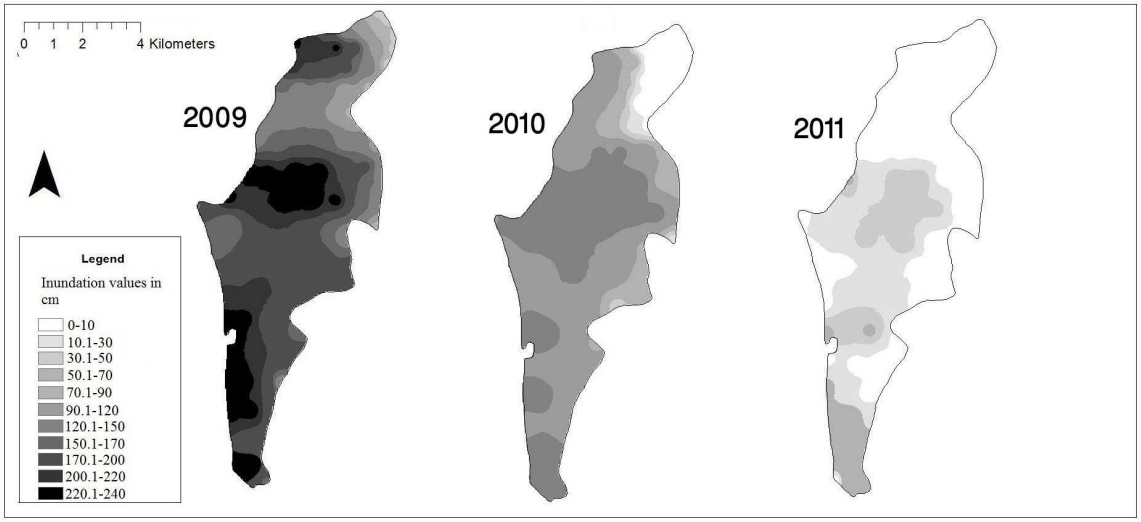

Figure 3: Inundations during different years after Aila

4.3 Delayed polder rehabilitation process

Key informants told that until the water receded by a certain amount the rehabilitation process couldn't be started. Bangladesh Water Development Board (BWDB) started polder rehabilitation programme. Polder rehabilitation included the repairing of the broken embankments and the reconstruction of the sluice gates. Under the coastal embankment rehabilitation program funded by World Bank, rehabilitation work was started and infrastructural development was finished by the following year of Aila on August, 2010. Construction of 3.2 km of retired embankment along with the renovation of 56 water control structures was done in the first phase of the rehabilitation program. Also six new flushing cum drainage sluices have been constructed to get the area free from submergence. Thus while the Authority thought to construct retired embankment (ring embankment at the both side of the river), it was too late as within this time all breaching location has been widened by 10 to 12 times of the original breaching width. The embankments reconstructed within August 2010 faced consecutive failures due to regular tidal exposure which made the recovery process even slower.

Despite massive reconstruction efforts, it took more than a year to reconstruct and repair the damaged polder and damaged water control structures. But the conventional approach of rehabilitation process became ineffective in some cases as the damage scenario worsened due to longer period of exposure of this area. Consecutive failure of the repaired embankment and delayed rehabilitation further aggravated the damage scenarios which in turn made the recovery process slower and difficult. As a result people suffered from inundation of the human settlements longer period of time, losing access to productive resources, loss of livelihoods and income.

4.4 Linking polder rehabilitation time with livelihood of different vulnerable groups

As conventional rehabilitation failed and rehabilitation of the polder delayed, the period of submergence of agricultural lands increased and significantly reduced the access of the people to productive resources (land). Lack of immediate efforts of rehabilitation not only worsened the damage scenarios but also made rehabilitation

process even more difficult and costly. The prolonged impact of the aforementioned facts was the prolonged sufferings of different livelihood groups. Inundation over prolonged periods was the main reason behind the persistent sufferings of people even after the physical systems were rehabilitated. Local communities were impacted by the storm surge hazard immediately after the Aila; however, the differential impacts depended largely on the rehabilitation time, duration of inundation and the subsequent degradation of soil quality. The major vulnerable groups', viz. farmers, shrimp cultivators, fisherman, wage labour and Sundarbans dependent group, as identified through field reconnaissance survey, experienced different degrees of impacts and vulnerabilities which have been discussed in the following sections.

4.4.1 Impacts on Farmers

The linkage between the polder rehabilitation time and the livelihoods of farmers has been shown in the Figure 4:

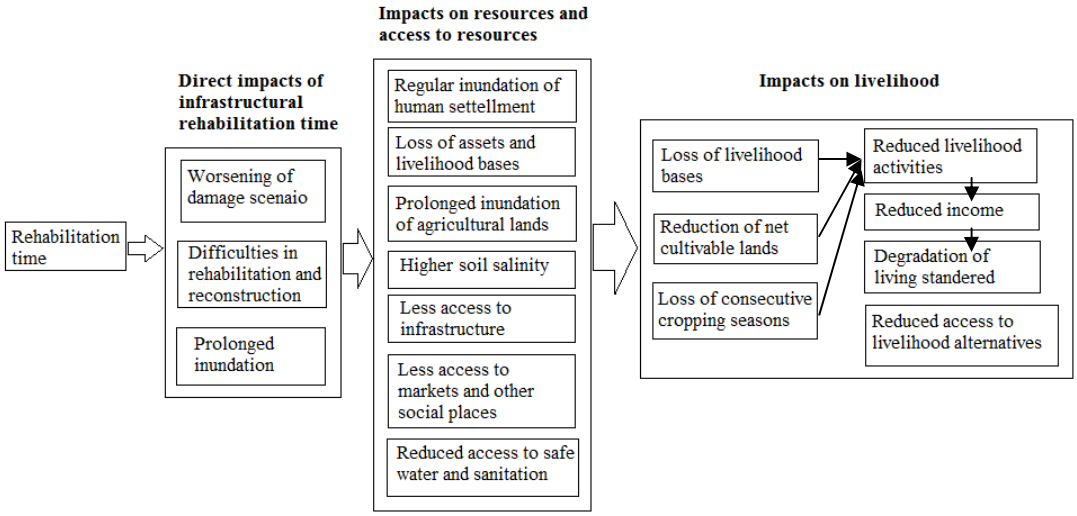

Figure 4: Linkage of rehabilitation time with the livelihood of farmers

The degree of impacts on the farmers' livelihoods depends on a number of factors, including capital loss, access to land resources and soil quality. All these factors are functions of duration of inundations which is directly linked with the rehabilitation and the reconstruction of the polder. The infrastructural renovation of Polder 32 fully settled the restoration of the polder landscape but the productive use of the land like crop cultivation and livelihood activities were not possible. After the construction of the retired embankment at both side of the Nalian River and the construction of closure at the breached locations of polder, agricultural lands were free from submergence. But the restoration of the productive use of the agricultural land like crop cultivation and other livelihood activities were not still viable due to increased soil and water salinity. Inundation induced soil salinity took an additional monsoon to leach out the salt from the soil surface. As a result people lost consecutive four cropping seasons. Production losses of three to four years due to inundation followed by adverse condition of land and soil salinity caused an estimated loss of 7,20,000 mounds of rice production in three years. Large farmers counted a huge amount of production loss as they have large size of cultivable lands and had to keep fallow for at least three years. Estimated loss for the large farmers in term of production loss was much higher compared to other livelihood groups. The impact was much severe to small and marginal farmers because of not only keeping lands fallow and losing production but also losing their alternative livelihoods in crop harvesting seasons. Losing the last piece of cultivable land, many small and marginal farmers had to migrate to other places to earn their living. People lost all possible means of income as agriculture was their main occupation. In some cases, livelihood restoration for farmers couldn't be accelerated because of capital losses due to loss of crop production. Significant reduction in livelihood options resulted in reduced income and lowering of the living standard. Many landless farmers had to stay on embankment as they had no financial capability to repair their earlier settlements. Also people faced problems regarding less access to fresh water. There were very less initiatives of livelihood rehabilitation by other means besides structural renovation. As a result people couldn't get the advantages of infrastructural development immediately. Also people suffered from persistent food insecurity in long run as a result of longer rehabilitation time and long-term inundation induced livelihood insecurity.

4.4.2 Impacts on Fisherman

The linkage between polder rehabilitation and livelihoods of Fisherman has been shown in the Figure 5.

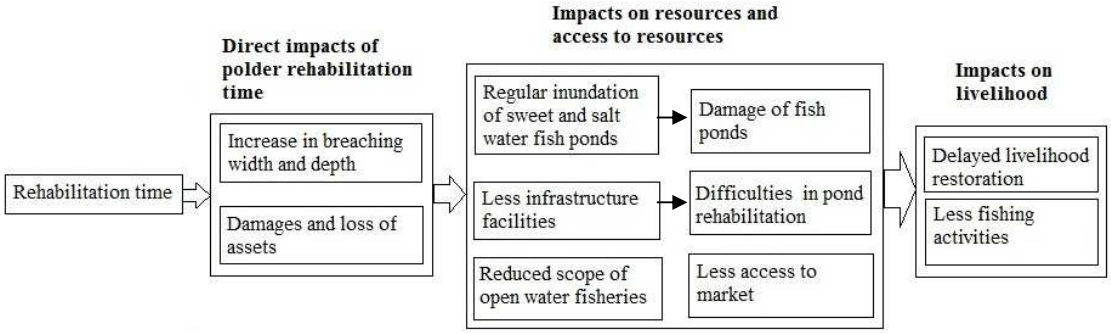

Figure 5: Linkage between polder rehabilitation time and impacts on fisherman

Fishing is an another dominating occupation in the study area. Fishing dependent community suffered more, especially pond fisheries (shrimp cultivation and sweet water pond) were stopped. Cyclone Aila affected a huge number of people and among them about 60% of the people were directly dependent on shrimp and sweet water fish farming in Kamarkhola and Sutarkhali unions. Salt water and sweet water fisheries were not possible for more than 2 years because of continued inundation of the sweet water fish ponds and shrimp ponds (ghers) due to broken embankment and persistant water logging induced by Aila. It demanded better infrastructural facilities with higher investment cost (taka 40000/pond) to restart pond fisheries. Many small scale pond fishing groups counted a complete loss due to wash out of the fish ponds due consecutive polder breaching. Normal River fishing for the fisherman was also difficult due to loss of fishing boat which cost taka 20000 to purchase. According to local fisherman, there were plenty of fish in the nearby water bodies and rivers after Aila. But losing their fishing net and boat they couldn't go for river fishing. Due to less scope of fishing activities huge human capital remained unemployed. Because of reduced income generating activities they were not financially capable to repair their houses and settlements. As a consequences of delayed and troublesome rehabilitation actions people of the Sutarkhli union lost their access to markets and other facilities slower the financial activities tof the fishing he livelihood groups of that particular area by restricting fish trading in the local markets.

4.4.3 Impacts on Sundarban-dependent Groups

Sundarbans dependent people practice diversified livelihood activities. Golpata collection, shrimp fry collection and fishing near the Sundarbans are their main livelihood activities. Golpata collection and fishing in the Sundarban are two most common livelihood activities that people practice to earn their living. There were very few local golpata collectors and traders. Most of the golpata traders lived outside that area and local people used to work on their boat as a labour and collector. Very few large farmers of the area have golpata collecting boat which costs almost taka 200000. All boats owned by the local people had been washed away immediately after Aila. After huge losses for long term sufferings it was quite difficult to purchase a new one. Livelihood restoration for them was more difficult. People who used to earn their living by fishing on Sundarbans had to suffer by losing their fishing boats and nets. They had to work for fish traders and get very small remuneration for this. Those aforementioned facts obstructed their livelihood activities and reduced their financial capacity and eventually degraded their living standard. Conventional infrastructural rehabilitation failed to restore the livelihoods of that people directly. Recovery of those people from livelihood insecurity demanded innovatively designed livelihood recovery programme beside polder rehabilitation and reconstruction.

5. CONCLUSIONS

Difficulties in livelihood restoration increased with the rehabilitation time. Simultaneously, people's response time to recover from shock also increased. Among different livelihood groups, farmers were the major livelihood group who suffered higher degree of impacts of slow polder rehabilitation. Also, people who are dependent on pond fisheries had to struggle a lot to restore previous livelihood practices. Rehabilitation of the polder and securing access to livelihood resources was an important factor in restoring livelihoods. The ecosystem restoration time is also an important factor in livelihood restoration process in the coastal areas of Bangladesh. It can be concluded that the livelihood restoration time was a function of infrastructure renovation time, ecological condition and access to resources and restoration cost as well. In this particular study finding

highlights need for the least possible structural renovation time as well as innovatively designed rehabilitation program. In such similar storm surge cases, this particular study recommends innovative recovery process in place of conventional rehabilitation program to minimize the rehabilitation time and accelerate livelihood restoration processes. Improved management of natural resources like land, water, soil nutrients should focus on reducing livelihood vulnerability.

ACKNOWLEDGEMENTS

This paper is inspired by the research activities of the IDRC-SAWA fellowship program of Institute of Water and Flood Management at Bangladesh University of Engineering and Technology.

REFERENCES

Action Aid (2009). *In-depth Recovery Needs Assessment of Cyclone Aila Affected Areas.* http://reliefweb.int/sites/reliefweb.int/files/resources/F6603B7EF22A16B4C125768D004B1190-Full_Report.pdf

Auerbach, L.W. (2015). Flood risk of natural and embanked landscapes on the Ganges–Brahmaputra tidal delta plain", *Nature Climate Change*, Published Online: 5 January 2015, Doi: 10.1038/Nclimate2472bbs.

BBS, (2001). "Information on Khulna and Satkhira District", Community Series, Bangladesh Bureau of Statistics, Dhaka, Bangladesh.

CFPR (2013). Centre for Participatory Research, Bangladesh. *Local Perspective on Loss and Damage in the Context of Extreme Events: Insights from Cyclone affected Communities in Coastal Bangladesh.*

DFID (2009). *Participatory Geographical information System: Environmental Mainstreaming Initiatives*. Paper No 7.

Government of People's Republic of Bangladesh. *Bangladesh: Strategic Program for Climate Resilience (SPCR)* (2010). Prepared for the Pilot Program for Climate Resilience (PPCR). Retrieved from: http://www.lged.gov.bd/UploadedDocument/PublicInformationFileGallery/10/Due%20Diligence%20Market.pdf

Government of the People's Republic of Bangladesh (2009). Department of Environment, Ministry of Environment and Forests Climate Change Cell. *Climate Change, Gender and Vulnerable Groups in Bangladesh*. Component 4b.

Government of the People's Republic of Bangladesh (2009). Ministry of Environment and Forests. *Bangladesh Climate Change Strategy and Action Plan 2009.*

Government of the People's Republic of Bangladesh (2011). Ministry of Land. *Land Zoning Report: Dacope Upazila, Khulna District.*

Jayasinghe, A., Mahanama, P. K. S., Senanayake, L., Bandara1, L. and Seifert, I., (2013). *Participatory GIS (PGIS) as a Tool for Flood Mapping in Climate Change Adaptation: A Study of Batticaloa City, Sri Lanka.* Paper presented in the European Climate Change Adaptation Conference (EECA), Norwegian Institute for Water Research (NIVA), Norway.

Khan, Z. H. (2014).Tidal River Management (TRM) in the Coastal Area of Bangladesh. IWM, Bangladesh.

Parvin, G. A., Takahashi, F. and Shaw, R. (2009). Coastal hazards and community coping methods in Bangladesh. *International Journal of Coastal Conservation*. 12(4), 181-193.

Rabbani, G., Rahman, A., and Mainuddin, K. (2013). Salinity-induced loss and damage to farming households in coastal Bangladesh. Int. J. Global Warming, 5(4), 400-415.

Sarkar, S., Kuri, K.C., Chowdhury, S.M. and Rahman, M.T. (2010). Mangrove : A Livelihood option for the coastal community of Bangladesh. Bangladesh research Publications Journal. 3(4), 1187-1192. Retrieved from http://www.bdresearchpublication.com/admin/journal/upload/09130/09130.pdf

United Nation (2010). *Cyclone Aila joint UN Multi-sector Assessment & Response Framework: In-depth Recovery Needs Assessment of Cyclone Aila Affected Areas*. Retrieved from http: http://reliefweb.int/sites/reliefweb.int/files/resources/F6603B7EF22A16B4C125768D004B1190Full_Report.pdf.