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Infrastructure Rehabilitation Intervention for Reducing Natural Disaster Damages in the South-West Coastal Bangladesh

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Abstract

Disaster is a common phenomenon in the world and rehabilitation after disaster is emergency to bring their normal life pattern and reduce the risk of future disaster. There is no prior information about infrastructure rehabilitation as an intervention after disaster in Bangladesh. This study was conducted in 3 unionsofpolder 31 of DacopeUpazilla, Khulna, Bangladesh. The findings of this study were assessed through survey in questionnaire form and FGD of 100 people in each union. The data obtained through questionnaire survey and FGD were recorded and analyzed using the Statistical Package for the Social Sciences software to build up the final output. The socio-economic condition and disaster perception were assessed through descriptive statistics. The rehabilitation condition of the infrastructure was not sufficient to reduce the worst situation of the people. There are lacking in rehabilitation of embankment (beribundth), sluice gate, permanent slope protection, cyclone shelter and canal re-excavation. So, the agricultural production, drainage condition, prevention of salinity intrusion is not good at all and result in less yield and water logging condition. So, it is needful toappropriate and permanent rehabilitation of infrastructure and its proper management which makes the protection system more sustainable.

Keywords:Infrastructure rehabilitation; Intervention; Natural disaster damages; Coastal Bangladesh

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1. Introduction

Bangladesh is a disaster prone country and its coastal belt is highly vulnerable. The South-western coastal regions of Bangladesh is most vulnerable to different natural hazards. Cyclones, storm surges, river bank erosion, flooding is more severe which result in loss of lives, livelihoods and property [1]. In coastal Bangladesh, poldering system have been developed to control flood, cyclonic surges and salinity intrusion as well as to ensure food security.

Disaster is a "serious disruption affect the functioning of a society, causing widespread human, material, or environmental losses and exceed the ability of the affected society to cope with the horrible situation using only their own resources [2]. *Parker* (1992), identified disaster as an unusual natural or man-made event, including an event which can caused by the failure of technological systems, temporarily overwhelms the response capacity of human communities, groups of individuals or natural environments and which causes massive damage, economic loss, disruption, injury, and loss of life.

Natural disasters are increasingly seen as a major constraint for sustainable development, noted in most of the regional reviews on the implementation of Agenda 21, prepared during 2001 in preparation to the World Summit on Sustainable Development [5]. These disasters are definitely increasing due to such factors as rapid urbanization, population growth, poverty, destruction of the natural environment and climate change. Billions of people in more than 100 countries are periodically exposed to at least one natural disaster and there are around

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30 identified natural disasters worldwide [7]. In developing countries human suffering is more acute especially those that are severely indigent [4]. In the decade 1900-1909, natural disasters occurred 73 times, but in the period 2000-2005 the number of occurrences rose to 2,788 [7]. In the first decade of the 21st century, an average of almost 255 million people each year was affected by natural disasters an increase of more than 25% compared with the previous decade. Among them earthquakes and droughts are the biggest killers. Besides, floods and storms are hazards that affect most people. The population density in the coastal area is highly dense because of availability of natural resources. Globally, 1.2 billion people (23% of the world's population) live within 100 km of the coast and approximately 2.5 billion or 50% are likely to do so by 2030. During the last four decades, economic losses have increased more than ten times in each decade due to disaster effect[6].

Disaster Risk Reduction (DRR) is the conceptual framework of elements considered with the possibilities to reduce vulnerabilities and disaster risks throughout a society, to avoid or to limit the undesirable impacts of hazards, within the broad context of sustainable development [8].According to UN International Strategy for Disaster Risk Reduction [9], is the concept and practice of reducing disaster risks through systematic efforts to manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Rehabilitation/Build back better is defined as the restoration of facilities that have deteriorated over time due to inadequate regular maintenance. The rehabilitation phase typically starts at the end of the relief phase and may last for several years. It can be undertaken by governments, civil society, international and/or non-governmental organizations (NGOs). Recovery and rehabilitation is approved out of weeks and months after the disaster. It involves the re-establishment of basic services (e.g., communications, commuter transportation, electricity for homes), infrastructure (e.g., roads and bridges, schools), and livelihood. The phase is not only to restore what existed previously but also to set communities on a better and safer improvement path and to facilitate resilient recovery[1].Thus,the study was conducted to identify the disaster risk reduction intervention through infrastructure rehabilitation which can help to the improvement of agricultural production as well as to remove salinity intrusion and develop the livelihood pattern of the coastal people.

The specific objectives are as follows-

i. To identify interventions of infrastructure rehabilitation
ii. To assess overall condition of coastal people

2. Materials and Methods

2.1.Selection of study area

The area of this study were selected toTildanga and Pankhali union and Chalnapourasauva of Dacopeupazilla, Khulna district, Bangladesh (Figure 1). The study area is situated in the south-western coastal region of Bangladesh which is highly disaster prone in nature. As the Tildanga union is located along the mouth of Shibsa and Dakhiriver, Pankhali union along the joint of JhapJhapia and Bodhra river and Chalnapourasauva along the bank side of Posur river, almost every year natural disasters pay visit to this region. Besides this, river bank erosion is also a huge damaging event in the study area. However, this area is selected considering the following criteria;Data availability and Vulnerable to disaster.

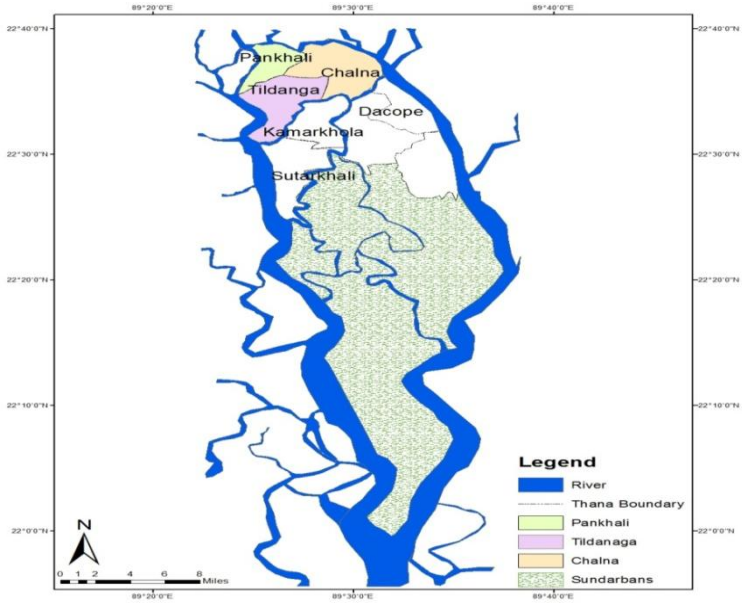


Figure 1.Location map of the study area (Tildanga, Pankhali union and Chalnapourasauva of DacopeUpazilla)

2.2 Soil characteristics

The study areas consist of river eroded silt soil.Sandy soil was found in river bank.

2.3 Climate characteristics

Ten year difference temperature characteristics and yearly rainfall (mm) pattern in the study area (Table 1; Figure 2).

Table 1. Seasonal climate characteristics in the study area

Season	Months	Characteristics
Summer	March to May	Hottest, dry and maximum evaporation
Monsoon	June to October	Highest rainfall, wet and high humidity
Winter	November to February	Cool, dry and low wind velocity

(Source: Interim Report, KDA, 2010)

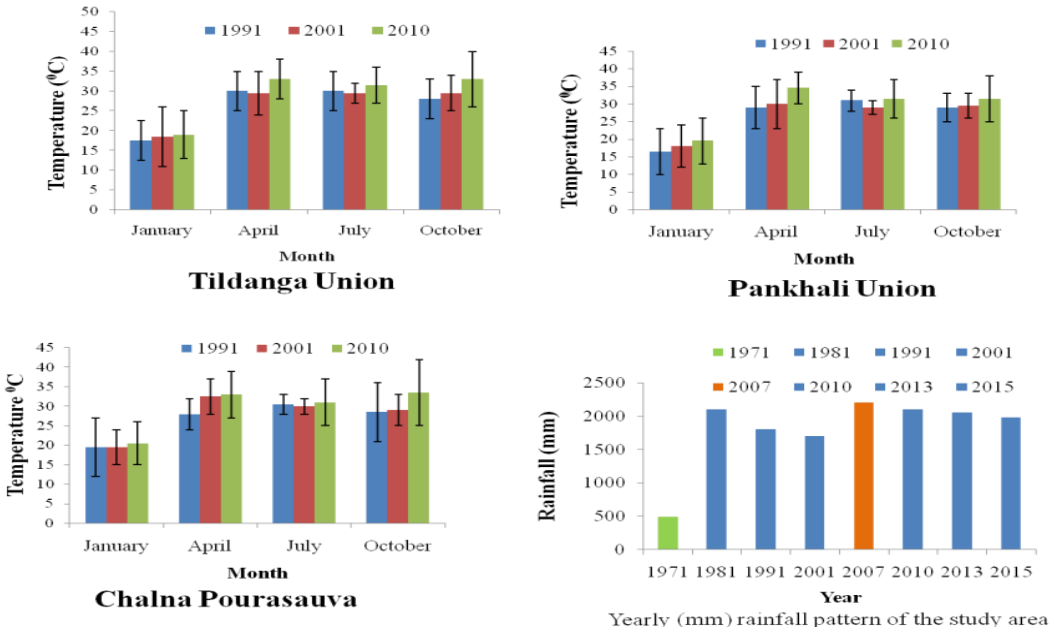


Figure2.Temperature and yearly rainfall (mm) pattern (10 year difference) in the study area

2.4 Salinity

Salinity level in the study area before Aila 2001, after Aila 2011 and at present 2016 (Table 2).

Table 2.Salinity level in the study area

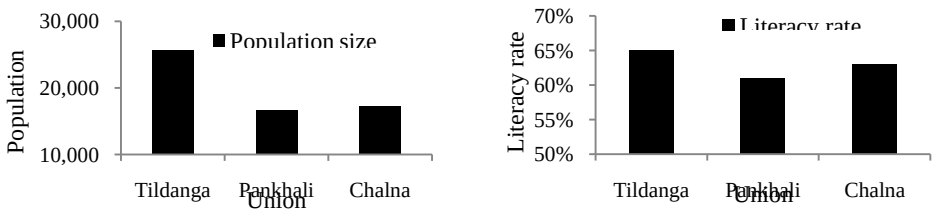
Union	Before Aila 2001 (ppt)	After Aila 2011 (ppt)	At present 2016 (ppt)
Tildanga	8-22	10-25	2.5-8
Pankhali	2.5-8	8-14	2.6-8
Chalna	8-22	12-29	4.5

(Source: Agricultural Extension Office, DacopeUpazilla, Khulna, Bangladesh)

2.5 Vegetation covers and Biodiversity

Cultivation land in Tildanga union, Pankhali union and Chalnapourasauva were 3370, 2210 and 758 hectares respectively. There exist some tree species of mangrove ecosystem as Golpata, Gewa, Goran, Sundari, Keora, Byne etc. The main crops are paddy, potato, turmeric, onion, garlic etc. and the main vegetables are tomato, bean, eggplant, turnip etc(Source:DacopeUpazilla animal estate and fisheries office).

2.6 Demographic features and educational status (Figure 3)



(Source: Education Office, DacopeUpazilla, Khulna)

Figure3.Relationship between population size and literacy rate

2.7 Socio-economic status of the study area (Table 3)

Table 3.Occupational status in the study area

Area / Occupation	Tildanga	Pankhali	Chalna
Agriculture	52.35%	45%	43.75%
Fishing	3.98%	5.45%	6.83%
Pisiculture	4%	4%	5%
Agricultural laborer	15.27%	12.50%	18.28%
Wage laborer	6.24%	7.50%	9.45%
Commerce and service	12.23%	18.63%	14.29%
Others	5.93%	6.92%	2.40%

(Source: Field survey, 2016)

2.8 Reconnaissance survey

Before data collection a reconnaissance survey has been conducted in the study area to understand existing situation. In order to get a view of the social, economical, environmental and physical condition of the study area, a reconnaissance survey was initiated to acquire some basic ideas regarding to the disaster risk in the study area, impact of disaster, different disaster risk reduction mechanism, and overall livelihood pattern in the study area. The survey helped to select the sampling unit, sampling method, questionnaire survey etc.

2.9 Questionnaire design

2.9.1 Draft Questionnaire preparation

Questionnaire Survey and Focus Group Discussion (FGD) is the primary element for collecting the primary data. At first a clear draft questionnaire was prepared. It was prepared both open and close ended questionnaire to conduct the interview of the household member in the study area.

2.9.2 Questionnaire survey

Simple random sampling has been applied as sampling procedure.100 respondents from each union were selected randomly. So, a total of 300 respondents were selected for questionnaire survey.Data has been collected mainly through questionnaire survey-2016. Focus group discussion was also conducted among the people of the study area. Each group consisted of 10 to 20 people of different profession including the people of the study area.

2.10 Data collection

Primary data were collected through questionnaire survey and FGD and secondary data were collected from previous studies including books, journals, review of published literature on the concerned topic, and internet searching.

2.11 Data Analysis

Data collected from questionnaire survey and FGD were compiled and recorded on Microsoft Office Excel spread sheets. The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software (Version 21). The results were represented as table and graphically.

3. Results and Discussion

3.1 Frequency of common natural disaster

As the study area was located in the coastal area so, it was a disaster prone region. Almost every year different types of disaster visit this region. This type of disaster causes huge loss of house, crop yield as well as livestock. Among the disasters cyclone, storm surge and river bank erosion is more important. Most of the place in the study area becomes flooded due to river erosion and cyclonic storm surge. This type of disaster occurs in different times of the year which we can see from the following table 4:

Table 4.Disaster calendar in the study area

Name of disaster	Month											
	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cyclone												
Storm surge												
RB erosion												
S. intrusion												
Water logging												
Thunderstorm												
Lack of PW												
Earthquake												
Kalboishaki												

Note: RB=River bank, S=salinity, PW=Potable water

The personal concern of the respondents about the disasters is different in different areas. In the areas someone is highly concern, someone is moderately concern and someone is low concern about the disasters. The following table 5 shows the respondents perception about different types of disaster:

Table 5.Respondents concern about different disaster

Name of Disaster	**Percentage of respondents**		
	Tildanga	**Pankhali**	**Chalna**
Cyclone and induced surge (HC)	45	58	60
River bank erosion (HC)	35	25	15
Salinity intrusion (MC)	10	10	10
Water logging (MC)	5	4	10
Drought (LC)	5	3	5

Note: HC=Highly Concern, MC=Moderately Concern, LC=Low Concern

The data was collected through questionnaires in different villages of the study area. Most of the respondents stated that, cyclonic storm surge and river erosion are their almost regular phenomenon. Salinity prevails in water and soil almost throughout the year but remains sometimes in a limited range which become suitable for agricultural production but not for drinking. Water logging occurs during rainy season due to reduce the water flow in the river. Drought can occur in different year and persist only for a few months and for this it is less concern for the respondents.

3.2 Infrastructure rehabilitation in the study area

Rehabilitation of infrastructures is necessary as the embankment is broken and other infrastructures remain in lumber condition. In the study area the following rehabilitation and construction program has been completed to reduce disaster risk in the last 7 years. Summary of rehabilitation activities in the study area during the last 7 years (Table 6).

Table 6.Infrastructure rehabilitation activities

Year	Name of location	Name of activities	Length (km) of rehabilitees
2013-14	Khaminibashia, Tildanga	Repair of embankment	0.140
	Arakhali, Tildanga	Alternative dyke	0.210
2014-15	Khona, Pankhali	Ring dyke	0.340
	Jalbunia, Pankahli	Alternative dyke	0.300
	Khaminibashia, Tildanga	Do	0.570
2015-16	Khaminibashia, Tildanga	Alternative dyke	0.340
	Jalbunia, Pankahli	Do	0.500
	Khona, Pankhali	Do	0.180
	Gainbari, Tildanga	Do	0.090
	Gainbari, Tildanga	Repair of embankment	0.080
	Arakhali, Tildanga	Alternative dyke	0.150
	Khaminibashia, Tildanga	Do	0.240
	Khaminibashia, Tildanga	Repair of embankment	0.250
	Khalisha, Chalna	Alternative dyke	0.170
	Lakshimikhola, Pankhali	Do	0.180
	Moukhali, Pankhali	Do	0.195
	Gainbari, Tildanga	River slope protection work	0.690
Year	Name of location	Name of activities	Number of rehabilitees
2011-12	Tildanga, Pankhali,	Repair of sluice gate	7
	ChalnaTildanga,Pankhali	Repair of water drainage infrastructure	11
	Tildanga, Pankhali	Canal re-excavation	4

Rehabilitation of infrastructures by BWDB and other organizations

Among the rehabilitation programs we can consider the several ones. Here we can give the first priority on embankment rehabilitation.

3.3 Benefit from existing infrastructure and loss from infrastructure damages

The figure 3 represents the benefit from embankment rehabilitation, river slope protection work, sluice gate and loss from damages of this infrastructure. In the case of figure 3(A), most of people in the study area respond that after proper management of embankment they get the highest benefit as easy communication (EC) and prevention of saline water intrusion (SWI), besides get the benefit of flood mitigation (FM) and sometimes a part of income generation (IG). But when the storm surge height is more, the embankment becomes destroyed and the damages overcome the normal level. From figure 3(B), as there is no permanent slope protection work so, they get the lowest benefit from river bank erosion (RBE). But, they get benefit from loss of cultivable land (LCL), loss from house and livestock (LHL) and saline water intrusion (SWI) prevention to some extent. But, most of the benefit is not satisfactory according to their requirement. In figure 3 (C) as the sluice gates are not repaired and maintained properly so, they get less benefit during flood, water logging and highest intensity of storm surges but the gates maintain the normal flow of high tide and low tide (HTL).

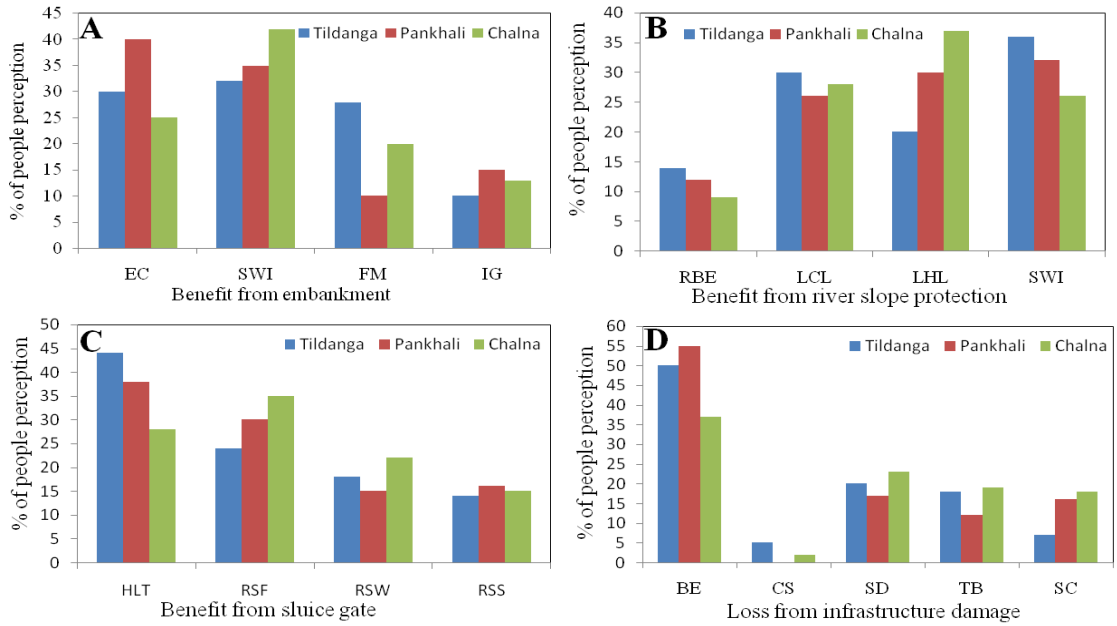


Figure 3. Percentage of people perception about the infrastructure

Sometimes the infrastructure (embankment) damages to provide protection against disaster, sluice gate, and culvert do not work properly to protest high intensity storm surges, reduce the intensity of flooding (RSF), reduce the severity of water logging (RSW) and canals are not capable to store rain water. In this situation some damages can occur of which saline water intrusion and water logging condition becomes more serious in the study area. Flooding is not permanent but creates in water logging which result in agricultural losses and is also serious problem. Figure 3 (D) represents the overall loss from infrastructure damages including breaking of embankment (BE), damages of cyclone shelter (CS), sluice gate damage (SD), toilet breached (TB) and damages of slope condition (SC).

3.4 Factors affecting rehabilitation

Rehabilitation activities of the study area can be affected by different factors including age, experience, education, gender etc. From the figure 4 it is clear that, among all the three areas those people are within the age of 17-30 years involved in rehabilitation activities as they are in younger age. People who are in 8-12 years' experience can easily take part in the rehabilitation program and where primary passed people involved more. In this case it is seen that male people involved more than female but the contribution of the female is not less to some extent. From the point of financial support the contribution of NGOs is more than GOs as the govt. authority is less aware about the people's worse condition. Most of the people in the study area respond that disaster can hit the area within 5 years difference and during disaster there also need the rehabilitation activities. Above all, all of these factors affect the rehabilitation programs positively or negatively.

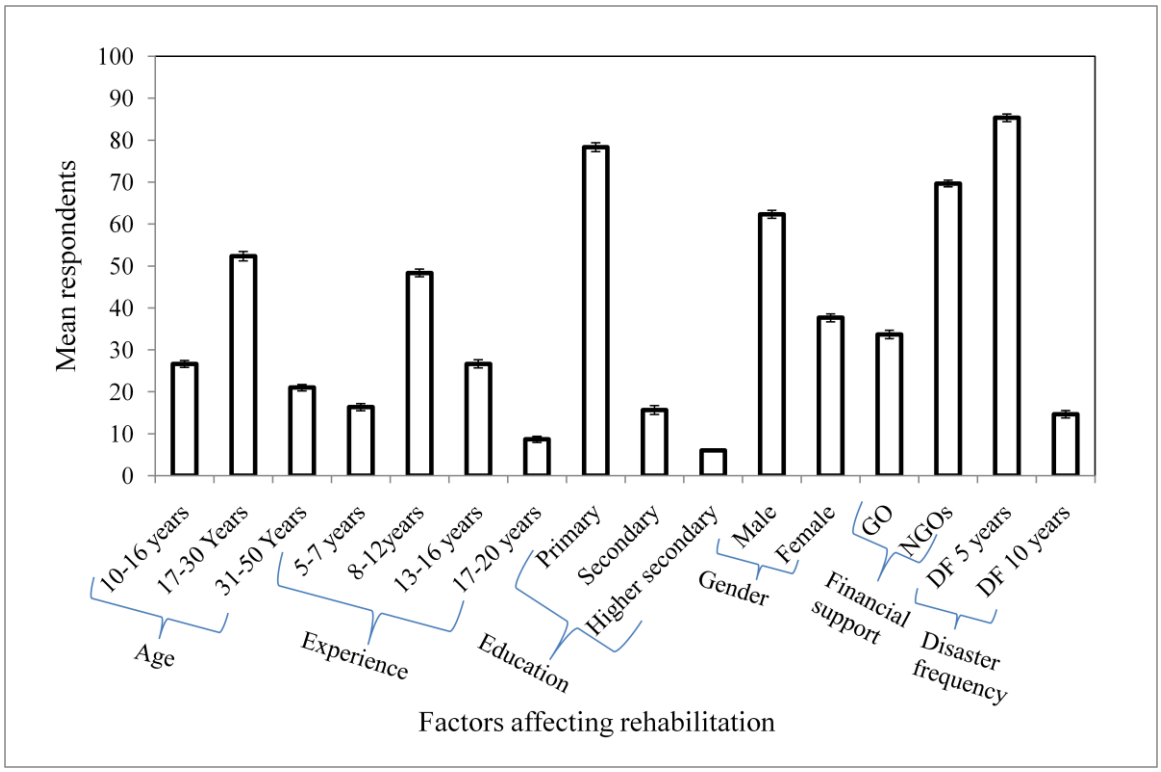


Figure 4.Factors affecting rehabilitation activities

3.5 Involvement in rehabilitation activities

In Tildangaunion approximately 60% people respond that, they had participated in the recovery program after last disaster and almost every time they do participate in the embankment recovery due to river bank erosion. Sometimes they do this work in exchange of monetary support. In Pankhali 50% people work in such activities. Sometimes, they have done this work with their own support, neither from Govt. or non-govt. organizations. In Chalna almost 35% people become involved in such activities. They do this in exchange of monetary support from the associated organizations. In maximum case this work has been done from the support of BWDB. They mainly involve in the construction of alternative embankment, canal re-excavation and slope protection work. Different other non-govt. organizations become involved in this case. Almost 40% women become participant in such activities.

3.6 Problems faced for water logging condition

Water logging is a common problem as there are many low lands in the study area. During disaster when storm surge height overtop the embankment and polder and stay for a long period then water logging condition exist. Closing and siltation of canals are another cause. During that period people face the losses which are focused in the below table. Almost all the area suffers the losses. To combat with the situation people take the activity understood in the above figure. In the figure B it is clear that, people of the study area take different technology i.e. applying crop variety, boat/vela for communication, some preserve food while other do not and other (Table 7).

Table 7.Water logging condition problems

Problems / Area	Loss of crop (%)	Late cultivation of crop (%)	Water borne disease (%)	Hamper normal life (%)
Tildanga	26	28	19	27
Pankhali	31	24	30	15
Chalna	23	32	21	24

3.7 Damages of toilet facilities during disaster

During disaster people also face toilet damages besides the infrastructure damages. In the study area it is seen from the figure 5 that, those toilet are earthen become fully breached and those are concrete become half breached or blocked in water. In Tildanga and Pankhali union the highest number of toilet become breached and

in Chalnapourasauva maximum toilet become blocked in water. However, most of the people suffer the toilet damages during disaster and they do not get repair facilities after disaster period quickly.

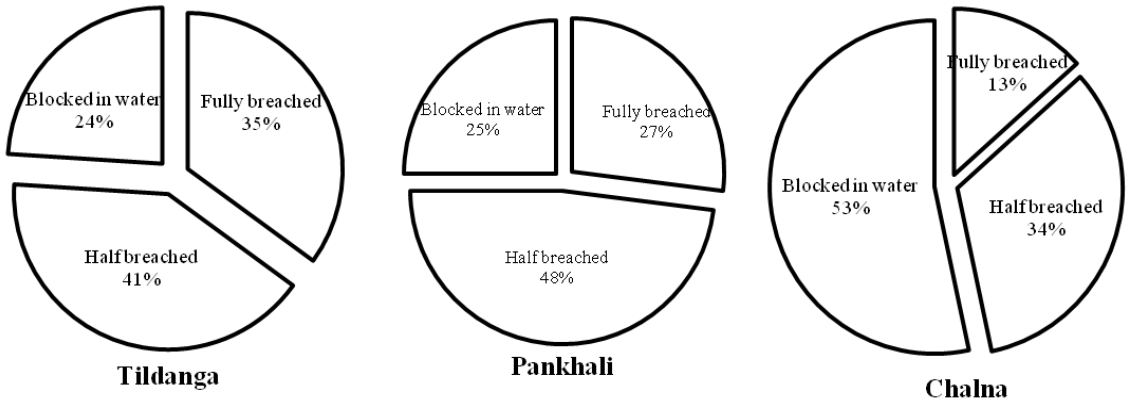


Figure5.Damages of toilet facilities in disaster period

3.8 Maintenance of infrastructure

Proper management of infrastructure in the study area is very difficult. The main responsibility of maintaining the infrastructure is put on the Bangladesh Water Development Board (BWDB). But, the maintenance activity remains weak as reported by the respondents and observed by the field survey.They do not employ appropriate person to maintain the structure. They do not maintain the embankment but do some repair work to maintain road connectivity.

The union parishad (UP) chairman plays great role in maintaining the infrastructure. He/she has vast knowledge about the local problems and holds authority to resolve the problems. The UP is largely involved in repair work and often spends their resources and tries to get fund from the Government (UNO). Sometimes the UP cooperates with BWDB to repair embankment and allocate fund from UP budget. So, this is an indication that the UP can do better if they has more resources.

Different NGOs including BRAC, ASA, Shushilan, Prodipan, Rupantar, Addin, Nijera Kori, World vision, Adams, Ashroy, Heed Banglades, DSK, Grameen Bank, HEED Bangladesh are actively involved in various local level development and disaster mitigation programs. This include anti shrimp movement, micro-finance as well as water supply and sanitation.Here we can understand the difference between the authority and local people for maintenance of infrastructure (Table 8).

Table 8.Maintenance and involvement in rehabilitation of infrastructure

Involvement authority	**Tildanga (%)**		**Pankhali (%)**		**Chalna (%)**	
	Yes	No	Yes	No	Yes	No
Associated authority including BWDB	25	75	30	70	12	88
Local people including UP authority	85	15	72	28	65	35

3.9 Satisfaction about existing disaster management activities

Disaster management activities play vital role to enhance the preparedness capacities of local people, providing assistance during and post disasters and enhancing mitigation capacity of the locality. In the Upazilla there is no any Government's DM (Disaster Management) office, only disaster management committees present but not active at all. The DMC members hardly sit together to take any action to manage the local disaster. It is usually turned into a paper committee headed by Union Nirbahi Officer (UNO) at Upazilla level and Chairman at union level. Only positive sight is that there is some sort of practice of local warning system. The local people satisfaction is not same about the existing disaster management activities. Some people are satisfied, some is moderately satisfied and some is not satisfied (Figure 6).

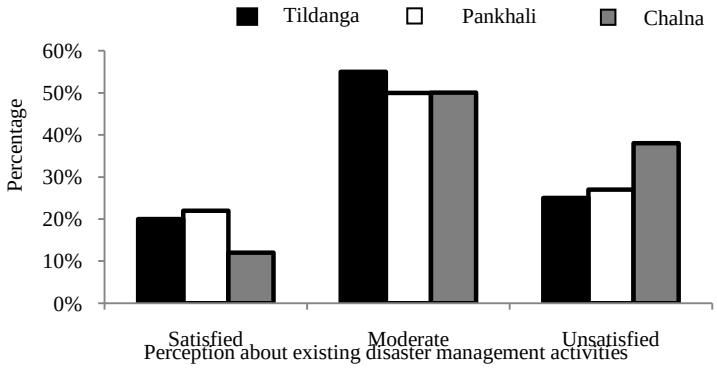


Figure 6.Respondent's perception about existing disaster management activities

From the above figure it is clear that most of the people are moderately satisfied for the existing disaster management activities. A few of them is satisfied and the rest of them is not satisfied. So, it is necessary for the authority to improve the management capacity and to remove the disaster effect from the local people.

4. Conclusion

The study revealed that rehabilitation of infrastructure after disaster should be effective. Proper implementation of these activities can reduce the damages and protect the local people from the degree of damages of future disaster. It can help to increase agricultural production, prevention of salinity intrusion, removal of water logging condition, reduce drought condition and improve the livelihood pattern of the people. But, there is lacking of proper rehabilitation of infrastructure and its appropriate management. The study advances in new sciences that infrastructure rehabilitation after disaster is an important point for the researcher. Maximum researcher could not explore and focus on this issue. If the researchers understand the importance of this issue then they do better research on it. It is important for the researchers to turn the issue at the organizational level which helps to reduce the adverse situation of the local people. The consciousness of the authority on rehabilitation after disaster helps to improve the normal life of the people when it is implemented at the field level. Proper management of rehabilitation activities including embankment (beribundth), sluice gate, canal, cyclone shelter helps to provide improved livelihood system. Besides, they can overcome the scarcity of pure drinking water by removal of saline water intrusion and availability of deep tube well as water is the essential element of life. But, appropriate rehabilitation is very rare and which is done is not sufficient to remove disaster risk. Permanent rehabilitation in case of embankment (beribundth), river slope and sluice gate is necessary but in maximum case all of these activities are temporary. So, this research becomes effective and it should be done after disaster as soon as possible for the improvement of the livelihood pattern of the people. It may assume that as river bank erosion is a severe problem in the study area so, it can reduce by increasing the slope height with concrete block and applying vetiver grass for controlling such erosion.

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