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Influence of humanitarian assistances on ecosystem services in Bangladesh coast

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ABSTRACT

The coastal ecosystem of Bangladesh is diverse and the life and livelihood of the people are largely dependent on ecosystem services (ES). The frequent natural disasters negatively influence coastal ecosystem services and consequently interrupt human life and resources. Government and non-government organizations provide humanitarian assistance to the local community to recover damages induced by disasters in coastal areas. In this research, we used participatory workshops (n=4) and face-to-face questionnaire surveys (n=131) to study the influence of humanitarian assistance on ecosystem services on the Bangladesh coast. Our study revealed prominent ecosystem services in the study area; those were provisioning services: crops, livestock, capture fisheries, freshwater; regulating services: erosion regulation, climate regulation, natural hazard regulation; cultural services: recreation and tourism, boating to the Meghna coast, migratory birds watching. The livelihood of people was heavily impacted by the disasters; however, training support guided them to manage their income by selling their commercially produced animals (e.g., cattle, goats and poultry) before disaster seasons. Humanitarian assistance for supplementary nutrient supply, sanitation and drinking water facilities influenced the unwanted extraction of natural resources from the fragile ecosystems after the disaster. Our study suggested that future research should focus on the influence of one-to-one humanitarian assistance, to what extent ES improvement through this assistance is achievable for natural disaster protection on the Bangladesh coast.

Key Words: *Humanitarian assistance, Ecosystem Services, Natural Disasters and Coastal Bangladesh*

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I. Introduction

The coastal ecosystem of Bangladesh includes world's largest single tract of mangroves (the Sundarbans), beaches, coral reefs, dunes, wetlands and covers 30% of the cultivable land of the

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country (Rahman et al., 2021). This coastal ecosystem provides diverse ecosystem services that have influential role in human well-being and livelihoods (MEA, 2005; Adegboyega et al., 2018). The provision of essential goods and services through natural and human-induced ecosystem processes is called ecosystem services e.g. clean air, water and food (De Groot et al., 2002; Lette and De Boo, 2002; Costanza et al., 2014). Ecosystem services (ES) can be direct provisioning services, indirect regulating or cultural services. It can also be habitat services or inputs to human well-being (Müller and Burkhard, 2012; Dearing and Hossain, 2018). Changes in the frequency and intensity of droughts, flooding, and storm damages are common phenomena on Bangladesh coast. Impacts of those disasters mainly create damage to the coastal livelihoods and ecosystem services (Hossain et al., 2015).

Humanitarian assistance is the activities conducted to relieve directly or to reduce human suffering, diseases, hunger or hardship (Gallardo et al., 2015). These activities are governed by various statutes, policies and range from steady-state engagements to limited contingency operations. The disasters increase human sufferings and hamper everyday life and create the loss of ecosystem services and biodiversity. Impacts of disasters, such as riverbank erosion, floods, cyclone and drought, on livelihoods and overall socio-economic condition are most severe (Hossain et al., 2010; Amin et al., 2018). Coastal people's livelihoods, crop production, livestock production, fish habitat, fisheries and the health of community people are also affected by the disaster events (Amin et al., 2016; Amin et al., 2018). Moreover, a negative impact on soil health and increasing soil salinity level can damage overall agricultural productivity (Szabo et al., 2015; Rahman et al., 2020).

For livelihoods, people of coastal Bangladesh are mainly dependent on marine and in-land fisheries along with agriculture (Shanu and Rahman, 2017). Considering the adverse impact of disaster events, affected communities are not getting as much support as they need to maintain a sustainable livelihood (Szabo et al., 2018). For this reason, considering the changing context, people of this area are adopting various alternative livelihood options based on their experience and capacity to adapt to the adverse effect of climate change (Ur-Rahman et al., 2011; Amin et al., 2018). Heavy rainfall and waterlogging in the monsoon period result in the loss of crops in this coastal community. As a whole, coastal communities are becoming more vulnerable to maintain their livelihood sustainably day by day. It is anticipated that adverse impacts on the coastal community will exacerbate the incidence of rural poverty (Islam, 2016; Islam et al., 2019). In reality, impacts on poverty are likely to be severe in developing countries where the agricultural sector is an important source of livelihood for most rural populations (Abedin et al., 2014; Hossain et al., 2020a).

Due to several climatic disasters, people lose their properties and the coastal ecosystem becomes unstable (Hossain et al., 2020b). Extractions of resources from the unstable ecosystem cause an extra burden on ecosystem integrity and recovery. The government, with its auxiliary forces along with several NGOs and INGOs, works to develop the overall socio-economic conditions of the people of the coastal community in Bangladesh (Sattar et al., 2020). Several NGOs provide humanitarian assistance to develop their livelihoods and nutritional requirements after the disaster (Amin et al., 2016; Sattar et al., 2020). Although this assistance undermined the influence of the ecosystem service in the coastal system, however, there is some autonomous relief of pressure due to the provision of this assistance. This study thus attempts to study the influence of humanitarian assistance on ecosystem services in the highly disaster-prone coastal areas of Bangladesh. Our study focused on the following questions:

- What are the existing ecosystem services in the coastal Char Kalkini Union of Bangladesh?
- What is the extent of losses of ecosystem services due to natural disasters in the study area?
- What are the contributions of humanitarian assistance to maintain the flow of ecosystem services?

II. Materials and Methods

Study area

Bangladesh coast is isolated based on three natural systems processes and events that increasing vulnerabilities of the coast. The criteria are tidal fluctuations, salinity intrusion cyclone and storm surge risks. It consists of 19 administrative districts, of which 12 districts demonstrate all three criteria and are defined as exposed coast. Many of the extremely poor people in the coastal region of Char Kalkini are vulnerable to the natural disaster that increases their pre-existing economic and social vulnerabilities (Hasnat et al., 2016; Hossain and Szabo, 2017). This study area is the

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southeastern coastal region of Bangladesh and located on the Coast of Meghna River. This area is under Lakhsmipur district in Kamalnagar Upazila, covering an area of 40.03 sq km. Char Kalkini union is located between 90⁰47'30'' E to 90⁰47'30''E longitudes and 22⁰47'30''N to 22⁰45'0''N latitudes (Figure 01). Char kalkini union consists of four villages (Char kalkini part –1 and 2, Char Martin and Char Lawrance).

Climate-induced natural disasters like severe cyclone, shocking tidal surges, severe floods, underhanded river erosion, excessive rainfall, overwhelming salinity intrusion, sea level rise etc. are occurring more frequently in the study areas, which exacerbates the vulnerability of socio-economic conditions of the affected people (Hasnat et al., 2016; Hossain et al., 2020c). Being a coastal region of Bangladesh, the Coast of Meghna River is most vulnerable to climatic disaster (BBS, 2011). Every year, the local people fight against several disasters such as riverbank erosion, cyclone, floods, water logging etc. During the monsoon period, most areas face seasonal floods and waterlogging that hampers agricultural and fishing activities. Due to the recurring disaster events every year, the ecosystem process is negatively affected in this area. Loss of biodiversity, property damages and damages of ecosystem services are very common in this area due to disasters (Hossain et al., 2017; Amin et al., 2018). To improve the overall socio-economic conditions of people, different government and non–government organizations provide humanitarian assistance (Hossain and Roy, 2012; Sattar et al., 2020). Our interest is to determine the influence of the assistance on the conservation of natural environment, including ecosystem services.

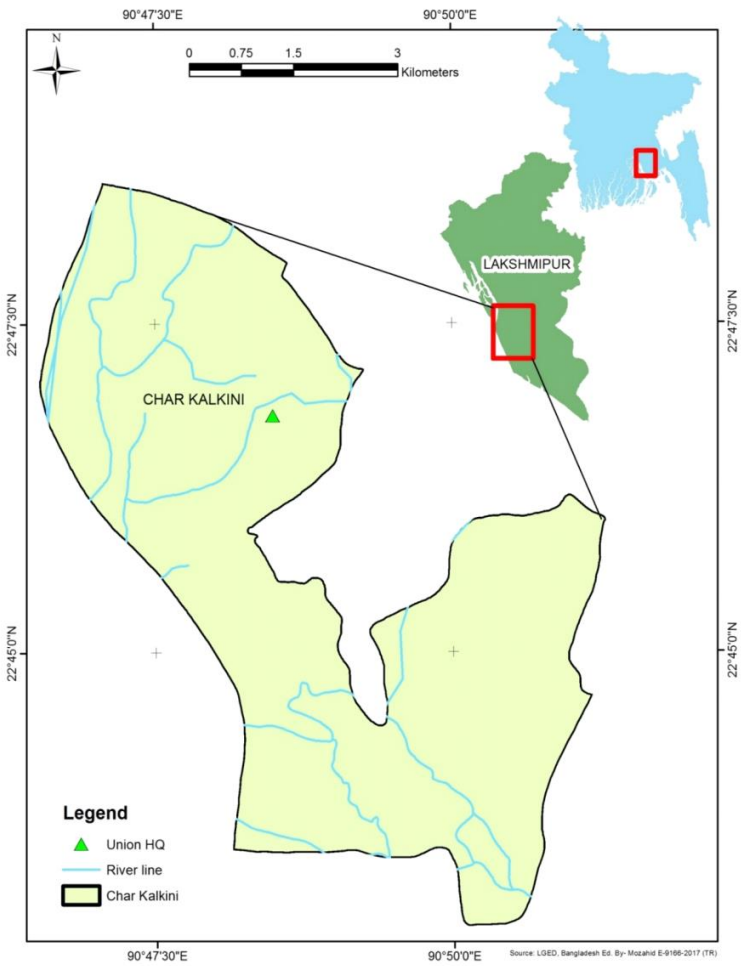

Figure 01. Study area map (Char Kalkini union)

Identification of existing ES, its status and influence of humanitarian assistance

We used both qualitative and quantitative methods for this study. Four consecutive workshops, semi-structured questionnaire surveys were conducted in a highly vulnerable coastal area to answer the research questions. Following are the methods used for this study:

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Firstly, a literature review from different articles, books and journals was carried out to list the potential ES in similar coastal environmental settings. The ES search was conducted following the higher category of the Millennium Ecosystem Assessment 2005: provisioning, regulating cultural, cultural services (MEA, 2005). Secondly, after a reconnaissance survey in the study area, a checklist of ES was prepared. Thirdly, the checklist of the ecosystem services was verified and finalized during the four consecutive focus group discussions. Focus group discussions were organized from October to December 2017 for conducting this research. The main focal persons of these discussions were community peoples of different occupations (e.g., farmers, day laborers), local administrators (chairman and members of union parisad) and elite persons (school teacher, respectable elders). We received information and understanding of the real-world status of disaster impacts on local ES in the last five years through these workshops. Finally, a list of the existing ES was prepared based on the survey information.

We conducted face-to-face semi-structured questionnaire surveys to review the ES's status after disaster during the last five years. Our initial questions were about the demographic characteristics of the respondents. The following questions were the recent disasters in the study area. The consecutive questions focused on livelihood prospects and damage that occurred due to this disaster on their livelihoods. We used a priority index to rank them to quantify people's perceptions. Further questions were asked on the loss of monetary value due to disasters, the causes of loss, negative impacts on species, and influence on livelihood status. Questions were asked about humanitarian assistance and its contribution to their livelihoods and resource extractions managed and unmanaged ecosystems.

Sample size determination

The total population of Char Kalkini Union is 30357 (BBS, 2011). From them, Males 15760 of the population, and females 14597, which is almost 50.8% males and 49.2% females. The sample size calculated using the following formula (Kothari, 2004):

S = sample size
X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (95%)
N = population size
P = the population proportion
e = acceptable error in proportion

The above formula has been translated and used to estimate the acceptable error (e) that determines the range of accuracy from the questionnaire.

Where the sample size (S) is 131, population proportion (P) is 0.5 and the table value of chi-square (x^2) is 1.96 (Kothari, 2004). Here, the population proportion is considered 50% as the total population is infinite and the actual proportion is unknown. The calculated acceptable error is 0.05, which indicates the estimate is considered within 5% of true value i.e., measured value is ±5% of true value. Our face-to-face semi-structured questionnaire survey was conducted among 131 households from October to December 2017.

Priority index analysis

Priority index analysis has been carried out to rank the order of most preferred and less preferred options. This tool was used to assess the best effective outcome on disaster impact severity, coping with natural hazards and contribution to livelihoods development. The scale of priority was about the people's perception of each priority factor. The priority scale was used in this study were Not identified= 0, High priority =1, Medium high priority =0.75, Medium priority =0.50, Low priority =0.25. Priority index is calculated for each disaster by multiplying each priority with its relative subject given in the addition and dividing by summation of the regularity.

III. Results

Socio-demographic characteristics

Out of 131 respondents, about 4% of respondents ranged from 18-28 years and others are respectively 29-39 years, 40-49 years, 50-59 years and 60-69 or >60 years. Most of the respondents

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covering 29-49 years old and that covers 41%. This data suggests that most of the respondents were in the active age group and contributing to family income. More than 90% peoples are engaged in farming and fishing activities. Peoples mainly dependent on fishing activities. According to their needs, people alternate their income sources and changed professions for a small duration in the off-season. Among 131 households, about 54% people's occupation is fisherman, 31% are farmer. About 43% people's income range is about 200 – 5000 Bangladeshi Taka (BDT)/month, 48% income range is 5500-5800 BDT/month. Peoples were having income of more than 8000 BDT per month is only 9%.

Ecosystem services

The higher categories ecosystem services exist in this study areas were provisioning services: crops, livestock, capture fisheries, freshwater; regulating services: erosion regulation, climate regulation, natural hazard regulation, cultural services: recreation and tourism: boating to the Meghna coast, several migratory birds watching (Table 01). We also studied the vulnerability of the ecosystem services (Table 02). This study revealed that regulating services such as erosion regulation and natural hazard regulation were degraded and at high risk in this study area. The highest vulnerable cultural service was recreational boating in the Meghna coast and the highest vulnerable argi-produce were vegetables, shrimps, grains and oilseeds.

Table 01. Ecosystem services in the char land coastal area

Services	Subcategory	Comments	Examples
Provisioning services			
Foods	Crops	Agricultural products or plants	• Grains • Vegetables • Fruits • Oil seeds
	Livestock	Commercial and domesticated animals	• Chicken • Cattle • Ducks
	Capture Fisheries	Fish captured through trawling from ponds and rivers and other non-farming sources such as canals.	• Crabs • Shrimps • Fishes (such as Ilish, Boal, Rui, Catla and other local named species)
Timber and other wood fiber	Trees and from natural or semi-natural forest or plantations		• Rain tree • Mehogoni • Chambol
Freshwater	rainwater, river, canal, pond water for human and animal use		Freshwater for drinking, from tube-well and rainwater.
Regulating Services			
Air quality regulation		Influence ecosystems have on air quality by emitting chemicals to the atmosphere.	
Climate regulation		Regional and local	Forests can impact regional rainfall levels. Lakes regulate humidity levels and influence frequency of frosts, important for agriculture
Erosion regulation		Tree plantation programme can contribute to erosion control.	
Natural hazard regulation		Capacity for natural systems to reduce the loss caused by natural disasters	
Cultural services			
Recreation and ecotourism		Recreational services from natural or managed ecosystems.	Boating to the Meghna's coast Several migratory birds watching.

Disaster severity

Our study area is located on the coast of the Meghna River. Char Kalkini is most vulnerable to several climatic disasters such as floods, cyclones, waterlogging and riverbank erosion. According to the respondent, riverbank erosion was a severe disaster in terms of previously experienced loss of

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livelihoods and property damage. About 48% of total damage occurs due to riverbank erosion, floods positioned 2nd and its severity perceived as 28% of the total damage. Cyclone is the third-highest damage-causing disaster in this area (Figure 02). Waterlogging is the least severe disaster in the study area (Table 03 and Figure 02).

Table 02. Matrix on Ecosystem Services vulnerability

Ecosystem Services	Enhanced/ Low risk	Mixed / Moderate risk	Degraded / High risk
Provisioning	Rain tree Mehogoni Chambol	Chicken Ducks Cattle Crabs Fishes	Oil seeds Grains Vegetables Shrimps
Regulating	Air quality regulation	Climate regulation Water regulation	Erosion regulation Natural hazard regulation
Cultural		Birds Watching	Boating in the Meghna coast.

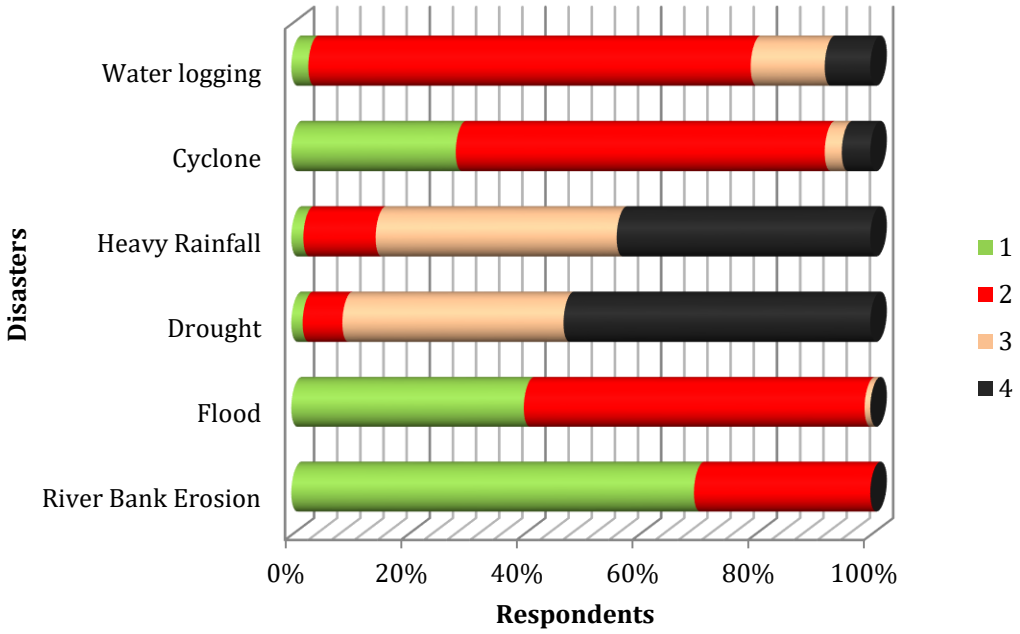

Figure 02. Perceived disaster severity in terms of damage of livelihood and property in the last five years (in order of severity 1 being the most severe and 4 being the least severe).

Table 03. Priority of recent disaster faced by the local community people in Char Kalkini Union

Disasters	Priority					Total frequency	Priority index	Rank
	No (0)	1st (1)	2nd (0.75)	3rd (0.50)	4th (0.25)			
Riverbank erosion	0	71	31	0	0	102	0.923	**I**
Flood	0	41	60	1	0	102	0.84	**II**
Drought	0	2	7	39	54	102	0.38	**VI**
Heavy Rainfall	0	1	60	20	21	102	0.60	**V**
Cyclone	0	29	65	3	5	102	0.789	**III**
Water logging	0	3	78	13	8	102	0.686	**IV**

Impacts on livelihoods and monetary loss

According to the respondent, around 33% of peoples faced little impact on their livelihoods, 41% faced partial impact and 26% faced loss of livelihood in the recent disasters (Figure 03). Perceived property damaged ranges in the study area is 2000 BDT/yr – 20,000 BDT/yr. Around 31% perceived a property loss of 10,000 BDT/yr and 24% perceived a loss of 20,000 BDT/yr. Salinization, loss of fishing reservoir, pollution, increase morbidity and habitat loss were the responsible cause of livelihood

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impact. Loss of fishing reservoir and salinization in the dry season was perceived as the main cause of biodiversity loss in the study area. This loss of biodiversity (e.g. fisheries diversity) caused livelihood opportunities for a larger population. Loss of fishing reservoir was perceived as a major cause of livelihood damage as the majority (60%) of the study area involved in fishing. The following severe causes were salinization, reduced breeding and habitat loss (Figure 03).

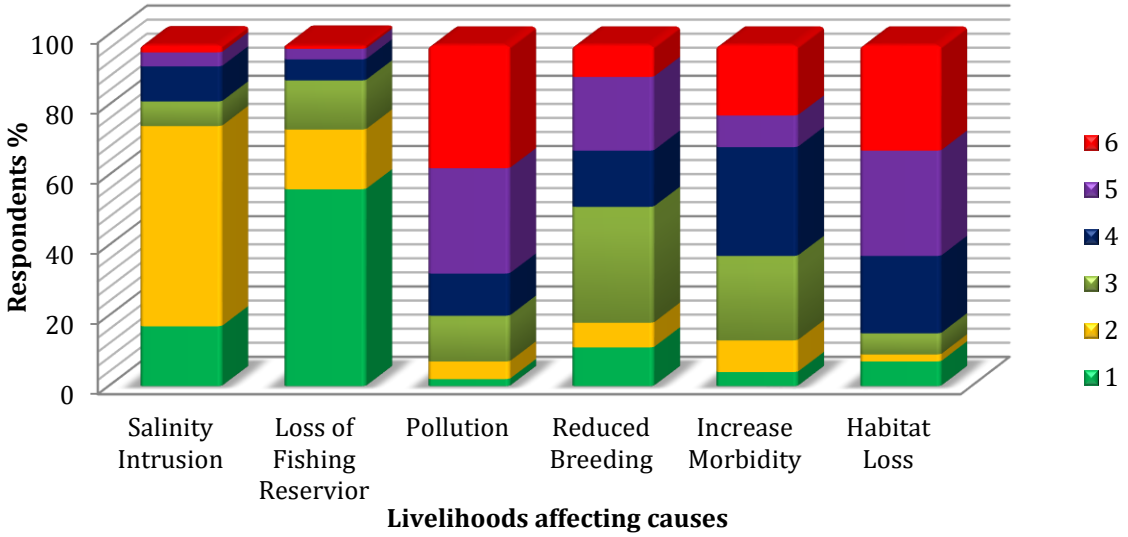

Figure 03. Perceived disaster-induced reasons of livelihoods damage (1 being the most severe and 6 being the least severe that creates the loss of livelihoods).

Contribution of humanitarian assistances

Our study revealed that according to the extent of the loss of overall services, a little assistance was given among the people on the coast. Almost 100% peoples are affected in the study area; however, 60% of peoples receive assistance from different sources. Our study revealed that several authorities were working in this community to improve the overall socio-economic conditions of people. Governments of Bangladesh supply humanitarian assistance to improve an overall condition which was 43% of the total. Bangladesh Red Cross and Red Crescent and Swiss Red Cross together contribute 43% of the total assistance. Others community-based NGOs and INGOs (International NGOs) cover 14% of the humanitarian assistance in the study area. The assistance provided by the government and humanitarian organizations were cash grants, seeds, sapling, hygiene support, shelter and livelihood supports (renovation of fisheries facilities) and livelihood training e.g. alternative livelihood skills. Among the assistance, food supply was the highest and other major supports were seeds (>50%), sapling (~50%), cash grant (~50%) and hygiene support (Figure 04).

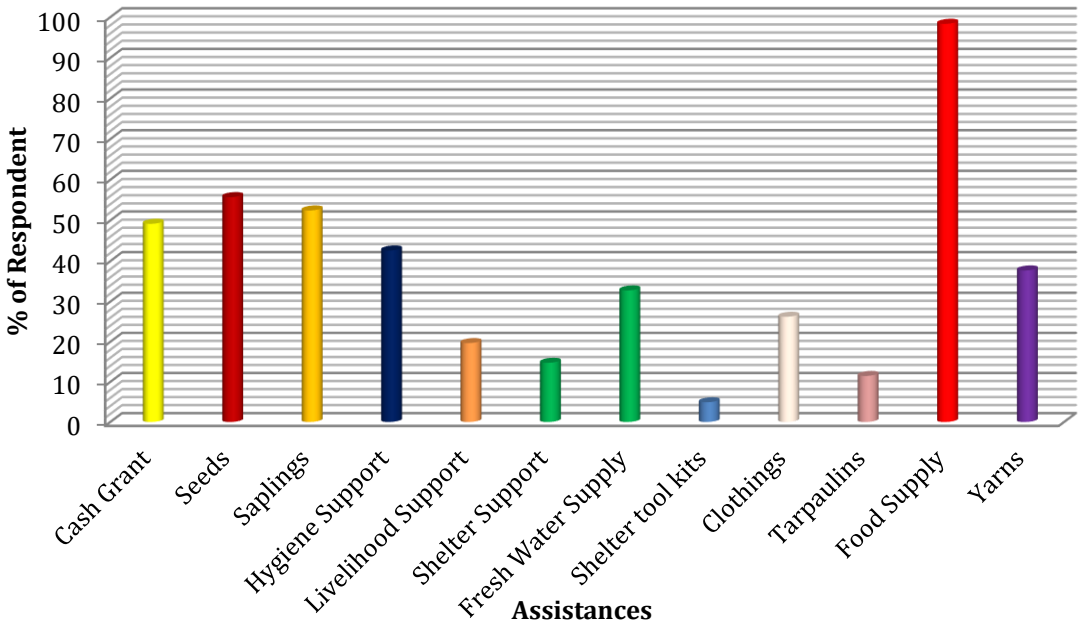

Figure 04. Post-disaster humanitarian assistances from different authority

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Figure 05 represents the contribution of humanitarian assistance to the improvement of ES. We identified a couple of benefits (Figure 05) that could help to improve the losses of ES due to natural disasters. The main humanitarian assistance provided was alternative nutritional supply, thus less pressure on the damaged natural ecosystem to collect food. Again, due to the destruction of the surface water sources, the drinking water supply as an alternative source provides support and opportunities to the natural surface water body to be self-recycled. As an alternative livelihood support peoples also receive training on livelihood improvement and get the resources protection idea of selling their poultry and cattle before disaster seasons arrived, essentially peoples face less resource losses. This training helps them to avoid the severity of disasters and improve the livelihoods. According to the impact severity value, livelihoods development becomes the best recoverable option after receiving assistance, although in the third category of the priority (Figure 05).

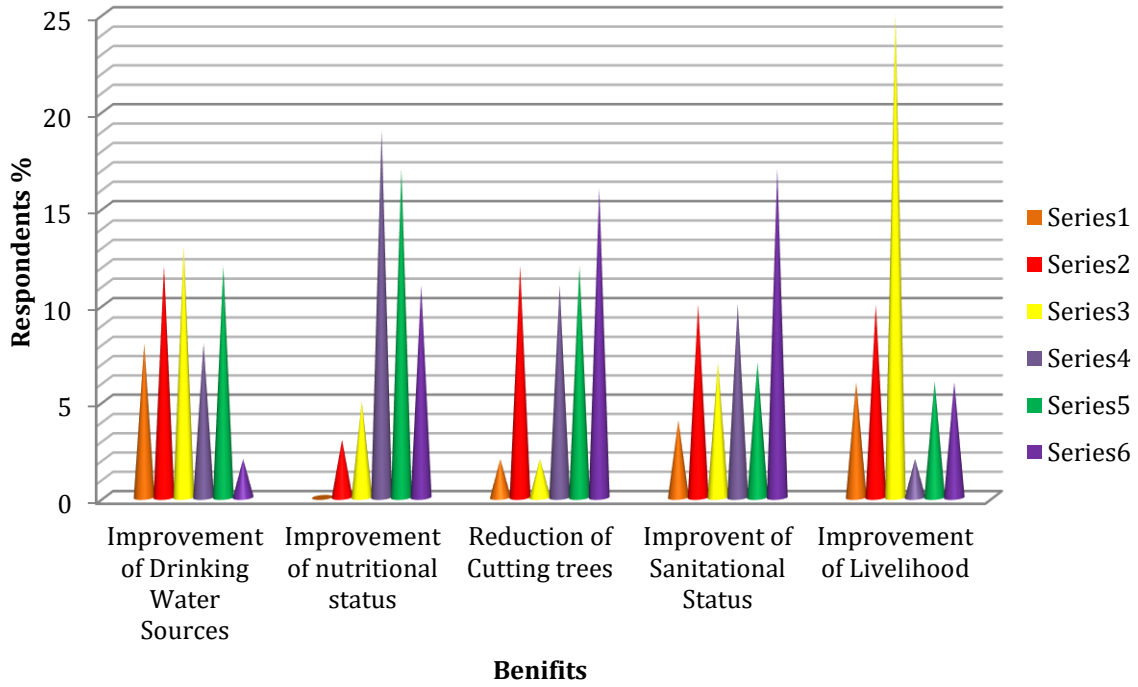

Figure 05. Improvement of ecosystem services after receiving humanitarian assistance (series 1 being the most influential and series 6 being the least influential feature of humanitarian assistance to improve ES).

IV. Discussion

This study reviewed the context of ecosystem services lost due to different natural disasters and the contribution of humanitarian assistance on ecosystem services conservation. The Bangladesh coastal ecosystems provide ecosystem services substantially important for the livelihood of the coastal community. These ecosystem services include all the higher category services explained in literature: provisioning, regulating, cultural and habitat services. Natural disasters are a frequent phenomenon in the coastal areas of Bangladesh, causing livelihood damage and negative impacts on natural ecosystem services (Amin et al., 2016; Hossain et al., 2017; Amin et al., 2018). In our study area, people receive different services from the ecosystem such as foods, crops, oilseeds, fishes and woods. The major occupation in this area was fisherman and farmer and they depend on different ES to facilitate their livelihoods. Our study revealed that most people faced several disasters and lost their property. About 53% people's profession was fisherman and they became helpless during the disaster seasons. Around 26% of peoples lost their livelihoods every year due to disaster events. Inhabitants used to survive against riverbank erosion, floods and cyclone in this area (Hasnat et al., 2016). Our study revealed that about 31% of the respondents had to experience property damage due to the devastating effects of riverbank erosion in this area.

Several NGOs and government organizations work together for the improvement of socio-economic condition of people. Different types of assistance have been provided to the community people such as cash grants, food supplies, fresh water supplies, livelihood supports, shelter supports, seeds and

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saplings. This assistance can contribute to the conservation of natural ecosystem services and livelihoods development in this area. It can help to facilitate their livelihoods, conservation of natural areas, forest resources and can contribute to agricultural productivity. Around 60% of respondents receive assistance during and after disaster events. Several government and non-government authorities work such as for humanitarian assistance in this area. This humanitarian assistance provided by the government and non-government organizations has higher potential for livelihood improvement, supplementary nutrient supply during disaster-affected period, improvement of the potable water supply and sanitation, which ultimately help to recover unwanted extraction of the ecosystem services in a fragile system after the disaster (Sattar et al., 2020). Policy and future research need to focus on how and what extent of intervention is needed to protect this ecosystem and its inhabitants for ES protection (Willcock et al., 2016). The ecosystem services like natural protection benefits improvement could an option to reduce the cost of recovery and rehabilitation if policy focuses on that issue.

V. Conclusion

The coastal ecosystem in char lands is a highly productive and diverse system in Bangladesh, susceptible to frequent natural disasters. Our study showed that riverbank erosion is causing the greatest harm to the ecosystem services and livelihood of the people. People had to cope with natural disasters with many adaptation techniques. Humanitarian assistance in this area provides opportunities for livelihood improvement and supplementary nutrient supply during disaster, which helps protect the severe destruction of the ecosystem services in a fragile system after the disaster. Future research and policy need to focus on one-to-one ecosystem services improvement (e.g. erosion regulation) through humanitarian assistance.

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