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IMPACT OF CYCLONE SIDR ON RURAL LIVELIHOOD USING PARTICIPATORY RURAL APPRAISAL (PRA) TOOLS: A CASE STUDY OF A COASTAL UNIT IN BANGLADESH

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Abstract: The study analyzed the status of post-cyclone livelihood capitals (human, natural, financial, physical and social) and the underlining causes behind the conditions. A south-central coastal unit (Angaria union, Dumki Upzilla of Patuakhali district) of Bangladesh was selected for its vulnerability to cyclone Sidr. Extensive questionnaire surveys at the household level was conducted of 150 households through random sampling method. Both descriptive and inferential statistics were used to analyze the data. Access to natural, human, financial, physical and social capital were calculated using standard equations and it was found that 72%, 52%, 59.8%, 53% and 43.42%, respectively, were in habitual condition (normal level). The aftershock of cyclone Sidr, the access to natural capital decreased to 55% of the average level; the human capital was 10% less compared to the consistent state and proportion was 22.7% for financial capital, 19% for physical capital and 24.78% for social capital. Causes behind such immense decrease may be the lack of proper institutional and administrative settings, poor livelihood strategies (adaptive and coping), hand-to-mouth income status, consequently poor living standards, lack of financial capital and sole dependency of resources in an unsustainable manner. This study advocated to promote coordinated disaster risk reduction programs for mitigating cyclone impacts and providing assistance for rebuilding post-cyclone livelihoods.

Keywords: Cyclone, rural livelihood status, participatory rural appraisal (PRA), vulnerability

Introduction

The hydro-meteorological and geophysical factors rooted the exposure of natural disaster in Bangladesh. Moreover, the matter of distress is the increased frequency and vulnerability to natural disasters, distinctly identifies Bangladesh as the highest risk and disaster-prone country (Global DRR Report, 2009). Among the disasters, cyclone and flood is most frequent and considered to be the major hazards of the country (Paul, 2013). Almost every year at least one major tropical cyclone strikes the country (Mooley, 1980; Haque, 1997; Paul, 2013) which has made the coast of Bangladesh more unsafe than any other regions of the world (Murty & Neralla, 1992; Paul, 2013).

Patuakhali, the daughter of the sea, is now known as the voice of South for its newsworthy experiences of damages in recent years by the hit of distressing tropical Cyclone Sidr in 2007 and potential vulnerability to changing climatic state. It is to be noted that, despite outstanding innovation in meteorological science, the progress of sophisticated warning systems and practical understanding of natural disasters, adverse impacts upon societies throughout the tropical and the subtropical world remain harsh (King, 2010). Moreover, tropical countries like Bangladesh where the livelihood of the general people is a large concern and development process is slow, and yoke of a severe disaster remain enduring. Case in point, impacts of two major disasters faced by the country this century, Sidr in 2007 and Aila in 2009 are still lingering in the damaged communities. With the increasing dynamism of meteorological phenomena, the risk of severe catastrophes like a cyclone, drought, flood, etc. is now greater than ever before (IPCC, 2007). According to the strategy paper of the UK Department for International Development (DFID, 2000), natural disasters

are more frequent in the poorest countries. In contrast, natural disaster is identified as one of the threats to achieving the poverty reduction target as well as states the vulnerability of poor people to shocks needs to be reduced because they are usually the hardest hit as of have poor access to assets which are more susceptible to disaster (DFID, 2000).

Since the environment in the third world is largely a livelihood issue (Blaikie et al., 1994) hence resilience, vulnerability and livelihood are no longer discrete terms. Therefore, making an ecosystem-based economy like Bangladesh a disaster resilient one by incorporating holistic livelihood approach, the primary step is to identify the vulnerability context. Sustainable Livelihood Approach (SLA) is a standard and appropriate contemporary tool for such purposes which prevents and protects the risk of disaster in context of available access to livelihood capitals and institutional or infrastructural facilities. Therefore, the study is aimed at identifying the access to five human capitals, namely, human, natural, financial, physical and social in normal time and after disastrous condition. Hence, the present study was designed to identify the livelihood condition after a major disaster and to find out the loop-holes to suggest suitable mitigation options for the future.

Materials and Methods

Study Area

Angaria union of Dhumki Upazila at the interface of Patuakhali and Barisal district, Bangladesh was selected as the study area. Angaria covers 7.5 sq. km. surrounded by Muradiya is the west, river in the east and north and Lebukhali in the south (Figure 1). More than half of the populations in this the study area depends on nature related livelihood sources like agriculture, fishing, farm labor, farming, agri-business, etc. (BBS, 2012). About 150 households were selected from the total households of 632 by random sampling method. The sample size was determined using an assumed 95% confidence level for the household questionnaire survey (Yamane, 1967). Therefore, the site was selected for considering the vulnerability of the area regarding any sudden potentially grave disaster, like cyclone, and securing the livelihood of the vulnerable community.

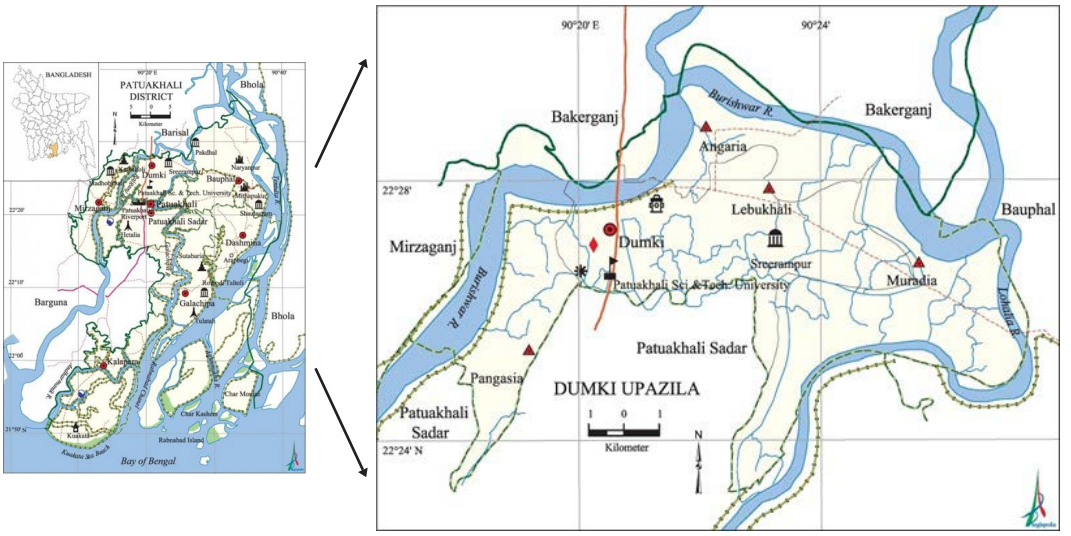

Figure 1: Map of the study area Angaria union of Upazila at the interface of Patuakhali and Barisal district, Bangladesh

Measurement of Livelihood Capitals by Participatory Rural Appraisal (PRA) Tools

An analytical model was developed following DFID's livelihood framework (DFID, 1999; Paul, 2013) and identifying the relevant indicators of five livelihood capitals and indicators was defined considering the coastal livelihoods of Bangladesh (Carney, 1998; Carney *et al.,* 1999). A five-point Likert scale was used to measure five types of livelihood capitals considering the discrete values of 0.00,0.25, 0.50, 0.75 and 1.

Primary data were collected using different Participatory Rural Appraisal (PRA) tools and other information were gathered from the local people by an extensive questionnaire survey which was drafted and tested before the field application. Pedestal of information assessment, collected from the pragmatic and predicted data was delivered by the focused group of local respondents, asset pentagons was prepared following DFID sustainable livelihood guidance sheet (DFID, 1999). The asset pentagons were analyzed both in habitual and unsafe state considering the impacts in a time of severe disaster for comparing the prying of disaster in deep nature dependent deprived section of the society.

Measurement of Livelihood Capitals by Participatory Rural Appraisal (PRA) Tools

Following DFID's livelihood framework an analytical model was developed by identifying the relevant indicators of five livelihood capitals, and indicators are defined considering the coastal livelihoods of Bangladesh (Carney, 1998; Carney *et al.,* 1999; Paul, 2013).

a) Human Capital Index (HCI): HCI was measured by considering a household composition, source of livelihood, education level, access to health services, human capital, disaster related training and level of experience gained from training (Eq. 1).

$$HCI = (\sum HCI1/N+\sum HCI2/N\ldots\ldots\sum HCI11/N)/11 \quad (1)$$

where, HCI = Human Capital Index, HCI1, HCI2….= Human Capital Indicators, and N=Total number of sampled respondents.

b) Natural Capital Index (NCI): NCI (Eq. 2) value was calculated by adding the average of selected natural capital indicators i.e. access to open water bodies, soil fertility status, trend of soil fertility change, sufficiency of water for irrigation, homestead garden and cooking fuel.

$$NCI = (\sum NCI1/N+\sum NCI2/N\ldots\ldots\sum NCI6/N)/6 \quad (2)$$

where, NCI = Natural Capital Index, NCI1, NCI2…..= Natural Capital Indicators, and N=Total number of sampled Respondents.

c) Financial Capital Index (FCI): Indicators considered to measure financial capital index are available financial deposits and monetary values of liquid assets of each household such as reserve of money in the form of cash, deposits in banks, cooperatives and groups, as well as available stock like livestock, poultry, jewelry, furniture, storage of food, cash crops, trees, cultivable land and other assets which can provide money. After converting all forms of such assets into monetary values for each household, has been divided by the aggregate highest available financial deposit and monetary value among the study villages to get financial capital index (Eq. 3).

$$FCI = Av/Avh \quad (3)$$

where, FCI=Financial Capital Index, Av=Available stock and monetary value of liquid assets of each household, and Avh = Highest available financial deposit and monetary value in the study area.

d) Physical Capital Index (PCI): PCI (Eq. 4) was measured by considering the quality of road to reach market, accessibility to road, transportation facility, access to cyclone shelters and household adornment like electronic devices, cell phones, etc.

$$PCI = (\sum PCI1/N+\sum PCI2/N\ldots\ldots\sum PCI5/N)/5 \quad (4)$$

where, PCI= Physical Capital Index, PCI1, PCI2…..= Physical Capital Indicators, and N=Total number of sampled respondents.

e) Social Capital Index (SCI): Duration of living, grain storage capacity, access to mass communication and individual communication, participation and connection and memberships in the groups are considered have been considered to measure SCI.

$$SCI = (\sum SCI1/N+\sum SCI2/N\ldots\ldots\sum SCI6/N)/6$$

Where, SCI =Social Capital Index, SCI1, SCI2…..= Social Capital Indicators, and N= Total number of sampled respondents.

Results and Discussion

Human Capital

Human capital represents skills, knowledge, ability to do labor and good health which together enable people to pursue different livelihood strategies and achieve their objectives (DFID, 2000). Hence, household composition, source of livelihood, educational level, access to health service, training, special skills and potential human resources are considered in this category of capital.

More than half of population in the study area were from larger households, which actually reduced the average household income and created pressure on the economy. From the studied population, most were dependent on agriculture and relied on the process of cultivation. Thus, any disturbance in the ecosystem has severe impact on human capital. For instance, 75% of the households were dependent on the sole income source. Moreover, among the surveyed population, most (40%) only completed their primary education and a very few people (13%) completed their secondary education which reduces the HCI.

There were only 3 family and health care clinics providing the health services to local people. Due to their service constraints, most time consumer had to rush (generally to the district level) in case of complicated cases or serious injury. While such installations failing to fulfill the need at local level, it was difficult to expect any feedback during and after the critical period of disaster. Moreover, quick communication to district level is a big constraint for bad road and transportation facilities. Among the surveyed population only 19% had special skill and training. Thus, overall HCI was low.

Natural Capital

Instead of having wealthy sources of water, people of the study area suffer extremely in summer from water stress, because of sliming ponds, drop in the water table and seasonal low flow in river. According to BBS (2001), the number of deep tube-wells in the study area were 260 for 3553 households, i.e., 1 tube-well for every 14 families, which clearly indicates the need of more installation.

82% of the respondents could get the natural support of the river for irrigation process. Hence instead of the ability to expense for technical support, many of the respondents were successfully farming crop, every year.

However, this advantage sometimes appeared as a disaster, when the river water rises unexpectedly due to heavy rainfall or the river dry out due to insufficient rainfall. Respondents also claimed the disadvantage of using river water for High Yielding Varieties (HYV). People had experience that after Sidr, while some were trying to produce some HYV with the help from non-governmental organizations like BRAC, failed completely and incurred severe loss. Nevertheless, while the land area is inevitably reducing day by day and necessity of food stock is increasing at an enormous rate, support from HYV in agriculture is unavoidable. Thus, extensive research is necessary to assure the suitable HYV in the study area.

The tendency of homestead gardening encountered comparatively low among the deprived section of community. Moreover, about 72% respondents claimed loss of plants during Sidr, valued, on average, BDT 20,000 and more. A large part (69%) of the households used wood and plant extracts like, dry leaf, branches etc., and additional 5% households used cow dung as their fuel source and 24% used both wooden extracts and cow dung. These sources of fuels are environmentally and economically inefficient. Moreover, it is observed that people commonly used traditional stove, which required unusually large quantities of liquid fuel and produce unexpectedly high indoor pollution. Thus, use of improved stove is to be encouraged to reduce the expense of both natural resource (plant) and financial resource (in health service for respiratory diseases) and introduce sustainable cooking process. However, due to dependency on natural resources the NCI was the highest in the habitual condition which failed to lowest during disastrous condition due to lack of sustainable techniques.

Financial Capital

Per capita income of the study population was 7169 BDT ($88.18), which was far behind the standard per capita income of the country ($1,602 in 2017, Source: The Daily Star, 2017). Though 68% of the respondents had farmland ownership but larger portion failed to fulfill their yearly requirement of grains from their own production. Thus, they are dependent on other sources for their regular food safety. Among the cultivars, 81% of lost standing crop during Sidr. Among the respondents some also lost their farm products like fishes and livestock. The losses in those cases were large enough, costs more the 100,000 BDT (considering the market value of 2007), whose impacts were not recovered by some yet. During Sidr most of the respondents were not prepared instead of getting warning and therefore damage to livestock was large. 68% of the respondents (72% had livestock) endured grave losses at that time, some even worth more than 100,000 BDT (considering the market value of 2007). The losses of some respondents were so high that they even failed to recover 5 years after Sidr. However, some respondents claimed about receiving liquid financial aids in exchange of livestock losses from NGOs and Governmental organization. However, the aid was very meager compared to the losses.

The saving status of the surveyed households were very poor. Only 29% could able to hoard after their regular livelihood expense while 35% of the respondents bear the burden of loan from the government and 25% from NGOs. Here to be noted, 10 and 11% of the respondents loaned from government and different NGOs, respectively, after Sidr to restructure damages, as the primary combating means.

During the survey, it was found that the trends of aids from the government failed to satisfy the need of the people. 29% of the aged respondents received aids from the government. However, epidemiological services for the children were satisfactory enough. Almost 100% of the respondents affirmed epidemiological services from government. Though, there was no service regarding nutritional status for the young. Only 12% of the female respondents were facilitating with government services like, maternity health care, widow pension, etc. 56% of farmer claimed receiving services like seed, fertilizer, and technical support from government in lump

sum outflow. For the core poor of the concerned area, government already launched several programs; one of them was accommodation support for 120 hard-core inhabitants *(Abason Prokolpo)*. A matter of concern was that such people have no fixed income sources and their self-esteem was very low, thus were likely to depend heavily on aids and loans. Consequently, those people had comparatively low income than the common inhabitants, while bear significant burden of loans from different locally acting NGOs. For promotion of education, the government provided aids like, scholarship, free books etc. Nonetheless, the major problem identified in that sector was the lack of good plan with special program encouragement and corruption in authorities, providing the voluntary services. In the study area, no services were encountered for the motivation of jobless people, as well as no aids for disabled people, while the budget 2010-2011 claimed 0.11% allocation for the development and aids of these citizens. However, the NGOs services/aids were comparatively poor or than the government. They were found to be interested in micro-credit, instead of development programs. Nevertheless, a remarkable finding during the study was that, in time of disaster, International NGOs provided many supportive services to the indigenous people including liquid financial support, in addition to the government. And this additional approach (Government and NGO) was the key to defeating the massive damage of cyclone Sidr.

Physical Capital

85% of the respondents had their own houses for living and among respondents 1% was landlord. However,the majority of the respondents' accommodation status was unwholesome. 89% respondents live in *kaccha ghar* (made of clay and Stannum). Only 2% respondents managed to live in a suitable residential condition. According to the respondents damage to the accommodation was severe during Sidr. About 63% of the respondents claimed suffering from damage dwelling during Sidr, of which 98% suffered from partial damage while the rest completely lost house and compelled to shift the old house, some even completely shifted (14%) the accommodation. These grave loss caused the underprivileged people to loan from the NGOs and financial institute at high rates of interest.

Only 39% of the respondents had access to electricity under the services of the Rural Electrification Board, Bangladesh. The rest used kerosene as the source of energy. Respondents stated that generally, a household of four members required 1 liter of kerosene every four days. It was a large expense for the rural poor, whose livelihood was even a burden. It is to be noted that shortage of illumination is a proven constraint for development and economy.

Communication and transportation encountered as the biggest problem of the study area. Although it is a small area covering 7.5 sq. km., yet because of communication inconvenience, access to the area remained time consuming and a difficult task during the field study. Subsequently people who had their own transport had the best advantage. However, only 8% households claimed having any transport ownership. This lack of communication and transportation could be a big constraint in the rapid transfer of aids, after a disaster.

Social Capital

The social status of a person depends on many factors, for instance economic status, endurance of living, age group (the old aged get privileges), educational status, household adornment, ownership of land and physical properties (livestock, appliances, water body), grain storage capacity etc. Membership in certain social groups and cooperatives may also be counted as a social capital but unfortunately, among the respondents, none claimed any involvement with such institutions.

A long live is an advantage in that community. During the study, we found that even among the respondents who had shifted their house after Sidr, they constructed a new one almost at the same place of their old one,

to avoid migration costs. Generally, because of indigenous knowledge and social norms people of long residence managed to get some priority in decision making issues, instead of having low economic status or poor educational background. On the other hand, in case of better economic status (which is related to income level, farm land ownership, grain storage capacity, water body ownership etc.) norms could be dissolved. In field area, economic status found as the greater priority to the people in case of setting social priority, in general. However, most of these criteria also considered under human, natural, financial and physical capital.

Access to Asset in Habitual Condition

In general condition (Figure 2), maximum access was encountered to natural capital (72%) and minimum access to social capital (43.42%). Conventional wisdom also supported this statement, since the area had rich ecological resources. Most of the respondents belonged to the deprived section of the society where livelihood was a big problem so do their social capital. On the other hand, human, physical and financial capital run almost in the same line as these capitals had many common indicators. Access to the human, physical and financial capitals were 52%, 53%, and 59.8%, respectively. Access to natural capital was 28% less than the standard, and the social capital was 56.58% away. Human capital lassed behind with 48% and physical and financial capital needed 47% and 40.2 % more respectively, access to reach the standard.

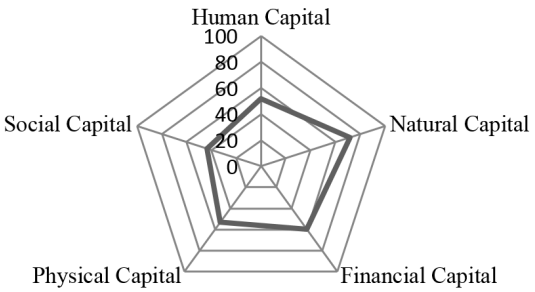

Figure 2: Status of Asset Pentagon in Habitual Condition

Asset Pentagon Contour in the Aftershock of Disaster

The livelihood of the respondents basically collapsed after the disaster of Sidr (Figure 3). Access to NCI reduced to 17% and accordingly in case of other capitals, because of the unsustainable livelihood method. HCI dropped to 42%, FCI to 37.1% and the SCI slumped to 31.8%.

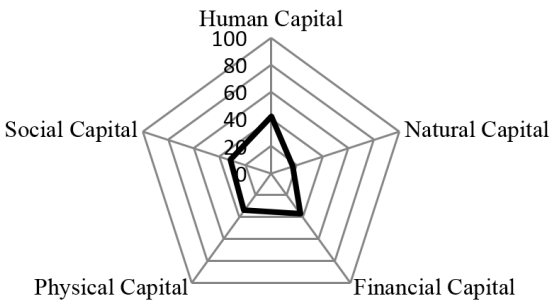

Figure 3: Status of Asset Pentagon Aftershock of Disaster

Depiction of Distressed Features of Asset Pentagon

Distressed features of access asset aftershock of a disaster in an unsustainable nature dependent community can highlight by comparing the scenarios in these two different conditions. Therefore, illustrating a combined Asset Pentagon to portray the comparative scenarios: two lines in the asset pentagon screening the similar situation of respondents, access to livelihood capitals in habitual condition and vulnerable condition. The dotted one stands for habitual state, and the solid one for the disastrous condition (Figure 4). In the aftershock of cyclone Sidr, the access to NCI was decreased to 55% of the normal level. HCI was 10% less compared to a consistent state, and the proportion was 22.7% for FCI, 19% for PCI, and for SCI, 24.78%. Drop in the NCI was attributed to pollution of the natural water resource, loss of productivity to farmland and extensive damage to ecosystem and biodiversity. On the other hand, damaged access to human capital were attributed to the physical loss and denied access to livelihood. The physical loss occurred mainly due to dwelling damage, loss of standing crops and livestock and damage to other physical properties. The social loss was mainly experienced by the people who were in the middle economic class. These people suffered from some severe losses due to their social status and norms reluctant to seek for aids and thus relay deeply on loans and schemes from various financial institutions. Although respondents are greatly dependent on nature for their regular earning sources and extensive damage occurred to their regular income sources, yet the financial collapse was cooperatively low because of the instant aids and services provided by the Government, international organization and locally acting NGOs.

Thus, from the above findings the solutions for ensuring sustainable livelihood access of the community to natural/human resources, financial resources and physical/social resources are given in table 1, table 2 and table 3.

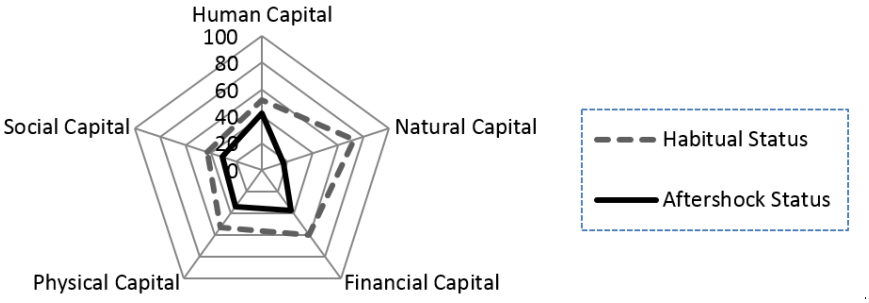

Figure 4: Livelihood Asset Pentagon of Respondents [Habitual Status vs. Disastrous Aftershock Status

Table 1: Assessed sustainable livelihood framework for natural/human resources for the study

Capital	Vulnerability Context	Assessed Remediation
	Cause	Livelihood strategy: applied and credible (field level implication)
Natural /Human	Drought	Monsoon water storage i.e. rainwater harvesting Cultivation of drought tolerant indigenous variety Fish culture in common water bodies through mutual effort of fishermen
	River erosion	Sequential measures and steps are similar to the land asset under natural capitals
	Intense precipitation in Monsoon/ Natural disaster	Diversification of income sources by increasing skills through training and nursing Formation of cooperatives and introducing saving schemes
	Reduced health care facility	Motivation and notion of health care facilities/services, necessary vaccination to the common people Encourage to use well-developed sanitary facilities and safety rules among commons
	Unsustainable cooking fuel/ facility	Introducing sustainable cooking technology like, solar stove, improved stove etc. for the people dependent on wooden extracts and bio-fuel for cooking
	Environmental stress due to sudden strike of natural calamities and climate change	Increase access to more health care facilities and services and encourage people to shift in to cyclone shelters or other safe construction before alert of natural calamitie in a timely manner
	Poverty Lack of awareness	Awareness development to reduce the household size and developing self-esteem In-house income generating activities by women, like homestead gardening, farming, handicraft, etc
	Poverty	Aids for education and awareness development. Offering employment tradeoffs with educational skill
	Lack of sufficient infrastructures and man power	
	Increased disaster/ Natural calamities	

Table 2: Assessed sustainable livelihood framework financial resources for the study area for

Capital	Vulnerability Context	Assessed Remediation
	Cause	Livelihood strategy: applied and credible (field level implication)
Financial	Population growth Lack of skill/ training Increased frequency of colossal disaster Lack of self-esteem and motivation	Monsoon water storage i.e. rainwater harvesting
	River erosion Fertility loss Colossal disaster like, cyclone/ flood/ drought Epidemic disease	Cultivation of short duration, high-yielding, local more durable and adaptive crop varietion (identified through extensive scientific research) Insurance and loan schemes for government Afforestation to reduce river erosion Crop diversification Supplement of agricultural aids (seed/fertilizer/ finance) Training in animal husbandry Awareness development on vaccination programs for critical and common epidemics regarding livestock Shifting livestock before disaster warning, instead, release them from confined place of dwelling
	Sudden Disaster like, natural calamity Poor income-generating activity/ low employment opportunity	Diversification of income-generating activity Motivation to develop saving practice. Developing human resource and elevate self-esteem to motivate self-development.
	Poverty Gap in governance	Awareness and ethical motivation of people toward developing a society that is willing to help the deprived and disabled section, Using religious and prospective leaders toward such ethical motivation Psychiatric treatment and training to local representatives of The government before their commence on duty in local governance and make them accountable to central government, on a regular basis

Table 3: Assessed sustainable livelihood framework for physical/social resources for the study

Capital	Vulnerability Context	Assessed Remediation
	Cause	Livelihood strategy: applied and credible (field level implication)
Physical	Poverty Natural calamity Population growth	Increasing income sources by following the suggestion of the previous sections Insurance and savings scheme introduction to face the shock of colossal natural calamity like, Sidr (cyclone) Growing awareness among the inhabitants Construction of cyclone resilient dwelling
	Limited supply	Limiting wastage of power, Policy favorable to rural area Use of renewable energy source through creation of cooperative
	Poor development Gap and corruption in local governance Frequent Disaster hindrance	Motivating people to use own convenient transport and providing aids or convenient credit scheme for such initiatives
Social	Disaster: cyclone, river erosion	Housing and financial aids for victims

Conclusion

The present study concluded that the study area was composed of a community living far beyond the standards instead of having strong natural, human resources and a well supportive governance. Combinations of different constraints like seasonal distress with poor infrastructural and institutional background continued to reduce the access to various livelihood capitals (NCI: 72%, HCI: 52%, FCI: 59.8%, PCI: 53% and SCI: 43.42%) even in habitat condition. The circumstances become even worse, in the abrupt distress of a natural disaster. That was evident after the stroke of historically devastating cyclone Sidr, where livelihood virtually collapsed. As a result of the aftershock, access to these capitals fall 17%, 42%, 37.1%, 34% and 31.8% for natural, human, financial, physical and social, respectively. Hence, the access to NCI was 55% less than the normal level; the HCI was 10% less compared to a consistent state, and this proportion was 22.7% for FCI, 19% for PCI and for SCI it was 24.78% less. The causes of such immense reduction are lack of proper initiatives and preparation for disasters, weak institutional and administrative settings, poor livelihood strategies (adaptive and coping), hand-to-mouth income status, consequently poor living standards, lack of financial capital in association with profoundly sole dependency on natural resources in an unsustainable manner. Therefore, to reduce the vulnerability of the poor people to severe cyclonic hazard, promotion of coordinated disaster risk reduction programs by identifying the vulnerable livelihood group and providing assistance to rebuild post-cyclone livelihoods are urgent by needed.

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