COASTAL LIVELIHOOD AND UNIFORMITY OF CYCLONE INFRASTRUCTURE: A CASE STUDY OF DACOPE, BANGLADESH.

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ABSTRACT

This research explores peoples' perception regarding the unavailability of infrastructural supports during catastrophic disasters. At the same time, it explores to prop up the recognition that the infrastructure has a vital role to play in societies' resilience during catastrophic situation. This research relied on intensive field investigation where a union was selected from a district randomly for questionnaire survey. Sampling was taken from Dacope Union of Dacope Upazila of Khulna district that was badly affected during cyclone Aila. Six available infrastructures were selected for this analysis. Uniformity of distribution (Ri), demand index (Di) and degree of demand (DDi) of the selected infrastructures were calculated. Most of the houses in Dacope union are katcha type. Therefore, based on housing pattern, the area can be considered very vulnerable. Survey results show that none of the selected infrastructure can support 50% of the total population; 40% of the total settlement areas have no infrastructural supports and most of the respondents groups, whose monthly income is below 45 USD, stand without any infrastructural support. Results drawn from this research will be useful for local and national level planners, as well as international donors for future disaster mitigation planning in the studied area and the methodology can be applied in similar areas and geographical territories.

Keywords: *Cyclone infrastructure, uniformity of distribution, demand index, degree of demand, coastal area*

1. INTRODUCTION

The coastal area is recognized as a zone subjected to intensive human use. The coastal areas of Bangladesh have perfect resemblance with such intensive uses. Presently, these areas are being used for agriculture, livestock rearing, fishing, shrimp culture, and salt production. Coastal areas also comprise sites of export processing zones (EPZ), airports, land ports, sea parts, harbours, and tourism. Unfortunately, these areas are highly vulnerable to both natural and man-made hazards and disasters like coastal cyclone, tidal surge, flooding, river bank erosion and drought, etc. The vulnerability of the coastal areas of Bangladesh is aggravated by climate change and its impact. Studies by the Intergovernmental Panel on Climate Change (IPCC) have already suggested that being a deltaic plain, climate change related sea-level rise and other hydro-meteorological effects could have a catastrophic impact on the coastal mangrove ecosystems such as Sundarban's and surrounding human settlements (IPCC, 2007).

Most of the industrialized countries of the North have several established state sponsored programs to respond on the vulnerability issues of their coastal areas - for example, the Netherlands or Germany's coasts are secured through extensive embankment construction, and other measures; which are primarily cannot be seen in most developing countries. Neither technical knowledge and relevant government responsibilities nor appropriate material resources are available in the developing countries (Mallick et al. 2011). So what should be done in developing countries, where almost all the settings are missing, unplanned and unimplemented? This study worked exactly with this problem in Bangladesh, one of the most vulnerable and poorest countries in the world. About 10% of the territory of Bangladesh is only 1 m above the mean sea level (Mohal et al. 2006).

Out of the 64 districts in Bangladesh, 19 are considered as coastal areas. Figure 1 shows the location of coastal areas of Bangladesh. The population of this area is 36.8 million and more than half of them (52%) are poor and about 41 % is below the age of 15 (Islam, 2008). Therefore, this study intends to provide a brief overview on the coastal livelihood in Bangladesh and to answer the question how the coastal societies of developing countries react on the menace and risk of climate change; and how they perceive it, particularly during cyclone, and how they improve their infrastructural facilities or built environment i.e. houses, road network, health facilities etc.

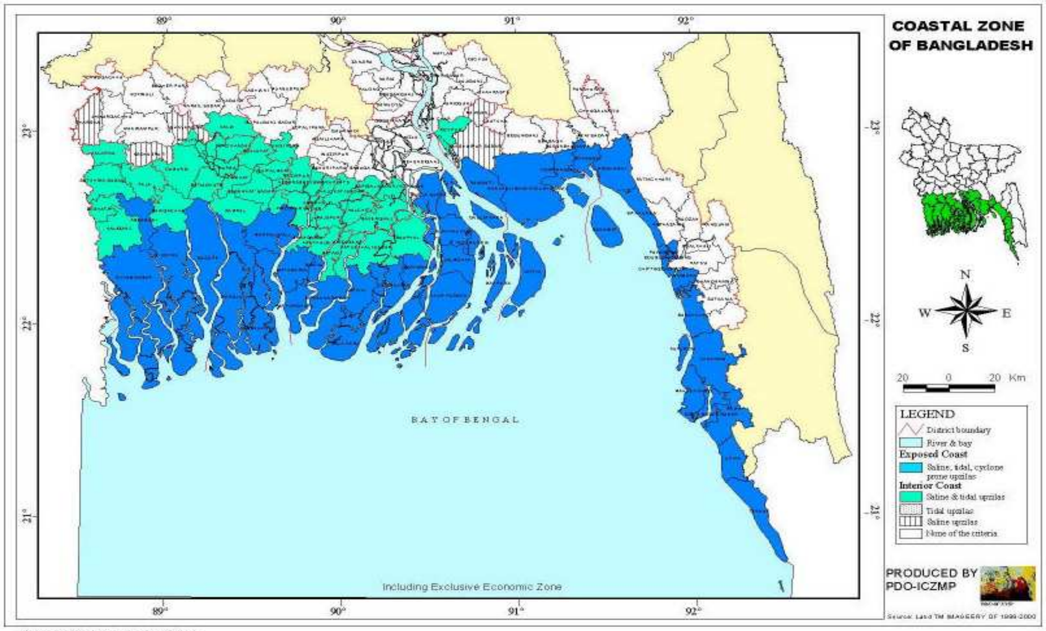

Figure 1: Coastal zone of Bangladesh (Source: Coastal Development Strategy, MoWR, 2006)

The objectives of the study are to determine the Uniformity of Distribution (Ri), Demand Index (Di) and Degree of Demand (DDi) for six type of available infrastructures of the study area. It also includes the identification of the infrastructural service coverage for the study area and its variations with economy and distance using buffer geo-processing in ArcGIS. Finally, overall impacts of inadequate infrastructural supports are discussed to recommend preventive measures during emergency situation in a coastal city.

2. METHODOLOGY

2.1 Study Area

Here the study is focused in Dacope Union of Dacope Upazila of Khulna district. Dacope union with an area of 7.44 sq. km is bounded by Bajua UP, Chalna and Vadra River in the west, Kailashgonj in the south, Chunkari River and Dhaki River in the north. This union consists of 12 villages and 2 mouzas under villages. Dacope upazilla is located in between 22°24' and 22°40' north latitudes and in between 89°24' and 89°35' east longitudes.

2.2 Data Collection and Field Survey

This research relied on intensive field investigation and questionnaire survey of the local people. About 95 households were surveyed for analysis. Group discussion sessions were conducted with the victims. The best available spatial data sets were obtained from Chalna UNO office. Table 1 shows summary of data sources.

Table 1: Summary of data sources

Data type	Unit	Sources
Socio-economic data	Per union	UNO office, Chalna, Khulna
Damages due to cyclone	Per union	UNO Office, Chalna, Khulna
Upazilla map	Per union	UNO Office, Chalna, Khulna
Field-survey	Household (HH) level	Field Survey conducted by Researcher a total of 95 households

2.3 Analysis Steps

For "uniformity of distribution", the geographic data were collected from Local Government and Engineering Department (LGED). Due to unavailability of spatial data based on cyclone shelter of the study area, the location of primary school considered as the cyclone shelter. Because, during normal period the cyclone shelter is used as primary school in all over the coastal belt and it is the prime concept for regular maintenance of those facilities. Furthermore, the location of primary health care facility in the locality, religious places, high school, family welfare centre and union headquarter are considered as the cyclone shelter. For the catchments area of a typical primary school, 1000 m distance for primary school is considered i.e. people who reside within 1000 m distance from a primary school can be able to take shelter safely during any emergencies, if there is good road communication like, paved or unpaved, using tricycles or walking on foot etc. Table 2 shows the parameters of other infrastructures.

Table 2: Infrastructures and its parameters

Infrastructure	Parameters (HH reside within radius of)
Union Headquarter	800 m
Primary School	1000 m
High School	1000 m
Temple	800 m
Clinic	1000 m
Family welfare centre	1000 m

For the calculation of "uniformity of distribution", equation (1) is used:

$$Ri = \frac{SHi}{SH} \tag{1}$$

Where,
Ri = Uniformity of Distribution Value of the I-th infrastructure,
SH = Total Number of Sample,
SHi = No. of sampled HH possessing the chance of I-th infrastructure.

The Ri varies between '0 to 1' ($0 \geq Ri \leq 1$). So, if the value of Ri = 1, then the ith infrastructure is equally distributed and support 100% of the total population; similarly if Ri=0, then there is no support of the ith infrastructure.

In addition the services and facilities such as cyclone shelter, hospital/primary health care centre, etc. were also included in the analysis. For analysing the "centrality of functions (infrastructure/Institutions)", firstly a 'demand index' of each respective infrastructure is developed by using equation (2):

$$Di = \frac{Ei \times SH}{SHi} \tag{2}$$

Where,
Di = Total Demand of the I-th infrastructure according to the existing support services in the study area without considering the population growth;
Ei = Total Number I-th infrastructure presently exist in the study area.
By using the Di and Ei value, a 'degree of demand (DD)' of the I-th infrastructure (DDi) is calculated by using equation (3):

$$DDi = \frac{(Di - Ei)}{Di} \tag{3}$$

The DDi varies between '0 to 1' ($0 \geq Ri \leq 1$). So, if the value of DDi= 0, then the I-th infrastructure supports 100% of the total population; similarly if DDi=1, then there is no support of the ith infrastructure. It also explains that the Ri value is the contra productive with DDi value. This analysis will help to find out the future spatial planning provision.

After finding out the DDi and Ri, this study tries to find out the result's correlation with social and economic conditions of the affected people. This section tries to answer how the lack of infrastructural supports, here termed as 'vulnerability due to infrastructure', affect the societal cyclone mitigation process. The available income opportunity after cyclone, changes in occupation, losses due to infrastructure, gender and age are considered to analyse this situation. Then using ArcGIS, Buffer geo-processing has been carried out for all the service infrastructures (Primary school, temple, clinic etc.) with their respective catchments area. Then the maximum infrastructural services (defined by catchments area buffer) available for each household location is identified. For this, new integer field "No_of_Service" was inserted in the attribute table of the household location feature class. A raster surface was then generated by IDW interpolation of the values of "No_of_Service" field. The raster surface is thus represents the infrastructural service coverage for the whole study area.

3. RESULTS AND DISCUSSION

3.1 Socio-Economic Condition in the Study Area

The socio-economic condition of the study areas describes peoples' educational background, their housing condition, occupation and their income level per month, response to the warning news etc. It is found that the area has population of 7768. Agriculture and fishing are the widely practiced occupation in this community. More than 75% people are involved in agriculture, about 20% people are labour and others are 5%.

This research reveals that more than half of the respondents have household incomes within Tk 2500 per month, which is below the poverty line. Figure 2 shows the monthly income of respondents.

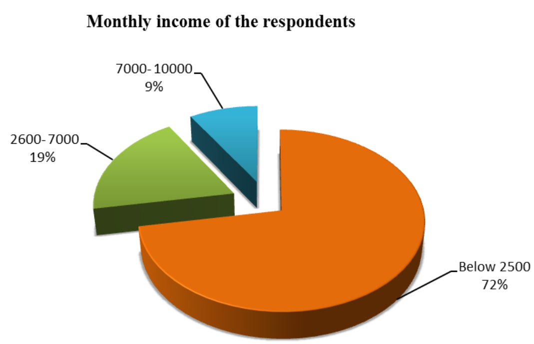

Figure 2: Monthly income (Tk) of respondents

Most of the respondents live in temporary housing i.e. katcha house system which is in a very poor condition. Figure 3 represents the percentage of existing housing structure in the study area and Figure 4 represents the existing housing condition in the study area.

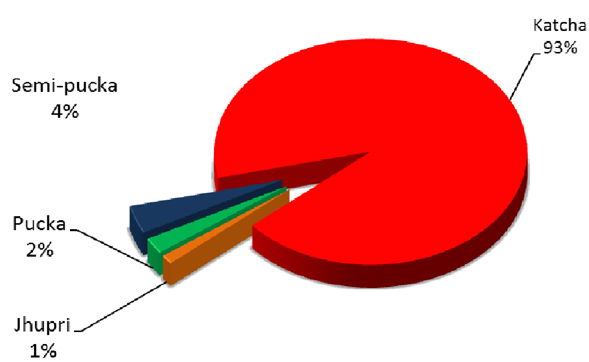

Figure 3: Type of housing structures (%) (BBS, 2011)

Figure 4: Existing housing condition in study area (Mud house)

This study also shows that about 65% people of the total community are literate and 35% are illiterate which is shown in Figure 5.

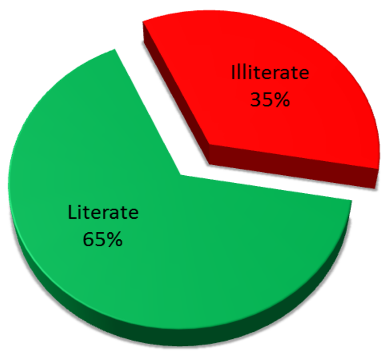

Figure 5: Percentage of literacy (BBS, 2011)

Though some of the people understood the existing weather signal, they were not timely alert about Cyclone Aila by the metrological department. After receiving the weather information usually they tried to make themselves safe. Table 3 shows what was their response to Aila either they were informed or not.

Table 3: Receiving warnings of Aila and immediate response of the respondents

Immediate response	News received (% of respondents)	
	Yes (78%)	No (22%)
Discuss with family members and decide to stay in home	50.1	6.3
Discuss with neighbours	10.4	5.5
Do not pay any attention about the news	12.5	10.2

According to the Table 3, about 78% of the people received the news of cyclone Aila and their immediate responses were only a simple discussion of family members and decided to stay at home. Though some people received news of Aila in time but they do not pay attention as they had very little faith about the early warning messages delivered from radio Bangladesh which was the primary cause of extreme losses.

3.2 Existing Infrastructure – Demand and Distribution

This measurement of the spatial pattern of intra-institute variations in the inter-household distances as well as the analysis by the nearest institute as a measure of the pattern reveals the tendency towards uniformity in distribution (Ri) of the selected supportive institutes. The Ri value varies here from 0.47 to 0.06 in the study area (Table 4). The highest Ri-value is equal to 0.47 refers to 47% of the community people have the chance to possess the benefit of the respective infrastructure and there is a provision of further development for the rest 53% community people, i.e. the DDi value for the same infrastructure is 0.53 (Table 4).

Table 4: Uniformity of Distribution (R) and Degree of Demand (DD) of selected public infrastructure

Infrastructure	SHi	Ei	Ri	DDi	% of HH possessing the supports
Primary School	838	5	0.47	0.53	47
High School	303	2	0.17	0.83	17
Religious building (e.g. temple)	100	1	0.06	0.94	6
Primary Health Care Centre	236	1	0.13	0.87	13
Family Welfare Centre	120	1	0.07	0.93	7
Union Headquarter	190	1	0.10	0.90	10

Here it is found that none of the selected infrastructure can support 50% of the total population i.e. the significance of vulnerability due to infrastructure is very high here. The same observation was also drawn by using the catchments area analysis of the existing public infrastructure in ArcGIS which is shown in figure 7. It shows that about 40% of the total settlement area has no support service. Figure 6 shows the surveyed households and the position of the infrastructures in the study area.

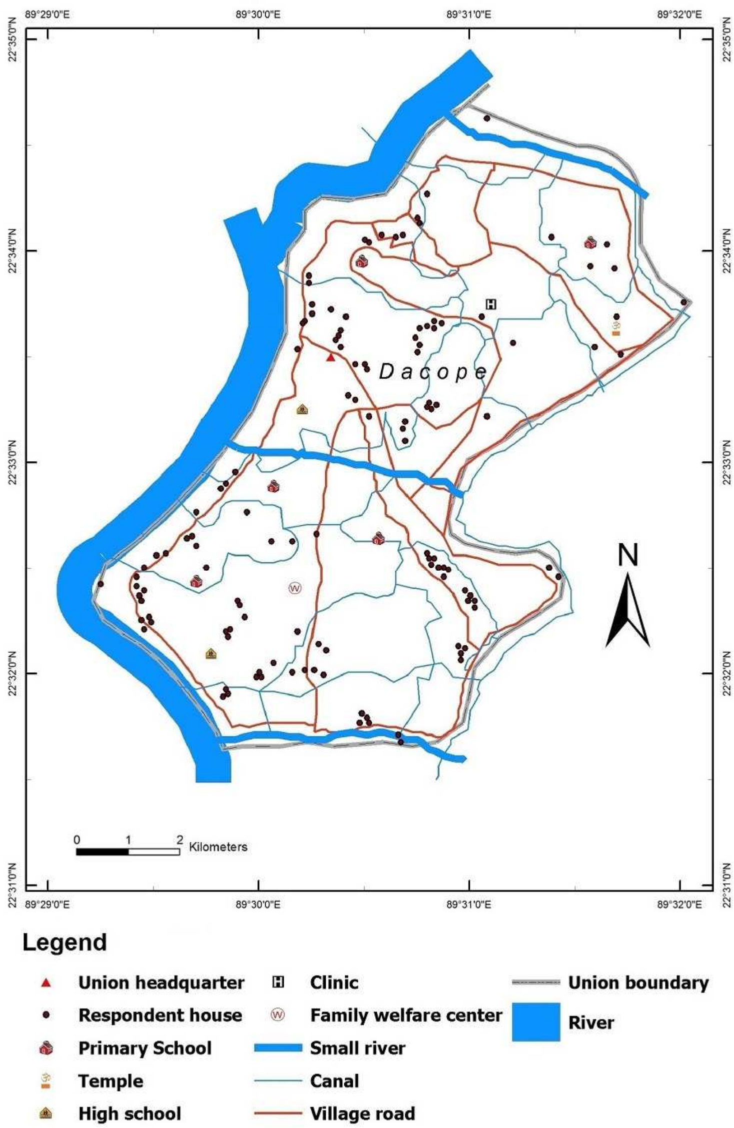

Figure 6: Surveyed household locations in Dacope union.

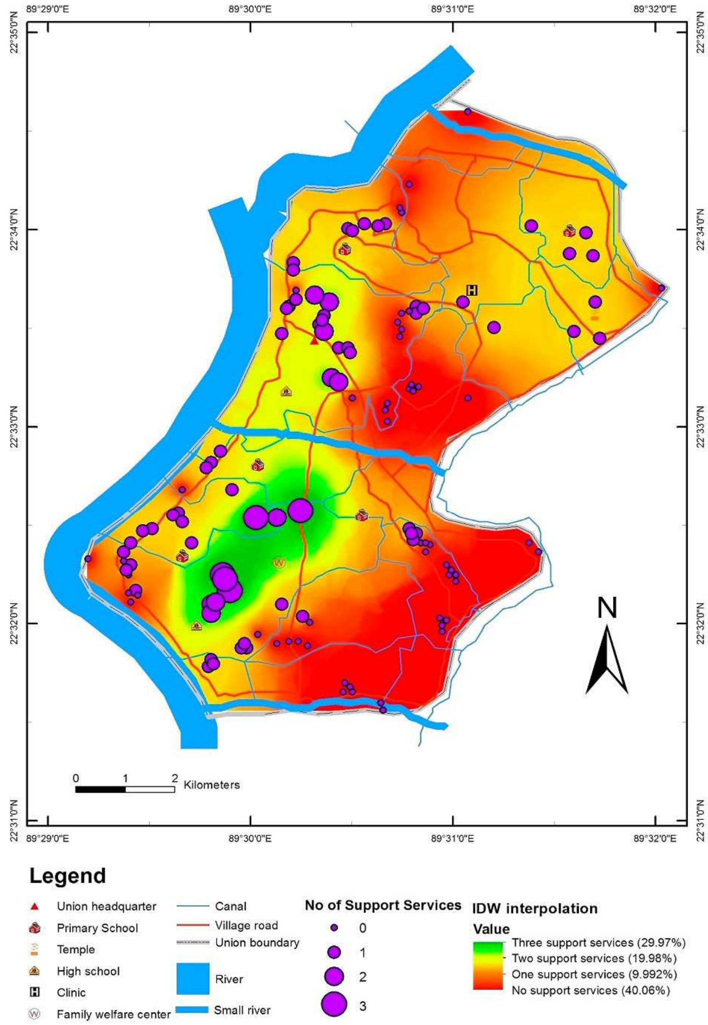

Figure 7: Infrastructural support and distribution of respondents

Another factor is the distance of safe shelters. Here the public infrastructures i.e. cyclone shelters, hospitals, school premises, religious buildings etc. were considered as safer place during the cyclone events. Figure 8 shows that the distance from household to the cyclone infrastructure and percentage of taking shelter during cyclone is negatively correlated because the possibility of taking shelter is decreases with the increase in distance from respondent house to the infrastructure.

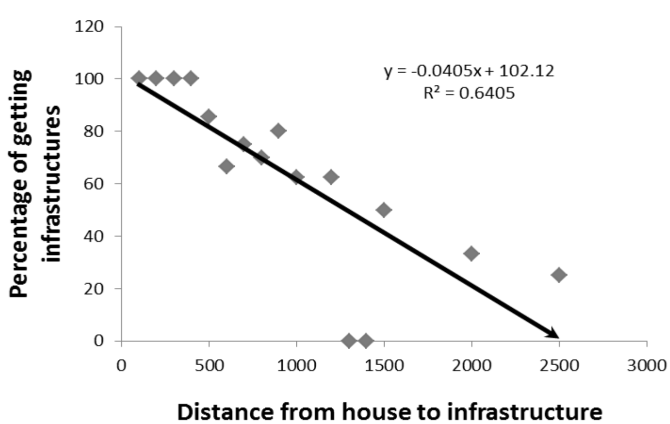

Figure 8: Relationship between percentage of getting infrastructure facility and distance

Usually peoples in rural Bangladesh invest money for a good quality house accordingly their financial capability. In this stage, the monthly income and investment to the residential house construction is considered. From the questionnaire survey it was observed that mostly 30% of the respondents used CI sheet for roof materials and 80% used ‘mud’ as wall materials. None of them had used bricks as wall materials. The status of residential house construction materials explicitly denotes the economic characteristics and socio-cultural status of the community. During questionnaire survey it was also observed that people who have a monthly income more than 90 USD possess at least a quality house. During group discussion with the affected people, it was found that the cyclone shelters are built nearby the rich or dominant people of the society. It was occurred mainly in two reasons: economic solvency and political power exercise. Thus, not only the inadequacy of infrastructure was the cause of increasing livelihood problems, but also the local social power system executed more complications for the general people.

Figure 9 depicts that most of the respondents groups whose monthly income is below 45 USD stands without any infrastructural support i.e. 44% of the low income people live in the no support service zone. Such simple observation may hints to the influence of local elites on the local disaster mitigation planning practice in Bangladesh.

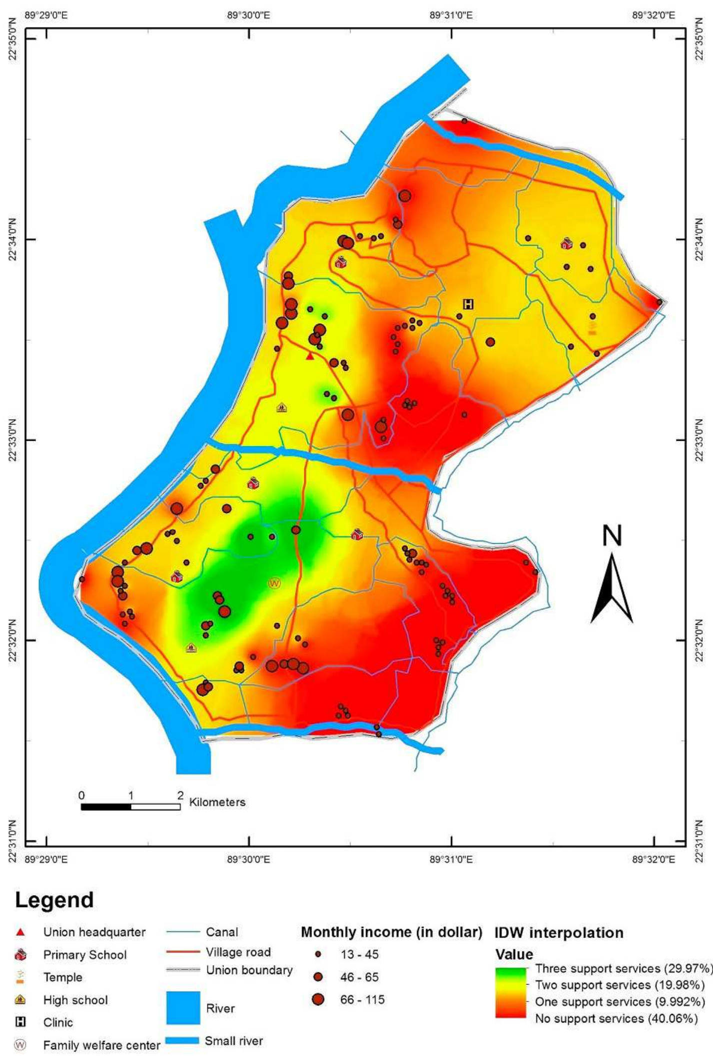

Figure 9: Respondents distribution according to their monthly income

3.3 Situation due to lack of Infrastructural Supports during Cyclone Aila

How does inadequate infrastructural supports affect during an emergency or disaster situation on a coastal city? It may be answered by calculating the damages and losses. The effect of saline water intrusion inside polders caused the destruction of houses, roads, culverts etc. It added more obstacles for the post disaster activities and also increased the sufferings of the victims. If there were adequate cyclone shelters or rehabilitation centre, the affected people could take shelter and continue other works temporarily. The following section outlays some important impacts of cyclone Aila in the studied coastal community.

3.3.1 Livelihood

Cyclone Aila devastated almost 85% bases of the livelihood of the respondents. Most unfortunate thing is that till now most of the affected people could not be able to recover the damages. Some of those are now engaged with wage labour activities offered by different GO's and NGO's to repair roads and embankments. However, these activities will be run for 40 days and after that their earning source is uncertain. Such contingency makes them frustrated and results into suicide of some of the affected people. (Kibria et al. 2015)

3.3.2 Housing and Relocation

Due to the Cyclone Aila and for aftermath water logging situation, infrastructural problems have been grasped the shelters including safe sanitation system, and raised vulnerability for people's livelihood. It was mainly occurred due to insufficient institutional as well as infrastructural supports for them. It changes their routine work, their income opportunities, and caused their social as well as geographical displacement. Majority of the Aila affected people in the study areas were forced to relocate their houses in embankments or raised land due to abolition of their houses by tidal surge and subsequent water logging. However, the relocated houses are mostly temporary and made of plastic sheets, bamboo or even wood. (Kibria et al. 2015)

3.3.3 Agriculture and Livestock

In the study areas almost all the agriculture land (>90%) were damaged. Most of the water sensitive fruit trees and vegetables died due to water logging. Majority of the respondents in the study area argued that it would not be possible to produce vegetables in salinity contaminated field before 2 to 5 years and for fruit species they have to wait for another 5 to 10 years. 85% respondents reported that Aila damaged their livestock resources.

4. CONCLUSIONS

This study emphasizes the need to focus on Disaster Risk Reduction in parallel to the disaster preparedness planning. Further technical assessment needs to be done to ensure that the mass-produced public infrastructures as well as family shelters are able to withstand category four or a lesser intensity of cyclones and to some extent flood and tidal surges. This should be an on-going learning process and needs to be done together with technical expertise from the government, academic institutes and infrastructure working group member agencies. The urgency to prepare for climate change might lead to a number of large infrastructural development projects in developing countries in near future.

Furthermore, this study shows the suffering during a hazardous event due to inadequate infrastructural supports. The situation may be similar along the coastal belt of Bangladesh. It may vary with some numbers, but the overall livelihood situation as well as infrastructural supports in developing countries is like presented here. Residents in coastal areas will have no recourse but to take refuge in rescue-shelter in the future. Engaging academic institutes and structural engineers to explore on sustainable building materials improvement and to understand 'non-engineered' and 'owner-built' housing construction process is further important. Otherwise, it will not be possible to save the populations who are living in such coastal areas.

Some recommendations for the future work are given below:

- It should be needed to build more cyclone infrastructure on those settlement areas where infrastructures are unavailable so that they can be able to support the total population.
- All public and private building should be above one storey so that it could be accessible to all.
- All shelters should have an adjacent Killa (high place, where cattle are being taken care of during any disaster) for livestock.
- Access routes from the communities to shelters should be metallic and those roads or tracks should be reinforced.
- The coastal embankments need to be designed, constructed and managed in a multi-purpose way to maximize their benefits as places of residence, economic production from forestry and also roads.
- In long term, small scale job opportunities should be introduced from the local investors, government and NGOs, i.e. training on craft, tailoring, poultry and fish feed firming, ice factory, umbrellas' bat factory, match factory, cold storage and other small and medium scale industries should be introduced to alleviate the poverty and reduce vulnerability of the local people.

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