## Vulnerability and Adaptive Capacity to climate Events: A Case Study on the Urban Poor in Bangladesh

Hasina Akther St118708 Doctoral Student, RRDP

#### **Committee members**

Dr. Mokbul Morshed Ahmad ( Chairperson) Dr. Thi Phuoc Lai Nguyen Prof. Vilas Nitivattananon

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#### Background

- Extreme rainfall and extensive urban growth with insufficient sewer systems causing urban flooding in many cities (Huang et al., 2018; Jenkins, et al., 2017; Sörensen & Mobini, 2017), commonly known as pluvial flooding.
- Over the last few decades, the frequency of urban flooding has increased (Hu et al., 2018), particularly in highly dense populated metropolitan areas (Jiang et al., 2018).
- This flood destroys property and lives, and having negative impact on the environment and health.
- The effects of flooding differ depending on social class, organizational setting, physical surroundings, and from one region or within the same city
- Impacts are socially differentiated in terms of the decision-making capability and resource capacity of households (Pandey et al., 2018).
- the urban poor or slum dwellers are the most vulnerable and their livelihoods are seriously affected (Rahman et al. 2010).

### **Problem statement**

- Over the last few decades, the **frequency of urban flooding has increased** (Hu et al., 2018), due to rapid urbanization, insufficient drainage networks, and climate change threats particularly in highly dense populated metropolitan areas (Jiang et al., 2018) like Dhaka city.
- High population density in Dhaka and their subsequent need for land; canals, ponds, and wetlands on the eastern and north-eastern zones of the city are constantly filled up
- This has not been done together with a sufficient drainage plan and therefore moderate to heavy rainfall simply leads to flooding and water-logging in lower areas of Dhaka city during monsoon (Ishtiaque, et al. 2015) named as a pluvial flood.
- the urban poor, make a house in an illegal, hazardous and risky areas and live in more vulnerable situations with limited access to basic infrastructure and facilities; and inadequate or no access to information and knowledge. Along with this condition, climate impacts due to extreme events are exacerbating underlying vulnerability (Moser and Satterthwaite, 2008).
- In Dhaka, nearly 40% of the city population is living in slums (Angeles et al., 2009) and every year the city receives between 300,000 to 400,000 migrants as a result of both push and pull factors (Banks et al. 2011).

Establishment of new slum or expansion of existing slum in high risk areas is particularly a matter of concern as the slum settlers might not be able to cope with the additional shocks in high risk areas like extreme climatic events because of their limited adaptive capabilities.

#### **Problem statement**

Two major aspects pointed out from these previous studies on urban poor in Bangladesh;

firstly, these studies are mostly based on river flooding as an extreme event, with little or no consideration given to the pluvial flooding

secondly, these studies refer to impacts and influencing factors of climate change, and adaptation and managing policies of urban poor

but not clearly explain the degree of vulnerability and the status of adaptive capacity which are very important for adopting successful adaptation strategies for the slum households.

 the present study makes an attempt to investigate the status of livelihood assets for considering the adaptive capacity and to quantify the level of vulnerability of this vulnerable group in Dhaka city

## **Objectives of the study**

#### **General Objective**

The general objective of this study is to inquire the vulnerability to pluvial flood and to assess the adaptive capacity of urban poor households in Bangladesh.

#### **Specific objectives**

The general objective of the present study is specified by the following objectives:

- 1. to assess the livelihood status of the urban poor households;
- 2. to understand the vulnerability of urban poor households to pluvial flood;
- 3. to explore the adaptive capacity of the urban poor households ; and
- 4. to assess the current policies and the responses at household level in adopting adaptation options to climate change vulnerability.

## **Rationale of the study**

- The studies on effects of climate change in Bangladesh are mostly based either on coastal areas or on rural communities (Ahsan & Warner, 2014; Toufique & Yunus, 2013). A few considerations have been made on urban poor communities,
- The urban poor constitutes a significant portion of the total urban population and make substantial contributions in informal sectors of urban areas, they are typically living in the most dangerous areas of the city and are the most vulnerable to adverse weather.
- this study investigates the livelihood status of the urban poor households in terms of household capitals of a livelihood approach which makes it possible to understand the common picture of the livelihood status of the urban poor households
  - To know the level of urban flood vulnerability of urban poor families may help in the development of effective adaptation policies and programs for reducing flood vulnerability (Sam, Kumar, Kächele, &Müller, 2017b)
    - the urban poor are placed far from the power structures, they are likely to be a less concern for governments, including in emergency planning. So, the suggested adaptation options for the urban poor households might assist not only for vulnerability reduction but also poverty reduction along with basic development and improve the adaptive capacity as well.

## **Scope of the study**

only urban flood known as pluvial flood is considered

- Dhaka city was selected for this study as a study area
- Livelihood assets are assessed based on livelihood capitals adopted from Sustainable Livelihood Approach (SLA). Among the five types of assets, this study considered four capitals including human, social, financial, and physical.
- This study does not work on adaptation strategies of urban poor though it addressed some preparedness and coping mechanisms practiced by the respondents.
- vulnerability depends on different types of factors like environmental and non-environmental factors and institutional factors etc., this study considered only the non-environmental (socio-economic) factors.

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## **Conceptual Framework**



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# **Study area**

Screening	Area	Selection criteria		
steps				
Step – 1	Bangladesh	- One of the most vulnerable countries to		
Country		climate change		
		-Rapid urban growth with considerable		
		number of urban poor population		
Step-2	Dhaka city	- Urban population concentration of the		
City		country		
		- Flood affected area (urban flood)		
		- Urban poor agglomeration		
Step – 3	Dhaka North City	- Urban population		
Urban	Corporation (DNCC)	- Urban poor population		
areas	Dhaka South City	- Urban Flood affected (monsoon flood and		
	Corporation (DSCC)	water logging)		
Step- 4	2 Slum settlements	- Location - flood affected areas,		
Urban poor	from 2 urban areas	- Size and agglomeration (number of HH)		
settlements				



## **Sample size and Data Collection**

 $n = N/1 + N(e)^2$ 

Where,

n = sample size

- N = Total number of Households (878)
- e = level of precision (5%)

Study Areas	Total HHs of	Sample Fractions	Calculating Sample	Fixed sample	
	Sample settlement				
Mollah slum, Mirpur (DNCC)	468	0.45558	213	215	
Rail line slum, Gandaria	410	0.45558	187	185	
(DSCC)					
Total	878		400	400	

Source of data	Methods of data Collection	X		
Secondary	Statistical handbooks and census report, disaster/hazard maps, journals and books,	Statistical handbooks and census report, disaster/hazard maps, journals and books,		
	reports			
Primary				
Qualitative	Reconnaissance survey			
	Field observations			
	Key Informant Interview (KII)			
	Focus Group Discussion (FGD)			
Quantitative	Household Questionnaire Survey			

## **Data Analysis**

		Data Analysis methods
Quantitative analysis	•	<b>Descriptive statistical</b> tools included mean, frequency, percentage, and cross-tabulation.
	•	<b>Pearson's Chi-square test</b> was used to judge the difference between the urban poor settlements in case of their socio-economic profile and for each index.
	•	The quartile method was used to group the households into four classes such as very
		low, low, moderate and high to understand the level of livelihood status.
	•	Differences and association were showed by t-test and correlation.

Qualitative	FGDs and interviews using thematic analysis.
analysis	
	• For thematic analysis, researcher did open coding manually by identifyin
	meaningful chunks in data and then grouped the open codes into several categorie
	and finally, generated the themes from the categories.
	• A composite index and indicator based approach was applied for the assessment of
	normal and stressed livelihood status and the scale of vulnerability and adaptive
	capacity of the urban poor households. 12

## **Socio-economic characteristics of the Respondents**

Socio-Economic characteristics		Mirpur slum		Rail line slum		Chi Square Test
		Frequency	%	Frequency	%	
Age	<30 31-40 41-50 51-60 >60 Mean Std Dev	56 80 46 22 11 40.32 12.26	26.0 37.2 21.4 10.2 5.1	23 55 59 27 21 45.77 12.90	12.4 29.7 31.9 14.6 11.4	X <sup>2</sup> =21.53**
Household size	3 and less 4-5 6 and more Mean Std Dev	87 101 27 3.91 1.38	40.5 47.0 12.6	63 103 19 4.02 1.19	34.1 55.7 10.3	X <sup>2</sup> = 4.45
Monthly income ( BDT)	5001-10000 10001-15000 15001-20000 20001-25000 >25000 Mean Std Dev	28 78 79 17 13 16823.26 7395.902	13.0 36.3 36.7 7.9 6.0	49 62 36 25 13 15494.59 6530.44	26.5 33.5 19.5 13.5 7.0	X <sup>2</sup> = 11.77*
House ownership	Tenant Proxy Landlord/ owner Mean Std Dev	173 42 1.20 .397	80.5 19.5	20 165 1.89 .31	10.8 89.2	X <sup>2</sup> = 192.21**
Educational Attainment	No Education Primary Secondary SSC or equivalent HSC or equivalent	84 88 29 9 5	39.1 40.9 13.5 4.2 2.3	85 74 23 1 2	45.9 40.0 12.4 .5 1.1	X <sup>2</sup> = 7.38
Employment	Employed Unemployed	203 12	94.5 5.6	170 15	91.9 8.1	X <sup>2</sup> = 38.96**

Source, Field Survey, 2018, \* Significance level:  $p \le 0.05$ , \*\* Significance level:  $p \le 0.01$ 

# **Objective 1: Livelihood Status**

to assess the livelihood status of the urban poor households;

- Livelihood status in Normal and Stressed situation
- Livelihood variation in Normal and Stressed situation

## **Livelihood Status: Normal and Stressed Situation**

Capitals	Normal S	ituations (Tota	Index value)	Stres	Stressed Situations (Total Index value)			
	Mirpur Sl	um Rail Line	e Slum Pearson	n's $x^2$ Mirp	ur Slum Rail	Line Slum Pe	earson's $x^2$	
Human Capital	0.51	0.40	88.161	** 0.30	0.29	32	4.059**	
Financial capital	0.47	0.49	22.941	** 0.28	0.25	39	6.059**	
Physical Capital	0.44	0.41	125.00	7** 0.32	0.28	10	0.065**	
Social Capital	0.57	0.56	18.544	0.69	0.62	39	9.637**	
Livelihood Statu	s 0.495	0.4	54		0.397	0.359		
Level of measurement								
0 - 0.20	0.21- 0.40	0.41- 0.60	0.61- 0.80	1				
Very poor	ry noor Poor Mode		Good Verv		good			



Both urban poor settlements were in moderate status (0.41-0.60 in 0 to 1 scale) in a normal situation, while the status was poor (0.21-0.40 in 0 to 1 scale) in terms of capitals in the stressed situation except the social capital status in both areas.

Mirpur slum seems to be in a better position compared to the Rail line slum. This could be due to the differences between the socio-economic characteristics of the two study areas;

- In a normal situation, human capital and physical capital are in worse situation among the four types of capital.
- Poor health status with different types of health problems such as disability, chronic illness and seasonal illness;
- low frequency of food consumption (do not have had 3 meals in a day) and little or no skills with lower education level indicates the poor human capital status.
- poor housing materials with crowded room were found in the study areas.
- the poor condition of other physical structures such as road access (around 40% HHs did not have road access), drainage facility (29.3% did not have drainage facility and 50.5% had drainage system with open and poor maintenance), sanitation (78% sanitation was tin ring slab without water sealed and one sanitation used by more than four families) and water supply system (74% HHs depends on public stand pipe line).

- In a stressed situation, physical, human and financial capitals became more deplorable
- In stressed situation, housing structure became collapsed, road network was damaged completely; the drainage systems were blocked, and the sanitation and water facilities deteriorated totally.
- More than twenty families had to use one toilet and females were facing serious problems for sanitation needs including taking a bath. In the post-flood period the dwellers were injured and suffering from several types of water-borne diseases (skin diseases, diarrhea).
- About one-third of respondents lost their work and they had to borrow or beg for surviving. The condition became worst for those who did not have savings. In addition, they had to face very hard time with extra expenses for food and health care.
- In both situations social ties reflect good position.

> It was also found that the capitals influenced each other particularly in stressed period.

- Loss of dwellings and community infrastructure fade the financial asset and the impact on human capital influenced financial capital and social capital. The respondents claimed that during the stressed period they had to spend the large portion of saving for repairing their houses and assets, paying for food and water, and also for sickness, and even they had to borrow money from others

- Impact on human capital influenced the social capital, for example, the loss of lives can affect the surviving household as well as hamper economic and collective activities and outside the family.

A significant difference was found between normal situation and under stressed situation in terms of four capitals.

Capitals	T - Test	df	P -value
Normal Human Capital- Under stressed	32.188	399	.000
Human capital			
Normal Financial Capital- Under stressed	10.223	399	.000
Financial capital			
Normal Physical Capital- Under stressed	32.542	399	.000
Physical capital			
Normal Social Capital- Under stressed	6.889	399	.000
Social capital			



Positive relationship confirms that the normal situation of the livelihood status of the urban poor settlements influenced the stressed situation

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## **Objective 2**

to understand the vulnerability of urban poor households to pluvial flood;

- Vulnerability Assessment
  - a. Livelihood vulnerability Assessment
  - b. Socio-economic vulnerability Assessment

#### **Objective 2: Findings** Livelihood vulnerability



LVI is on a scale from 0 (least vulnerable) to 0.5 (most vulnerable).

LVI: Mirpur Slum 0.295, and LVI: Rail line Slum 0.300

Mirpur slum is more vulnerable than Rail line slum in terms of livelihood strategies and water component

whereas Rail line slum has the more vulnerable score than the Mirpur slum in social networks, health, food , housing and natural disaster.

Therefore, households are vulnerable more than one components (Devi, 2016; Duy can, 2013; Hahn et al. 2009; Toufique and Yunus, 2013; Toufiqe and Islam, 2014).

# **Socio-economic Vulnerability**

IPCC contributing fact	ors to vulnerability	Mirpur slum	Rail line Slum
Socio-demographic Profile			
(SDP)	Adaptive	0.237	0.183
Livelihood Strategies $(LS)$	capacity		
Social networks(SN)			
Health(H)	Sensitivity	0.341	0.396
Food (F)			
Water(W)			
Housing (Ho)			
Natural Disaster (ND)	Exposure	0.327	0.347
SeVI		0.477	0.520

The SeVI was highest for Rail line slum (0.520).

Therefore, it was found that the Rail line slum was most vulnerable in both cases, in terms of LVI and SeVI. This result match with the result of Sam et al. (2017) a study based in India.

LVI and SeVI values were found to be different

### **Objective 3.**



to explore the adaptive capacity of the urban poor households

- the lower adaptive capacity confirm the higher sensitivity and higher adaptive capacity indicate the lower sensitivity in Rail line slum and Mirpur slum respectively.
- Socio-demographic profile and livelihood strategies are found as more influential factors to adaptive capacity (Ahsan and warner,2014)
- It also found that adaptive capacity influences the exposure for instance due to lower adaptive capacity Rail line slum is more expose to flood than that of the Mirpur slum<sup>23</sup>. Similar findings were found in Hardoy and Pandiella, 2009 and Revi, 2008.

## **Objective 4**

to assess the status of current policies and the responses at household level in adaptation options to climate change vulnerability

- It was found that very recently the development policies are addressing the urban poor in development sectors such as housing, health, water and sanitation etc.
- although climate change is adding pace and complexity to Bangladesh's urban future, urban poverty still gets limited importance in national policy action for climate change
- The fund allocation for Research and Knowledge Management of CCA for the urban poor remains low.
- Informal organizations play an important role to the urban poor communities
- It was also found that the households invented some coping and preparedness measures then they practiced and adopted those to minimize the impacts of flood. However, these adaptive practices are informal which can offer only short term resilience to the extreme climate event.

## **Contributions of the Research**

Three ways such as in context base, in methodology and in policy level.

- Firstly, some key findings of this research represent the similar findings of some relevant studies. This study will enrich the literature as an extended work on livelihood status and vulnerability assessment of resource poor slum community of a developing country like Bangladesh
- Secondly, In measuring vulnerability, this study considered 'housing' as an additional subcomponent which is used in vulnerability assessment for the first time.
- Since the index was constructed from primary data, any researcher may control the type of information and the definitions of relevant categories of a given region, sector, or community.
- Finally, this study figured out the livelihood status and scale of vulnerability and adaptive capacity of urban poor settlements of a developing city. Since the characteristics of the urban poor settlements in developing countries more or less similar, these study findings may assist the policy maker in formulating adaptation strategies for this urban group not only in other city of Bangladesh but also in any developing city in the world.

# **Policy Implementations**

- Assets or capitals define people's capabilities to cope with vulnerabilities (Sen, 1997; Bebbington, 1999).
- The more assets people have, the less vulnerable they are; the greater the damage of people's assets, the greater their vulnerability (Moser & Satterthwaite, 2008).



Among the capitals, human and social capitals play an important role in livelihood status and these two capitals influence other capitals very effectively(Bebbington, 1999; Badjeck et al., 2010).

#### **Policy Implications( Continue)**

- Proper training and good education can develop human capital. Improving the quality of life not only secures better jobs and enhances their ability to participate in development activities in their community.
- The better income households received recognition from the community easily which enhanced their social capital.
- Good income also ensures better housing quality, and a better location of living positively influences access to government and NGOs.
- Similarly, better social capital ensures better organizational access through which income is positively influenced by better access to the economic system provided by the government and NGOs.

## Recommendations

- To provide education and training facilities for capacity building; and provide proper health facility. These will help to make strong human capital. Housing materials, sanitations, drainage system and inside road should be improved.
- To develop saving practice (individually and collectively) through well money management and maintain access to multiple sources of credit in stressed situation.
- More emphasis should be given to improve human capital and social capital. These will positively influence the other capitals
- The key concern should be given to improve food security, health facilities, and housing structure and safe and adequate drinking water supplies for establishing an adaptation strategy for these households to reduce vulnerability
- Local-level adaptation is needed to increase the individual or community's adaptive capacity.
- ▶ To improve cooperation among the implemented agencies and technical capacities
- ► To increase the investment on research sector

#### Limitations of the study

- > Due to sampling procedures, this study might be missed some of the most vulnerable families.
- > Household was main focus of data collection, and no particular attention was paid to gender specific analysis.
- Major part in livelihood status assessment does not follow any rigorous mathematical or statistical models such as principal component analysis, factor analysis, multi- criteria decision making etc.
- Vulnerability analysis has been primarily based on social or non-climatic components rather physical or climatic components
- The vulnerability index is the equal-weights in measuring sub-components that are not perfect in all cases

#### **Proposed Future Research**

this study propose some issues for further research on the relevant topic,

- Similar types of research studies should be undertaken in other parts of the country that validate the findings of this research and to explore the additional components of vulnerabilities.
- The future research can focus on developing unequal weighting tools for vulnerability assessment through mathematical and statistical modeling.
- The future research may emphasis on some relevant topic in flood vulnerability assessment which could be covered in detail in current study such as community resilience, institutional capacity, flood governance etc.

## **Outcome of this Research**

#### Article

1. Akther,H and Ahmad, MM (2021) Livelihood under Stress: The Case of Urban Poor during and post-flood in Dhaka, Bangladesh, The geographical Journal, <u>https://doi.org/10.1111/geoj.12379</u>

2. Akther,H. Ahmmad, MM and Nguyen,Thi, PL (....) Livelihood Vulnerability to Urban Flood: The Case of Urban Poor Households in Dhaka, Bangladesh (Submitted)

3. Akther,H and Ahmad, MM (.....) Livelihood in Normal and Stressed Situations: Pluvial Flood Prone Slum Communities in Dhaka, Bangladesh (Submitted)

#### Book chapter

1. Akther, H. and Ahmad, MM (2021) Livelihood and Pluvial Flood: Case of Urban Poor in Dhaka City, Bangladesh, Walter Leal Filho et al. (Eds): Handbook of Climate Change Management, 481867\_0\_En, (Chapter 44-1) Chapter DOI 10.1007/978-3-030-22759-3 44-1

