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Analyzing Vulnerability to Flood Hazard of Urban People: Evidences from Dhaka Megacity, Bangladesh

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Abstract: *Bangladesh experiences flood almost every year causing tremendous loss of property and life. Among other cities, Dhaka, the capital city and one of the most populated megacities of South Asia faces flood very often. This study aims to analyze the influence of socioeconomic, physical and demographic vulnerability to flood hazard of urban people (for both non-slum and slum). The structured questionnaire investigation, key informer interviews and empirical observation were administrated to collect required data from the eastern part of Dhaka megacity. The key findings of the study expose that the socioeconomic, physical and demographic factors have a considerable function to control people's vulnerability to flood-induced hazards. The empirical data suggest that least education, insecure job and fragile housing condition make the slum people extreme vulnerable to flood. The slum people having vulnerable physical circumstance, nominal coping capacity and least education have fewer accesses to high paying and secure job, well-constructed housing and resilience to cope with potential flood hazards moreover this group of urban inhabitants are typically vulnerable to future calamities. Surprisingly their strong social network and neighborhood help them to rescue from crisis. In contrast, single-family composition and not to going shelter center make the non-slum people vulnerable. But, awareness and well preparation protect them from the natural disasters. The study finally concludes that the inherent susceptibility of households is responsible to increase the vulnerability of urban people to flood hazard.*

Keywords: *Flood, Urban vulnerability, Coping capacity, Slum, Dhaka megacity*

1. Introduction

Flood is a most costly and destructive hazard among the natural hazards. Presently, it becomes as a very big perturbation for many countries over the globe [1]. In last two decades, it killed 100,100 lives and invaded about 1.3 billion people. Since 2000-2015 flood has affected approximately 97 million people per year [2]. It is also the concerning matter for Bangladesh, because flood is the most expensive natural hazard in Bangladesh. It is estimated that almost 175 million USD is lost and thousands of people are affected every year in Bangladesh due to flood [3]. However, floods accustomed to confine to rural the regions, but currently it also happens in metropolitan areas. But, owing to elevated population density and various economic functions, cities of the world, especially the developing countries are facing many challenges to deal with flood-induced troubles. This circumstance could be linked by the *ratchet consequence* of vulnerability [4].

Although vulnerability is being discussing as an important theoretical topic in research field for more than a decade but in practically the term vulnerability is applying from last few years [5]. It causes damage to lives, assets, livelihood thus vulnerability represents the system of the community's physical, economic, social or political susceptibility to damage as the result of hazardous events. The concepts of vulnerability within the disaster management context are too complex and varied. In general, it refers to the susceptibility of a community to harm from an event, often determined by a community's geographical exposure [6]. For illustration, the dimension of a natural hazard might have different impacts for different individuals and/or societies. In the circumstance of the same magnitude of flood, the wealthy people suffer fewer in terms of their income, wealth and belongings but the poor may still experiencing more challenges owing to their disability to deal with natural calamities [7].

The megacities have a great role to economic development and social growth, so they are the most risky areas to environmental hazards, specifically megacities from developing countries [8]. Several studies have noticed a number of factors influencing vulnerability to natural exposures in urban areas and megacities. Such as [9] noted that urban vulnerability to disaster is resulted from several aspects like man and environment interaction and the influences of political economy. However, [10] mentioned that the rising human vulnerability to flood in megacities is resulting from high population density, unplanned urban development with dynamic socio-economic characteristics.

Presently, some investigations have completed to explore flood vulnerability in different areas like, [11] confirmed that for reducing future vulnerability to flood need improvement of livelihoods, advance

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forecasting system. Furthermore, [8] has carried out a noteworthy work for flash flood vulnerability and pointed out two factors (physical and social vulnerability) of it. As well, [12] illustrated how and when the social dimension of flood vulnerability is incorporated for understanding of the physical threat of flood in urban area. [13] referred that economic incentives in Dhaka megacity are not sufficient for flood affected slum people. This makes them vulnerable to next floods as well any kinds of hazards. However, [2] demonstrated that the physical and socio-economic vulnerability are promoting the major problems for informal settlements of South Africa and Nigeria as well as poverty emerges as an important indicator of flood induced vulnerability. As [14] have established a link among flood vulnerability, poverty and risk by applying utilitarian approach and characteristics of households. However, it is found that a few studies have been done on various aspects of vulnerability to flood hazard in urban areas in Bangladesh. Consequently, this study intends to explore the socioeconomic, physical and demographic vulnerability of urban people in Dhaka megacity. In addition, it would try to state the present coping capacity of urban people to flood hazard.

2. Study Area

Dhaka, the capital and only mega city of Bangladesh is located in the central region of the flat deltaic plain and situated on the northern bank of Buriganga River. Besides, it is the largest administrative, commercial and industrial center of Bangladesh. It becomes 'megacity' in 1991 with 6.8 million residents. It consists of 90 wards accommodating above 10 million people and containing 4966 slums [15]. It is situated between latitudes 23°39' and 23°54'N and longitudes 90°20' and 90°28'E (Figure 1). The megacity is surrounded by several rivers like, the Buriganga to the south, the Turag to the west, the Tongi khal to the north, and the Balu to the east. The elevation of Greater Dhaka lies between 2 to 13 m above mean sea level (msl). Most of the urbanized area lies at the elevation of 6 to 8 m above msl. Approximately 90% of the annual rainfall occurs in rainy season (May to March) and the mean yearly precipitation is 2,000 mm. The temperature varies between 42-5°C. Monthly evaporation ranges from 80 to 130 mm [16]. Like other megacities in Asia, Dhaka megacity also faces flood problem.

Flood is not a new phenomenon for the inhabitants of Dhaka city. The city has been facing flood since its early age. Historical data show that Dhaka city was heavily inundated during 1787 and 1788. Major floods in the Greater Dhaka area occurred in 1954, 1955, 1970, 1974, 1980, 1987, 1988, 1998, 2004, 2007, 2008, 2010 and 2013 due to spillover from surrounding rivers.

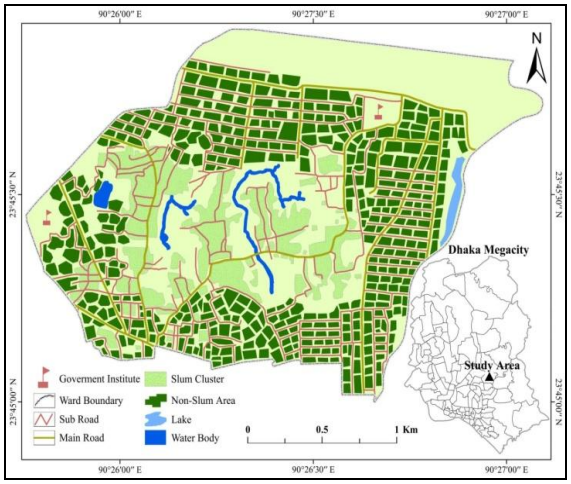

Figure 1: *Location of the study area*

Among these, the 1988 and 1998 floods were catastrophic. There are many causes responsible for the occurrence of floods in Dhaka city. Among them high water level of peripheral river system and the rainfall are most prominent. The radical geographical setting of Dhaka megacity has made it vulnerable to natural hazards especially to flood and the rapid urbanization has increased the scale of flood vulnerability. The major portion of Greater Dhaka is moderate to very high flood prone area. Only a little portion (8.04%) is least vulnerable to flood hazard. On the other hand, 28.70% of greater Dhaka is highly vulnerable to flood hazard [13]. Among vulnerable population slum dwellers are mostly vulnerable because, often they are least educated, economically poor and live in marginal areas.

3. Methodology

To fulfill the objectives, both primary and secondary data are collected for the present study. The study is conducted mainly based on primary data. To find out the causes of flood vulnerability of slum and non-slum dwellers, a field survey as well a questionnaire survey at household level were administered. The eastern part (ward no. 3, part of Khilgoan Thana) of Dhaka megacity is selected purposively. This ward consists of 12490 households [17]. With the ward map firstly the study selected 145 building among 311 and 30 slum clusters among 88 by applying simple random sampling methods. The selected 145 buildings and 30 slum clusters were respectively. Among the total households, 297 households (Slum = 151; Non-Slum = 146) were randomly sorted out to questionnaire survey.

Before questionnaire survey, a reconnaissance survey was carried out to get the general information of physical environment, human characteristics, settlement pattern, socio-economic structure, and disaster history of the study area. After reviewing the existing literatures related to vulnerability and responsible factors of flood vulnerability [18, 19, 12] a structured questionnaire was developed for

collecting data. Prior to final questionnaire survey pre-testing of the questionnaire was carried out to modify the questionnaire. Having finished reconnaissance survey and pre-testing, questionnaire was modified for final survey. Irrelevant questions were omitted while few additions have been made based on the pre-testing. Three factors (socioeconomic, physical and demographic) associated with flood vulnerability also the coping capacity were considered to develop the survey questionnaire. Note that these factors are defined based on the existing literatures [20, 10, 5, 21].

4. Results and Discussion

4.1 Analyzing of Socioeconomic Vulnerability

Socioeconomic condition is the most significantly measured features in vulnerability research. Analyzing social vulnerability to natural hazards is an important step to assess over all vulnerability of a community. Because, it mostly apparent after a hazard [22].Flood also increases the vulnerability of city dwellers economically as well. Particularly it is the most severe hazard for low status socioeconomic groups. On the basis of previous studies [18, 23] the current study has chosen some particular indicators like education, occupation, household income, social network and continuity of work during flood to analyze and assess socioeconomic vulnerability.

4.1.1 Education and Occupation

Education is the key human capital, assists people to take proper decision and adopt required mitigation techniques to get rid from natural hazards. This indicator is very important to assess vulnerability because educated people are normally more alert to extreme events moreover play vital role to reduce the damage resulted from flood. Existing literatures recommend that high-educated families can cope better than low educated families [16, 24]. The present study finds that the majority respondents (46.4%) of slum have no formal academic education and engaged in rickshaw-pulling, day-labor and housemaid while 36.4% holds primary level education (Table 1).

***Table 1**: Relationship between education and occupation*

Occupation	Household heads' educational qualification																			
	Slum										Non-Slum									
	Illiterate		>1<5		>5<10		HSC		Total		>1<5		>5<10		SSC & HSC		Bachelor & Master		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Unemployment	13	8.6	0	0.0	0	0.0	0	0.0	13	8.6	0	0.0	0	0.0	10	6.8	1	0.7	11	7.5
Service	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	2.7	2	1.4	22	15.1	46	31.5	74	50.7
Business	3	2.0	9	6.0	1	0.7	2	1.3	15	9.9	3	2.1	2	1.4	18	12.3	24	16.4	47	32.2
Rickshaw-Puller	23	15.2	14	9.3	5	3.3	1	0.7	43	28.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Day-labour	26	17.2	27	17.9	11	7.3	6	4.0	70	46.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Housewife	3	2.0	1	0.7	0	0.0	0	0.0	4	2.6	2	1.4	0	0.0	11	7.5	1	0.7	14	9.6
Housemaid	2	1.3	4	2.6	0	0.0	0	0.0	06	4.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	70	46.4	55	36.4	17	11.3	9	6.0	151	100	9	6.2	4	2.7	61	41.8	72	49.3	146	100
χ^2-test	$\chi^2 = 30.541$, Sig. value = .010, df = 15, $\alpha = 0.05$										$\chi^2 = 28.091$, Sig. value = .001, df = 9, $\alpha = 0.05$									

Very few (6%) slum dwellers have higher secondary education and 11.3% respondents' educational qualification is limited to class five-ten. In surveyed slum clusters, none was found with bachelor and master degree. In non-slum, about half (49.3%) of the respondents are high educated (holding bachelor and master degree) and 41.8% has secondary and higher secondary level education. These results are constant with the study of [18].

The empirical results show that the educational level of slum people is far away from the non-slum. Several earlier studies [8, 1, 24] revealed that the consequence of floods differ with the social status. However, among the poor, the daily labors, construction workers and rickshaw-pullers are most vulnerable groups [7]. In slum, most of the people are normally engaged in informal activities like rickshaw pulling, day laborer, petty business, small job services etc. Around half (46.4%) of the slum household head's occupation is day laboring. They work as hotel boy, factory labor, hawkerring, driving and so on. As such, the highest (28.5%) number of respondents is found as rickshaw puller. The majority of these occupations are related to physical labor and do not confide on sophisticated infrastructures, so these people are defenseless to disaster impacts, as their work stops during flood. As a result, floods directly disrupt their income flow very easily. The existing deficiency of economic capital makes the slum dwellers extremely vulnerable to exotic thrust. Some inhabitants (9.9%) survive with business. However, very few (8.6%) are found as unemployment. On the other hand, most of the people of non-slum occupy formal and secure job like service (50.7%), business (30.2%) (Table 1). The low paid job of slum dweller makes them vulnerable to flood hazard as well as any kinds of hazards or disasters as compared to non-slum people. The Chi-square result ($\chi^2 = 30.541$, Sig. value = .010, df = 15, $\alpha = 0.05$ for slum and $\chi^2 = 28.091$, Sig. value = .001, df = 9, $\alpha = 0.05$ for non-slum) of education and

occupation of slum and non-slum is statistically significant.

4.1.2 Income

The relationship among hazard, vulnerability and poverty are very complicated. Nevertheless, several studies have noticed that low earning people are mostly vulnerable to natural exposures [5, 2, 22, 23]. The communities with high income are more resilient against disaster. Therefore, for showing flood vulnerability of slum and non-slum dwellers, this study categorize the income level of them differently but the numbers of classes are uniform. However, the monthly household income range of slum dwellers is Tk. 3500 to 52000 (*1 USD = 79.27 Tk.*). Around one-fourth (25.8%) households of slum belong to the low-income group and 36.4% earns Tk. 7501-11500 (Table 2).

Table 2: *Association of household income and impacts of flood*

Impacts	Income level (Tk.)																			
	Slum										Non-Slum									
	3500 to 7500		7501 to 11500		11501 to 15500		More than 15500		Total		12000 to 20000		20001 to 28000		28001 to 36000		More than 36000		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Continuity of work																				
Yes	7	4.6	23	15.2	11	7.3	4	2.6	45	29.8	2	1.4	20	13.7	13	8.9	22	15.1	57	39.0
No	27	17.9	23	15.2	16	10.6	11	7.3	77	51.0	5	3.4	2	1.4	4	2.7	13	8.9	24	16.4
Partially	5	3.3	9	6.0	7	4.6	8	5.3	29	19.2	11	7.5	16	11.0	20	13.7	18	12.3	65	44.5
Total	39	25.8	55	36.4	34	22.5	23	15.2	151	100	18	12.3	38	26.0	37	25.3	53	36.3	146	100
χ^2-test	$\chi^2 = 13.366$, Sig. value = .038, df = 6, $\alpha = 0.05$										$\chi^2 = 15.985$, Sig. value = .014, df = 6, $\alpha = 0.05$									
Causes of work break																				
Working area F	29	19.2	25	16.6	18	11.9	16	10.6	88	58.3	13	8.9	15	10.3	21	14.4	25	17.1	74	50.7
Stayed HTCF	1	0.7	4	2.6	0	0.0	3	2.0	8	5.3	3	2.1	1	0.7	3	2.1	2	1.4	9	6.2
Due to illness	2	1.3	3	2.0	5	3.3	0	0.0	10	6.6	0	0.0	2	1.4	0	0.0	4	2.7	6	4.1
No work break	7	4.6	23	15.2	11	7.3	4	2.6	45	29.8	2	1.4	20	13.7	13	8.9	22	15.1	57	39.0
Total	39	25.8	55	36.4	34	22.5	23	15.2	151	100	18	12.3	38	26.0	37	25.3	53	36.3	146	100
χ^2-test	$\chi^2 = 20.201$, Sig. value = .017, df = 9, $\alpha = 0.05$										$\chi^2 = 17.225$, Sig. value = .045, df = 9, $\alpha = 0.05$									
Days of work break																				
0	7	4.6	23	15.2	11	7.3	4	2.6	45	29.8	2	1.4	20	13.7	13	8.9	22	15.1	57	39.0
1-5	16	10.6	14	9.3	12	7.9	5	3.3	47	31.3	6	4.1	7	4.8	12	8.2	9	6.2	34	23.3
6-10	6	4.0	5	3.3	3	2.0	10	6.6	24	15.9	8	5.5	10	6.8	11	7.5	11	7.5	40	27.4
> 10	10	6.6	13	8.6	8	5.3	4	2.6	35	23.2	2	1.4	1	0.7	1	0.7	11	7.5	15	10.3
Total	39	25.8	55	36.4	34	22.5	23	15.2	151	100	18	12.3	38	26.0	37	25.3	53	36.3	146	100
χ^2-test	$\chi^2 = 22.533$, Sig. value = .007, df = 9, $\alpha = 0.05$										$\chi^2 = 21.778$, Sig. value = .010, df = 9, $\alpha = 0.05$									

A little number (15.2%) household's income is more than Tk. 15500. This quantity is not sufficient to fill up their basic needs. But, in the non-slum, the highest monthly household income is Tk. 125000 and the lowest is Tk. 12000. Among non-slum people, more than one-third (36.3%) household's monthly income is above Tk. 36000 and 25.3% earns Tk. 28001 to 36000, while a small amount (12.3%) of households are included in low-income group.

Flood interrupts people's income in many ways as it breaks the continuity of work and eats up working days. Since, the majority (51%) households' head of slum cannot continue their work during flood. Among them the highest number (17.9%) is from the income group of 7501 to 11500 Tk. whereas only 16.4% from non-slum cannot continue their work owing to flood. Surprisingly most (44.5%) household head's work was hampered partially due to flood. It seems that slum dwellers are mainly vulnerable to flood because 58.3% household head could not go to work place as the working area of them was flooded. It affected their income severely. Among them majority households are from low-income group. Moreover, some (11.9%) of household heads' work was stopped due to illness and to take care their family members. In contrast, the result of work break due to flood almost same in non-slum area. As 61% household heads' work was hampered due to flood but surprisingly there was no effect on their income because they are appointed with stable jobs. The current study also finds that the Chi-square test of income and loss of working days is $\chi^2 = 22.533$, Sig. value = 0.007, df = 9 and $\alpha = 0.05$ for slum and $\chi^2 = 21.778$, Sig. value = 0.010, df = 9 and $\alpha = 0.05$ for non-slum which is statistically significant. However, about 15.9 of the slum dwellers suffer from loss of working days between 6-10 days, 31.3% for 1-5 and only 29.8% does not loss. On the contrary, near about 61% habitants of non-slum experience 1-10 days loss of working days and more than one-fourth (39%) people do not loss their working days. Surprisingly, only 2.7% resident from non-slum was workless for more than 10 days. The low-income group households were affected extensively more than the high-income group (Table 2). In consideration of vulnerability, the significant function of household income level is strongly

associated with other indicators like causes of work break and number of days of work break.

4.1.3 Social Network

The power of social network and value of society might magnify or reduce the vulnerability of disasters. Thus, the influence of social arrangement is closely linked with social vulnerability. This study has been chosen a criterion (during financial emergency where people go to rescue) to evaluate social network. In slum, nearly 38.4% household heads go to their relatives, lived in Dhaka to meet up their financial problem and 33.8% go their neighbors. However, only 23.3% household heads from non-slum go their relatives, lived Dhaka to solve their economic crisis and more than one-third (37.7%) contacts their relatives, lived beyond Dhaka to solve their monetary difficulty. Rest 3.4, 21.9 and 13.7% go their neighbors, bank and NGO respectively for financial help (Table 3).

Table 3: *Social network status of urban people*

Getting help (financial)	Presence of relatives in Dhaka											
	Slum						Non-Slum					
	Yes		No		Total		Yes		No		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Relatives (Dhaka)	58	38.4	0	0.0	58	38.4	34	23.3	0	0.0	34	23.3
Relatives (beyond Dhaka)	8	5.3	11	7.3	19	12.6	41	28.1	14	9.6	55	37.7
Neighbours	28	18.5	23	15.2	51	33.8	4	2.7	1	0.7	5	3.4
Bank	5	3.3	1	0.7	6	4.0	19	13.0	13	8.9	32	21.9
NGOs	10	6.6	7	4.6	17	11.3	18	12.3	2	1.4	20	13.7
Total	109	72.2	42	27.8	151	100	116	79.5	30	20.5	146	100
χ^2-test	χ^2=40.382, Sig. value=.000, df=4, α=0.05						χ^2=18.86, Sig. value=.001, df=4, α=0.05					

Remarkably, [25] research on urban Bangladesh argues the significant responsibility of neighbors along with relations as financial supporter in case of flood. An interesting matter is that very few non-slum dwellers go their neighbors for solving their problems (in study area). The study concludes that the social network of slum dwellers is much better than that of non-slum habitants.

4.2 Analyzing Physical Vulnerability

Physical vulnerability prescribes the features of both natural and manmade environments like housing quality and condition, elevation. It also affects flood vulnerability. Housing quality, shelter, road networks, transportation system, existence of evacuation road, drainage system, flood dams, geographical location are mostly used in previous studies as the indicators of physical/structural vulnerability [1, 21]. The present study has selected four indicators (housing quality, shelter, road network and transportation system) of physical vulnerability to evaluate flood vulnerability in Dhaka megacity.

4.2.1 Housing Quality

The households residing *Pacca* (made of bricks and concrete) houses are less vulnerable to flood than the households residing in huts, manufactured by bamboo and flexible plastic sheets [4]. The surveyed data show that approximately 59.6% slum households live in *Kutcha* house (the wall is made of bamboo, roof Tin, polythene or straw and the floor is muddy) while only 27.8% in *Semi-Pacca* (the wall of home is made of bricks but the roof is made of Tin). Moreover, some (12.6%) are residing in *Jhupri* (a temporary home the wall and roof made by polythene or straw). Most of the surveyed households (around 88.4%) of non-slum live in *Pacca* house and only 11.6% reside in *Semi-Pacca* house (Figure 2).

It is obvious that, due to fragile types of housing make slum dwellers more vulnerable to flood [18]. Additionally, poor construction staffs of housing might increase the vulnerability for urbane settlement. Hence, the feature of home is the key parameter that influences urban vulnerability to calamities result from natural disasters.

4.2.2 Elevation

Elevation is one of the most critical indicators to analyze flood vulnerability. Since it has a great consequence on flood vulnerability of the study site, because the majority areas of Dhaka city are downcast lands as well as the ground altitude is especially low [16].

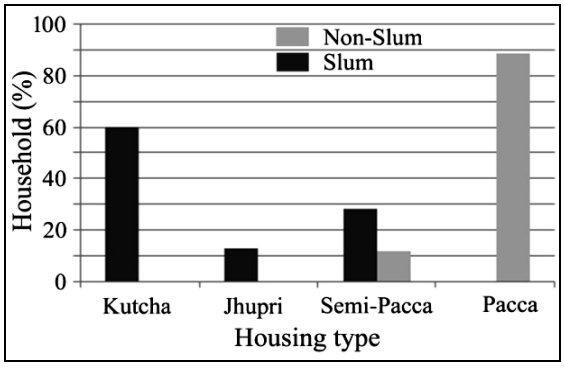

Figure 2: *Housing type of urban people*

The empirical result represents that, majority (55.6%) houses of slum and almost half (48.6%) non-slum house's elevations are less than 9 feet from the mean see level. 27.8% houses from slum and 33.6% from non-slum lays in between 10 to 11 feet (Figure 3).

Surprisingly, only 16.6% (from slum) and 17.8% (from non-slum) house's elevation are more than 11 feet. The current study also shows that, the altitude of houses of Dhaka megacity is quite low that reveals household's dormant susceptibility to flood.

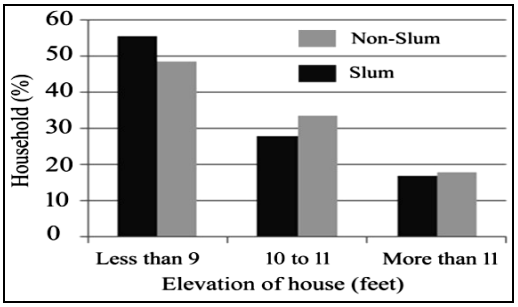

Figure 3: *Elevation of houses of Dhaka megacity*

4.2.3 Shelter

The accessibility to shelters and healthcare services play an important role to reduce vulnerability in disaster prone areas [5]. However, [26] noted that those people who go to shelter during flood they are less vulnerable. Because, the government organizations and NGOs are provide aid in shelter places. However, around 64.9% slum households shift to shelter during flood. Among them, 27.8% and 23.2% travel 4-5 and more than 5 km to reach shelter center. Only 13.9% households find the sheltering place within 1-3 km. While remain 35.1% households do not go to shelter. On the contrary, about only 22.6% households of non-slum went to shelter during catastrophic flood like 1998 flood and most (16.5%) of them stayed nearby (1-5 km) shelter places. The rest 77.4% households did not go to shelter during flood (Table 4). Sometimes the shelter places do not provide better facilities. That is why non-slum dwellers feel reluctant to go to shelter.

Table 4: *Sheltering situation of the study area*

Sheltering details	Distance of shelter (km)															
	Slum								Non-Slum							
	1-3		4-5		> 5		Total		1-3		4-5		> 5		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Going to shelter center																
Yes	21	13.9	42	27.8	35	23.2	98	64.9	16	11.0	8	5.5	9	6.2	33	22.6
No	28	18.5	18	11.9	7	4.6	53	35.1	44	30.1	56	38.4	13	8.9	113	77.4
Total	49	32.5	60	39.7	42	27.8	151	100	60	41.1	64	43.8	22	15.1	146	100
χ^2-test	χ^2=17.402, Sig. value=.000, df=2, α=0.05								χ^2=8.515, Sig. value=.014, df=2, α=0.05							
Type of shelter center																
School	9	6.0	24	15.9	11	7.3	44	29.1	5	3.4	4	2.7	0	0.0	9	6.2
On road	5	3.3	8	5.3	4	2.6	17	11.3	0	0.0	0	0.0	0	0.0	0	0.0
On Embankment	5	3.3	4	2.6	15	9.9	24	15.9	0	0.0	0	0.0	0	0.0	0	0.0
Relative's home	2	1.3	6	4.0	5	3.3	13	8.6	11	7.5	4	2.7	9	6.2	24	16.4
Living own home	28	18.5	18	11.9	7	4.6	53	35.1	44	30.1	56	38.4	13	8.9	113	77.4
Total	49	32.5	60	39.7	42	27.8	151	100	60	41.1	64	43.8	22	15.1	146	100
χ^2-test	χ^2=32.614, Sig. value=.000, df=8, α=0.05								χ^2=15.926, Sig. value=.003, df=4, α=0.05							

Those people or communities are more vulnerable who lived far away from the shelter place. The Table 4 presents that a good number of households (29.1%) of slum asylum in school and 11.3% on road. Almost 15.9 and 8.6% households reside on embankment and relative's home during flood. It is closely observed that households take shelter on road and embankment is not safe and makes vulnerable condition. In non-slum, most of households (77.4%) do not leave their home during flood. Only 16.4 and 6.2% households moved to school and relative's home to take shelter during flood.

4.2.4. Road Network System

Infrastructure amenities like roads and railway networks have a considerable function in evacuation and these are counted as the lifeline for the society [14]. Thus, the road network is considered for analyzing flood vulnerability in Dhaka city. The road network of study area is not so good because the existing roads are so much narrow and clumsy. In addition, in slum area about 53% respondent thinks that the existing road network of their locality is not good and above 30% reports that the road network is good. More than 16% replies that the existing road network is very bad (Table 5). About 41.8% non-slum people believe that the existing road network is not good because they live inside of main roads. While 52.1% resides the front side of main road, so they consider that the accessible road is good. Interestingly, about 74.8% respondent of slum notices that their adjacent roads are submerged during flood. As a result, they cannot move easily to meet daily necessary. 53.4% interviewee of non-slum explains that the next road of their home goes under the flood water and 46.6% answer that the nearby road does not inundate.

Table 5: *People's evaluation regarding existing road network*

Road network condition	Submerge during flood											
	Slum						Non-Slum					
	Yes		No		Total		Yes		No		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Good	29	19.2	17	11.3	46	30.5	27	18.5	49	33.6	76	52.1
Bad	66	43.7	14	9.3	80	53.0	44	30.1	17	11.6	61	41.8
Very bad	18	11.9	7	4.6	25	16.6	7	4.8	2	1.4	9	6.2
Total	113	74.8	38	25.2	151	100	78	53.4	68	46.6	146	100
χ^2-test	χ^2=5.999, Sig. value=.050, df=2, α=0.05						χ^2=20.508, Sig. value=.000, df=2, α=0.05					

4.3 Analyzing Demographic Vulnerability

Demographic features are frequently applied as vulnerability factor [20]. The most commonly used demographic indicators are age, gender, family structure and size, race, new migrants and single parent households.

4.3.1 Age Structure and Gender

This study interviewed 297 households to collect primary data (separately in slum 151 and in non-slum 146). But, for age and gender the total population is 1381 (for slum 746 and non-slum 635) because each household is formed with some members. In the slum, active age (19-55 years) group occupies 52.4%, 40.9% is inactive group (i.e. children) and 6.7% elderly people. In non-slum the dominant age group is active age (58.0%) and 36.2% is inactive group rest 5.8% are elders (Table 6). The age above 55 years are most vulnerable than all others. Because, they live along and physically unable to move safe places, collect relief during flood. Interestingly, the number of elderly persons is more in non-slum area than slum, which makes more vulnerable the non-slum people in consideration of age distribution.

Table 6: *Age structure and gender distribution of urban habitant*

Age (years)	Gender											
	Slum						Non-Slum					
	Male		Female		Total		Male		Female		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
0-18	146	19.6	159	21.3	305	40.9	101	15.9	129	20.3	230	36.2
19-55	215	28.8	176	23.6	391	52.4	195	30.7	173	27.2	368	58.0
More than 55	17	2.3	33	4.4	50	6.7	30	4.7	7	1.1	37	5.8
Total	378	50.7	368	49.3	746	100	326	51.3	309	48.7	635	100
χ^2-test	χ^2=9.432, Sig. value=.009, df=2, α=0.05						χ^2=18.57, Sig. value=.000, df=2, α=0.05					

Gender status also influences flood vulnerability owing to disparate asset allocation, benefits, power, privileges, and wages of female with more household responsibilities [27]. The empirical data of field observation presents that both in slum and non-slum, male female ratio is almost equal. As the observed results slum shows that, 50.7% is male and 49.3% is female. In non-slum, 51.3% (based on questionnaire survey) is male and 48.7% is female (Table 6). The gender vulnerability of studied slum and non-slum areas are almost same.

4.3.2 Family Structure and Size:

The single-family composition would be the cause of high vulnerability while, with less family members, the household could face problem in case of casualty. However, [25] mentioned that the mean family size of Dhaka megacity is decreasing, reporting the growth of simple family. The Table 7 shows that 72.8 and 78.1% households from slum and non-slum belong to single family and remain 27.2 and 21.9% associate with join family.

Table 7: *Household characteristics of the Dhaka megacity*

Family details	Type of household head											
	Slum						Non-Slum					
	Male		Female		Total		Male		Female		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Family structure												
Single	84	55.6	26	17.2	110	72.8	104	71.2	10	6.8	114	78.1
Joint	39	25.8	2	1.3	41	27.2	20	13.7	12	8.2	32	21.9
Total	123	81.5	28	18.5	151	100	124	84.9	22	15.1	146	100
χ^2-test	χ^2=6.958, Sig. value=.008, df=1, α=0.05						χ^2=16.113, Sig. value=.000, df=1, α=0.05					
Family size (number of family member)												
1-2	10	6.6	2	1.3	12	7.9	24	16.4	0	0.0	24	16.4
3-4	37	24.5	16	10.6	53	35.1	63	43.2	10	6.8	73	50.0
5-6	58	38.4	9	6.0	67	44.4	31	21.2	11	7.5	42	28.8
> 6	18	11.9	1	0.7	19	12.6	6	4.1	1	0.7	7	4.8
Total	123	81.5	28	18.5	151	100	124	84.9	22	15.1	146	146
χ^2-test	χ^2=8.163, Sig. value=.043, df=3, α=0.05						χ^2=8.428, Sig. value=.038, df=3, α=0.05					

The present research moreover discovers that the family size of slum comprise 44.4% households with five to six persons, 35.1% three-four, 7.9% and 12.6% has one-two and more than six persons. Sometimes a family, with five of six members holds only a single room to live. In non-slum, 50.0% family is formed with 3-4 members and around 28.8% household dwell more than 5-6 members in addition 16.40% and 4.8% household belong to 1-2 and more than 6 members respectively (Table 7). Slum habitants are having more family members than non-slum habitants.

However, household head has a great responsibility and influence on his/her family as the family members depend on him/her in many ways. Field data from slum (Table 7) present that more than 80% household head is male occupied while only 18.5% is female. In non-slum, majority (84.9%) male head household and 15.1% female headed. In terms of household head, slum and non-slum inhabitants are characterized by male headed indicating the typical societies of Bangladesh.

4.4 Coping Strategy

To manage a disaster effectively, it is essential to analyze the condition of coping capacity of a community [21, 26]. The current study has identified some indicators such as concept about future flood, experience of past event, awareness, preparation to face flood, insurance, saving money to confronting any kinds of calamity for analyzing the coping capacity.

4.4.1 Flood Concept and Preparedness

An investigation by [15, 19] found that people with disaster experience are more fear and worried about future disaster, lives and property, which increases their risk perception. But the survey data from slum exhibits that almost all respondent's (92.7%) comment was 'yes' about future flood occurrence but 78.8% households did not have reservation of dry food. The majority household (76%) from non-slum shows positive knowledge about future flood along with 89.7% household confirms the reservation of dry food to consume during flood (Table 8). Many inhabitants noted that their reserve food was damaged with the floodwater. The result demonstrates that majority slum dwellers are not conscious and prepared to tackle any kinds of future misfortune.

4.4.2 Awareness

People, facing floods are enough prepared for potential events than the communities with less experience of flood [14]. Most of the people of Dhaka city have minimum experience to face flood. Because the findings confirm that 27.8, 29.8, 29.2 and 13.2% respondent from slum and 12.3, 38.4, 34.9 and 14.4% from non-slum experienced flood for 1, 2, 3 and 4 times respectively (Table 8).

4.4. 3. Savings and Insurance

The empirical data confirm that the household's coping measures do not influence their financial capital for a large extent. Unfortunately, due to their insufficient preparation like less savings, no insurance make them more vulnerable to natural disasters. The findings of the study point out that the general coping strategy is saving money to purchase food.

Table 8: *Relationship between the flood perception and preparation*

Flood Experience	Reservation of dry food for emergency											
	Slum						Non-Slum					
	Yes		No		Total		Yes		No		Total	
	HH	%	HH	%	HH	%	HH	%	HH	%	HH	%
Concept about future flood												
Yes	27	17.9	113	74.8	140	92.7	96	65.8	15	10.3	111	76.0
No	5	3.3	6	4.0	11	7.3	35	24.0	0	0.0	35	24.0
Total	32	21.2	119	78.8	151	100	131	89.7	15	10.3	146	100
χ^2-test	χ^2=4.182, Sig. value=.041, df=1, α=0.05						χ^2=5.271, Sig. value=.022, df=1, α=0.05					
Times of facing flood												
1	5	3.3	37	24.5	42	27.8	18	12.3	0	0.0	18	12.3
2	11	7.3	34	22.5	45	29.8	53	36.3	3	2.1	56	38.4
3	7	4.6	37	24.5	44	29.2	44	30.1	7	4.8	51	34.9
4	9	6.0	11	7.3	20	13.2	16	11.0	5	3.4	21	14.4
Total	32	21.2	119	78.8	151	100	131	89.7	15	10.3	146	100
χ^2-test	χ^2=9.977, Sig. value=.019, df=3, α=0.05						χ^2=8.362, Sig. value=.039, df=3, α=0.05					

The Table 9 exhibits that, in slum only 19.9% households have savings to face evil days whereas most (80.1%) of the households do not have. But that savings is not direct saving as they deposit money through NGOs twice in a weak/month or monthly installment. On the contrary, most (93.2%) of the non-slum households have savings. They keep their money in various places such as bank, post office, NGOs, relatives etc. Only 6.8% households of non-slum area have no savings. Any kinds of insurance like health insurance, house insurance, flood insurance or vehicle insurance can reduce vulnerability of hazards or disasters [6]. The surveyed data of study about insurance express that the insurance condition of slum people is reverse from the non-slum. Because, in slum only 19.2%, households have insurance, while 80.8%

have no and in non-slum, greater number (72.6%) households have insurance (Table 9). Here, insurance means any type of insurance in any format. It may be insurance of health, vehicle, fire etc.

Table 9: *Economic security to cope with flood*

	Slum		Non-Slum	
	HH	%	HH	%
Savings status				
Yes	30	19.9	136	93.2
No	121	80.1	10	6.8
Insurance Status				
Yes	29	19.2	106	72.6
No	122	80.8	40	27.4
Total	151	100	146	100

5. Conclusions

In the present study an attempts has been made to analyze to assess flood vulnerability of urban people based on socioeconomic, physical and demographic factors of human vulnerability to flood. The findings of the current study show that slum dwellers are more vulnerable than non-slum to flood hazard. It also demonstrates that the socioeconomic and physical factor of vulnerability is more responsible to make the vulnerable condition of urban people to the flood hazard. Similarly, education, occupation, household income, social network, interrupts of work during flood, housing quality and elevation, poor sheltering place and road network, vulnerable age, gender, family structure, low coping capacity, least savings, no insurance, less preparation are identified as the major indicators of flood vulnerability of urban inhabitants. However, the empirical results reveal that economically and physically slum people are more vulnerable. On the other hand, non-slum people are more vulnerable due to their week social network. To minimize the flood vulnerability of urban people need high level of community participation, empowering affected communities to reduce their own vulnerability. The coping capacity of slum people is not in good condition but, the non-slum people of study area can cope with flood more easily than slum people. However, the study has focused to analyze vulnerability to flood hazard of urban people based on the socioeconomic, physical and demographic factors along with coping capacity. There is an urgency to conduct more research focusing on more factors like institutional, political, and environmental. A number of relevant approaches and variables have been identified that can be used to measure vulnerability in different dimensions within for various natural hazards (i.e. cyclone, drought etc).

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