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Comparative Study of Urban Area Extension and flood Risk in Dhaka City of Bangladesh

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Abstract - Dhaka, the capital of Bangladesh could be the best illustration of human activities and associated environmental change. The capital Dhaka expanded rapidly between 1960 and 2005 built up areas increased approximately 15,924 ha, while agricultural land decreased 7,614 ha, vegetation decreased 2,336 ha, wetland /lowland decreased 6,385 ha, and water bodies decreased about 864 ha. The amount of urban land increased from 11% (in 1960) to 34% (in 2005). Historically, the direction of urban expansion of Dhaka has greatly been constrained by the low elevation of lands, surrounding rivers and risk of flooding also geomorphologic and hydrologically Dhaka city are greatly vulnerable to seasonal inundations. The present paper discusses comparative analysis of urban growth and flood risk in newly buildup urban areas of Dhaka, Bangladesh. Both primary and secondary data have been used in the present research. This study suggested comprehensive measures including structural and non structural measures that will be included a number of flood control and mitigation programs as well as alternative valuable resources for urban planners and decision makers to devise sustainable land use and environmental planning.

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Abstract - Dhaka, the capital of Bangladesh could be the best illustration of human activities and associated environmental change. The capital Dhaka expanded rapidly between 1960 and 2005 built up areas increased approximately 15,924 ha, while agricultural land decreased 7,614 ha, vegetation decreased 2,336 ha, wetland /lowland decreased 6,385 ha, and water bodies decreased about 864 ha. The amount of urban land increased from 11% (in 1960) to 34% (in 2005). Historically, the direction of urban expansion of Dhaka has greatly been constrained by the low elevation of lands, surrounding rivers and risk of flooding also geomorphologic and hydrologically Dhaka city are greatly vulnerable to seasonal inundations. The present paper discusses comparative analysis of urban growth and flood risk in newly buildup urban areas of Dhaka, Bangladesh. Both primary and secondary data have been used in the present research. This study suggested comprehensive measures including structural and non structural measures that will be included a number of flood control and mitigation programs as well as alternative valuable resources for urban planners and decision makers to devise sustainable land use and environmental planning.

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I. INTRODUCTION

Geographically Dhaka is located between 23° 58' and 23° 50' North latitudes and 90° 33' and 90° 50' East longitudes, topographically, the area is a flat land and is located mainly on an alluvial terrace, popularly known as the Modhupur terrace of the Pleistocene period [1]. Dhaka is surrounded by four major river systems, namely the Buriganga, Turag, Tongi and Balu, which are flowing to the south, west, north and east sides, respectively. Dewan and Yamaguchi (2008), [2] found their study that Dhaka expanded rapidly between 1960 and 2005, the amount of urban land increased from 11% (in 1960) to 34% (in 2005). The surface elevation of the area Dhaka are ranges between 1 and 14 m and most of the built up areas located at the elevations of 6-8 m [3]. The previous study about Dhaka city considering the hydrological aspects found that the surrounding rivers like the Buriganga, Turag, Tongi and Balu, (Fig-1) are mainly fed by local rainfalls and also receive spills from three mighty rivers crisscrossing the country, namely the Ganges, Brahmaputra and Meghna through their tributaries

and distributaries in the monsoon. In terms of geomorphologically, hydrologically and socio-economically the newly built-up northeastern parts of Dhaka city are greatly vulnerable to seasonal inundations.

II. MATERIALS & METHODS

Both primary and secondary data have been used in the present research. Composition of the total inundated area and extended urban areas has been made on the basis of some recent satellite imageries, old and new city flood maps that exhibit the flood situation of Dhaka City, as well as ground survey and observations. Furthermore an elaborate questionnaire designed for the purpose of gathering information related to urban growth and historical flood hazard in Dhaka city of Bangladesh. The secondary information sources were various organizations such as Rajdhani Unnayan Kartripakhya (RAJUK), Bangladesh Water Development Board (BWDB), Disaster Management Bureau (DMB), Ministry of Water Resource, Bangladesh Bureau of Statistics (BBS), Institute of Water and Flood Management (IWFM), Department of Water Resource Engineering (WRE) of Bangladesh University of Engineering and Technology (BUET) and Dept. of Geography and Environment of Dhaka University, Institute of Water Modeling (IWM), Different Journals, Articles, published and unpublished research papers etc.

III. OBJECTIVES

The following are the specific objectives of the study;

1. To examine the urbanization trend in Dhaka City of Bangladesh;
2. To investigate the flood risk in the surrounding area of Dhaka;

IV. RESULTS & DISCUSSION

a) Urbanization trend of Dhaka City of Bangladesh:

The urbanization of Dhaka started from the banks of the Buriganga river. Dhaka became one of the biggest cities of this region after the arrival of British. The British rural initially expanded the city up to Palashi where they built a garrison of the company army. It also became a communication hub. At 1801, Dhaka was a city with 200,000 people. But the population decreased

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due to the destruction of the Cottage Industries of Dhaka. Moreover the establishment of small industries made Dhaka more important. After the independence of Bangladesh on December 16, 1971, the city's population raised suddenly to 1403000 in 1974 [5]. The interpretation of the 2003 and 2005 land cover maps are indicated that Dhaka is being started to expand in all directions, specifically to north-east, south-east and southern trends by filling up low lying areas. Dhaka is expanding apace, at an average rate of 4.24% yearly projected to be the third largest mega city in the world by the year 2020 (World Bank). In order to lessen the flood susceptibility, earth filling is a very popular means of land development in Dhaka Metropolitan [5]. The earlier direction of the built up land was followed by north, north-west, and west trends, but the current trend shows a horizontal expansion [2].

b) *Level of Urbanization:*

Urbanization refers to the proportion of a nation's population living in the urban areas. Its

demographic meaning emphasizes largely on only two variables, population and location. The demographic approach focuses on location but it largely ignores individual behavior and the structure of occupations, in its most concise form it postulates that urbanization is a process of population concentration. Urbanization is indicated by an increase in urbanization over a period of time. For example, in 1981 the total population of Merul Badda one of extended urban area of Dhaka city was 32,120 and the urban population was 110 million [5]. Hence $U_{n81} = 110/32,120 \times 100$

The degree or level of Urbanization may be denoted as,

$$U_n = (U_p/T_p) \times 100;$$

Where U_n : level of urbanization

U_p : Total urban population

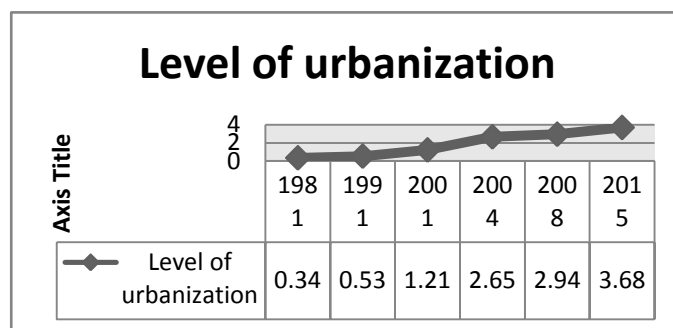
T_p : Total population 0=0.34%

Table 1 : Level of Urbanization of Merul Badda one of newly built-up urban area of Dhaka.

Year	Total Population	Growth Rate	Total Urban Population	Level of Urbanization
1981	32,120	0.34	110	0.34
1991	45,000	0.83	240	0.53
2001	73,156	1.86	890	1.21
2004	76,615	2.45	1880	2.65
2008	85,032	2.74	2500	2.94
2015*	90,758	3.43	3340	3.68

(*Projected) Source : BBS, 2004 and Field Survey, 2008.

Figure 2 : Level of Urbanization of Merul Badda one of newly built-up urban area of Dhaka.



Source : BBS, 2004 and Field survey, 2008.

The study explains an upward trend line of changing pattern of the level of urbanization. The level of urbanization of the study area is increasing gradually. Changes in land use are the end result of a variety of forces that drive the millions of separate choices made by individuals and governments.

c) *Flood Risk in Dhaka City of Bangladesh:*

Regionally, the Dhaka is located in the central part of Bangladesh, and lies in the sub-tropical monsoon zone under the humid climatic condition. The city experiences about 2,000 mm annual rainfall, of which more than 80% occurs during the monsoon

season [June-September]. The city of Dhaka, especially its lower areas have been suffering from floods of varying magnitudes and nature. The extent of spread, depth, duration, frequency and overall nature of these floods are peculiar and greatly different from each other. Analysis of flood-data (i.e. hydrological reports) reveals that at least one eighth of total area of the city of Dhaka goes under water during a normal flood. However, during the time of some severe inundations (i.e. 1988 flood and 1998's) about two-thirds or more area of the city was submerged under the floodwater [6]. Normally, the ordinary floods or rain-fed inundations of the city stay for shorter period. However, in the low-lying areas

of the city it stays for longer duration. These normal monsoon floods of the city, like those of other low lying areas of the country, come slowly, rise gradually, stay for a few weeks and then recede slowly. But, some abnormal greater floods, which are becoming more prevalent currently in the city along with other parts of the country, occur and spread very fast and achieve abnormally higher or deeper depths. At the same time these floods stay for longer time in different parts of the city. For example, during the abnormal floods of 1954, 1955, 1970, 1974, 1987, 1988, [7], 1998 and 2004 flood water went well in to the heart of the city consecutively.



Figure 1: Present Drainage System in Dhaka city.

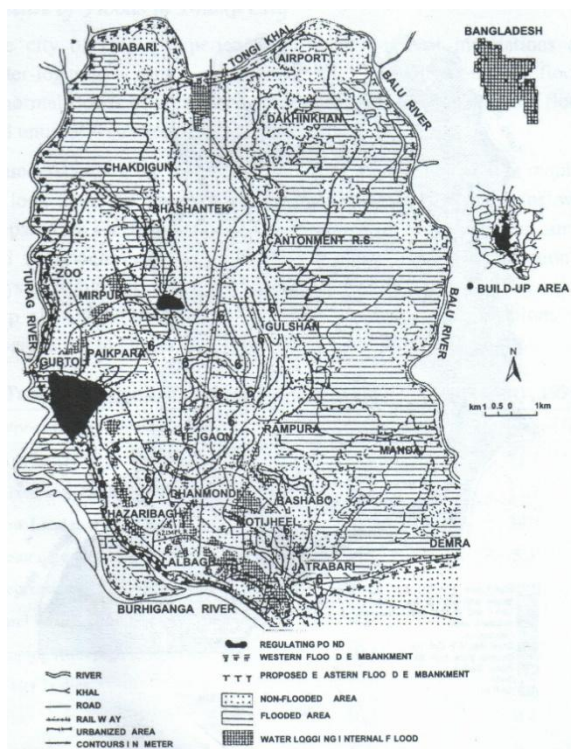


Figure 2: Relationship between Flood (Normal) Land Elevation and Urbanization in Dhaka City.

d) Flooded Area:

The total flooded areas of normal flood in and around Dhaka City is found to cover about 25 sq. km or about 17 percent of the urbanized area where 42.78 percent of the submerged area is under low land with an elevation of 1.5 to 5m heights. These areas cover some parts of Dakshin Khan in the northeast, Barua, Khilkhet, Dumni, Bahatra, Kallyanpur, Baunia, Chak Digun, lower part of Mohammadpur, Joarsahara and Badda (Fig-2). During the severe floods of 1988, about 10 sq.km (11.75%) area of 6-13m elevation zone went under flood water in Dhaka City's urban area and 21.22 sq.km (29.67%) and 50.52 sq. km (33.93%) of 1.5-5 and 5-6m elevation zones were flooded respectively [6]. In total about 82 sq. km of about 66 percent of the area of the city was affected by this severe inundation of 1988. However, this was an unusual occurrence in the city.

e) Depth and Duration of Normal Flood in Dhaka City:

The maximum and average depth of normal flood in Dhaka city is 5.7m and 3.0m respectively (BWDB 1989 and Islam 1996). In some areas of the city the depths of floods sometimes are being controlled or influenced by the local construction situation. The minimum and average flood duration in Dhaka City is 12 and 32 days respectively [3]. On the other hand, the depth of flood of 1987 was 1.0m in Uttar Khan while it was comparatively higher in Baunia and Bailjuri with a height of about 3.9m in the same elevation. It varied from north to south and east to west. This depth of flood condition happened due to favorable sources of coming water in the river and various physiographic conditions in Dhaka city and its adjoining areas.

V. KEY FACTORS OF FLOOD OCCURRING IN DHAKA CITY

a) Natural and Environmental Factors

1. About 60 percent of the city of low topography is criss-crossed by about 30 khals, which facilitates easy spread of flood water out of a total of about 300 sq. km area.
2. Only 110 sq. km of the built-up area is free from normal flood.
3. Synchronization of major river peaks and influences of those major rivers upon rivers Lakhya, Buriganga etc.
4. Heavy rainfall in upstream of the river Buriganga and Lakhya.
5. Tidal and wind effects on slowing down the river outflow (back water effect) of the river Buriganga.
6. Tectonic anomalies, such as- faults, lineaments etc. change the river flow/morphology, upliftments and subsidence of the land surfaces.
7. Changes in climatic condition of the region and increase in rainfall in the catchments of the rivers,
8. Silting up of the local rivers, bank erosion and land subsidence in some areas.

b) *Human Interferences*

1. Construction of unplanned roads, bridges, housing etc.
2. Flood embankments and dams.
3. Diversion structures, drainage congestion and choking up of the local urban drainage.
4. Indiscriminate earth fillings in the low-lying areas of the city.

VI. CONCLUSION

This study find out that, recent unplanned urban development in Dhaka city of Bangladesh have directly impact on drainage system of the city, from the above discussion it is evident that the low-lying areas of the City of Dhaka, especially its eastern and western buildup fringes are greatly vulnerable to seasonal inundations. The study further reveals that the spree of recent urban growth and the associated structural development have significantly been affecting the urban-inundations and drainage failure in the City. The process of ceaseless human interferences in the form of encroachment in the lowlands (i.e., bils, Jheels, Khals, etc.) of the City and unplanned construction of roads, building embankments etc. in different parts of the city are also affecting the hydrological situation of Dhaka City. In the recent views, the drainage failures and the resultant flooding and submersions of parts of the City have been gaining momentum. Constructions of flood protection embankment in Demra area (DND) and Kurmitola area have proven to be a partial failure in achieving maximum benefits. Only some appropriate integrated environment-friendly adjustment-oriented measures may bring some success in this respect. At the same time special attention need to be given to the facts that the normal natural settings i.e. morphological and hydrological situation of the City should not be disturbed in the process of urban-development. With this respect the endangered and extinct khals (channels) and, rivers and other existent important wetlands of the city should be preserved and saved for the sake of the smooth functioning of the City's choked and disturbed drainage system.

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