

Analysis of Causes and Impact of Water Logging in Khulna City of Bangladesh

Md.Mehedi Hasan Khan¹

¹Student, Department of Urban and Regional Planning, Khulna University of Engineering & Technology, Khulna.

E-mail: Center.mhkhan@gmail.com

Abstract

Khulna, the 3rd largest city of Bangladesh has experienced water logging problem for the last couple of years. This research is focused on the water logging situation that is caused by high intensity rainfall and runoff in the city area that is inundated due to unplanned and inadequate drainage system, Disappearance of natural drainage system and inefficient management. Depth and location of waterlogged areas are identified by using GIS technique and by conducting a field survey during 2017 in Khulna city corporation area. Perception of authorities of different organization and people living in Khulna city has been taken for identify the causes of water logging and its direct and indirect effects on them. This water logging problem has a positive influence on environmental degradation as well as social, economic and physical degradation also.

Keywords: Water Logging, GIS, Rainfall, KCC & KDA

1. Introduction

Bangladesh faces a number of environmental problems due to rapid urbanization, poor socio-economic development, inefficient resource management and industrialization. When a city faces rapid growth of population, the city becomes unable to cope with changing situations due to their internal resources constraints and management limitations [1]. With the population growth, cities are facing various environmental problem like Water logging, solid waste disposal, and black smoke from vehicular and industrial emissions, air and noise pollution, pollution of water bodies by industrial discharge etc. Out of these, water logging has become a very common problem in recent year. Currently around 5% of total land of Bangladesh is affected by waterlogging [1]. According to department of forestry of Bangladesh, it will increase to 14% by 2100 [2].

The prolonged water-logging has caused significant displacement presenting humanitarian challenges in safe water supply, sanitation, shelter, food security, and employment opportunity. [3] Social demoralization, diseases, unemployment and migration have been increasing in the locality where the places protracted by water-logging [4]. Socio-economic and agricultural activities have also largely been hampered due to water logging [5]. Further in many urban area road are sink due to this severe problem.

South-western region of Bangladesh is greatly affited by water logging problem. About 8000 hectares of waterlogged land occurs in Khulna- Jessore region [3]. The daily news Dainik Pourbanchal on July 22, 2005, screened that 1 million people of Khulna city fell in trouble due to water logging [6].

Excessive rainfall is the main cause of waterlogging in Khulna city. The city receives an average annual rainfall of about 1800 mm (KDA, 2017). Disappearance of natural drainage system, unplanned and inadequate drainage system, poor operational performance and maintenance of drainage systems are the other remarkable reason for water logging in Khulna. Since long, Storm water of Khulna city had been drained out through some natural drains (e.g. creek and canals). During the last three decades, most of these natural drains are either filled up or were encroached by human intervention. Some of these are replaced by narrow surface drains, which decrease the capacity of drainage system continuously and it increase the water logging problem in the city [1]. This problem is now become very challenging to control and minimize.

2. Literature Review:

Though Water logging is very common in Bangladesh but very few studies has been conducted to find out the causes of water logging and impacts on the human life as well as the economy. Some studies related to water logging, which has been conducted are described below:

In the study "Causes and Effects of Water Logging in Dhaka City", Tawhid, K. G., 2004, describe the existing of water logging scenario in Dhaka city. On the basis of analysis some causes and effect of water logging is

identified by the writer. With sense of his finding, writer suggests some recommendation to improve the water logging situation of the Dhaka city [7].

A study named, “Effect of Urbanization on Storm Runoff Characteristics of Dhaka City” by Bari and Hasan, 2001 describe the impact of land use changes due to urbanization on storm runoff characteristics in the eastern part of Dhaka City. It is found that, volume of peak rate runoff is proportional to the rate of urbanization. Low lying lands, those acted as retarding basin are continuously filled up. The result of these studies show that runoff volume is increasing with increase in built-up area [8].

Md. Shariful Alam and Nophea Sasaki, 2016 in their study “Impacts of Water logging and Adaptation Measures in Khulna, Bangladesh” investigate the causes of water logging in coastal district of Bangladesh. They also investigate the way, how individuals and institutions take initiatives to cope with the problem. They identified that the poor and inefficient drainage system is the major cause of water logging in Khulna city [9].

3. Methodology:

Khulna city is located at southern side of Bangladesh. The city is bonded by Rupsha River on east and south side and by Bhairab River by north side. Geographically, Khulna city corporation area is divided into 31 wards. It has a population of about 1.2 million with a growth rate of 4.5% per annum [10]

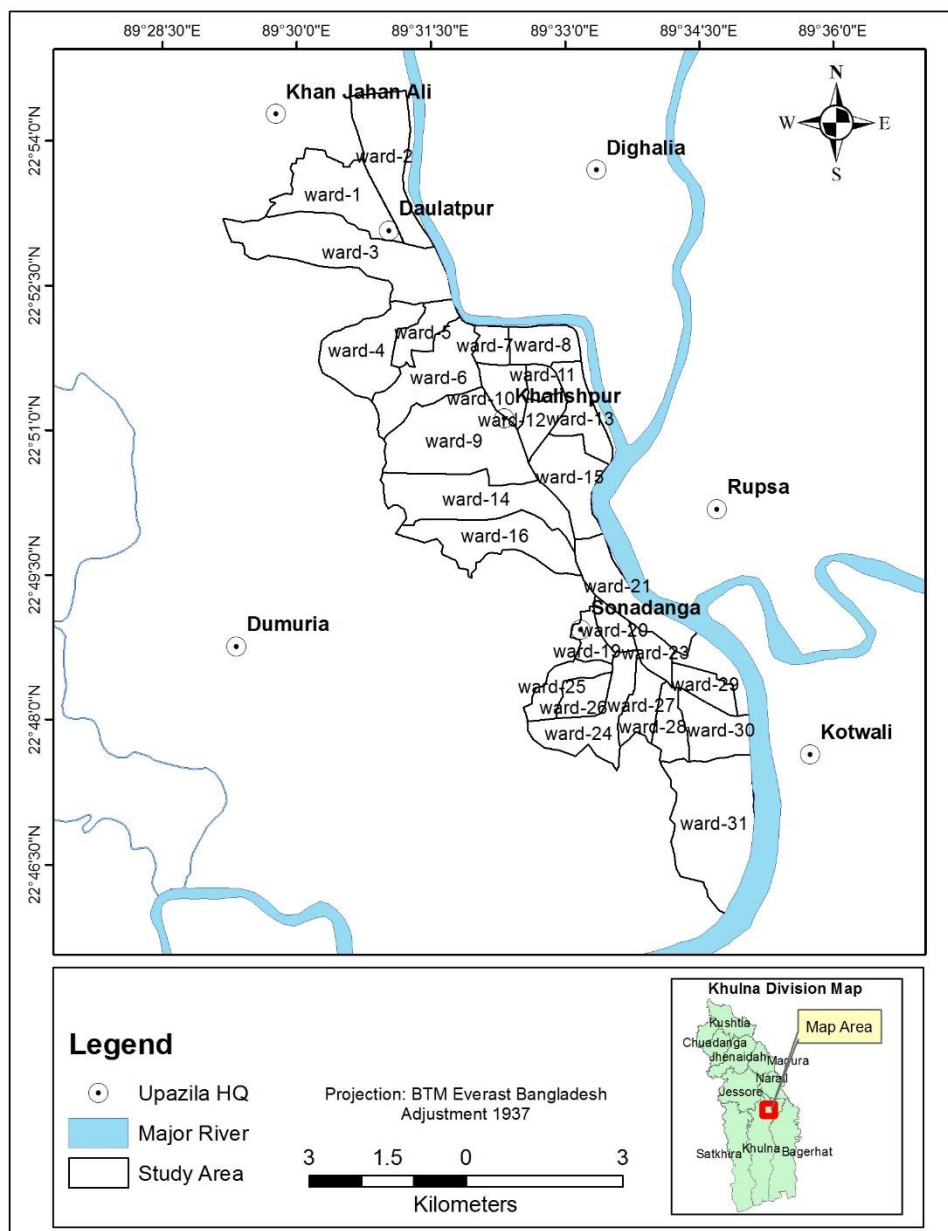


Fig. 1: Study area map Source: Prepared by author

Primary and secondary data were used for this study. A field survey within Khulna city corporation area was conducted to get the primary data during April 2016 to October 2016. Map of existing drainage system and spatial data were collected from Khulna City Corporation (KCC) and Khulna Development Authority (KDA). Other maps were collected from word book for Khulna city. After collection of relevant data, all the collected data were analyzed separately by using ArcGIS 10.4, SPSS and Microsoft Excel. For the analysis of spatial data, Geographical information system (GIS) techniques was used. By using drainage system map, causes of water logging has been identified. The opinion of senior citizen of Khulna city and the various organization who works on waterlogging problem in Khulna was also considered for determining the causes of water logging in Khulna City.

4. Result and discussion:

In rainy season, water logging is very common problem in Khulna city. But the severity of this problem is increasing day by day. As Khulna city faces a rapid urbanization, the hard scape soft scape ratio are increasing continuously. As a result, infiltration rate of water is becoming low day by day and that's creating a huge pressure on storm water runoff continuously. In the time of moderate to heavy rainfall, inflow becomes much higher than outflow and it causes the failure of existing drainage system and creates waterlogged problem in the city. According to KDA, 20.3% of roads in different parts of the city such as Royal mor, Tootpara, Goborchaka, PTI crossing, Sheikhpara, Khalishpur, Shantidham crossing, B.K. Roy Road, Teligati go under knee- deep water after a moderate to heavy rainfall. Though the water was flashed out from the roads after three to four hours, it creates flash flood in lower areas such as a part of Labanchara and west Tootpara and the lower part of Sonadanga and Goborchaka.

Khulna city is surrounded by 15 canals and 3 rivers. Since long these canals were used to drain out the storm water. But last three decades most of these natural drains are either filled up or were encroached by human intervention like construction of road or development of residential areas. Some of these are replaced by narrow surface drains. [1]. This reduces the effectiveness of natural drainage. Khulna city has a manmade drainage line of 547 m. Out of these only 7% is covered by RCC remaining 93% are open to air. (KCC, 2016). The Capacity and effectiveness of these uncovered drainage line is decreasing continuously due to various high weighted particles are aggregated into the drainage line and partially block the way of water flow. Sometimes it fully blocks the water way and creates unwanted water logging suddenly.

Water logging is now a major problem of the Khulna city as the existing drainage system of the city is unable to carry out the water that rearing on the roads after rain. [1]. Residences of this city suffer this problem mostly in monsoon. The result of field survey shows that, around 66% of houses are facing the water logging problem during monsoon. About 4% of the total households responded that storm water overflowed the plinth level of their houses. In April 3, 2005, Khulna city faced an 800mm of rainfall and it was overflowed 43% of total area by 2-3 ft. of water (KDA, 2016). It is found that, inundation depth of water in buildup area is comparatively low but it is occurring for a long time. In ward, no 13, 14, 16, 17, 21 water logging is very common. People are starting to believe that this is a normal part of their life. Prolonged water logging is commonly seen in Tootpara, Santidham, Sonadanga, Fulbarigate area and short duration water logging is seen in Rupsa, PTI, Satrasta, Barangatiarea.

4.1. Causes of water logging:

Excessive rainfall: As the Khulna city is located beside the Bay of Bengal so it faces a huge amount of rainfall especially in monsoon period. Also, the city faces around 72% of total rainfall due to nor'easter effect. In Khulna, Rainfall has been occurred for 20 days in July, 2017. Average amount of rainfall in this month for last 30 years is 164mm (Bangladesh Metrological Department). Generally, the city faces prolonged precipitation in the period of monsoon with low intensity which creates water logging problem in city especially, those areas where the drainage system is congested and becomes inefficient due to lack of maintenance. According to 74% responds, excessive rainfall is one of the major reason for water logging in Khulna city.

Population growth and unplanned development: Khulna is the 3rd largest city in Bangladesh. The city is now facing rapid urbanization with an urbanization level of 28.49% [11]. During 2001 to 2011 population of Khulna increased by 37%. This high amount of population growth and shortage of land, lead to the increase of hard scape soft scape ratio. As the area of hard scape is becoming high, so the rain water cannot infiltrate to ground water and it increases the surface run off. 45% respondents said that the existing drainage system cannot carry this huge amount of run off and they identified that population growth and unplanned development is one of the major causes of water logging in Khulna.

Disappearance of natural drainage system: In Khulna city, natural drainage system is continuously decreasing due to population growth and unplanned development. Natural drains are now filling up for building residential

area, uncontrolled and haphazard disposal of solid wastes and garbage etc. In last 10 years, the area of natural drains are decreased to 6%. Around 40% respondents mentioned that disappearance of natural drainage system as one of the major causes of water logging.

Unplanned and inadequate drainage system: In Khulna, maximum storm water and waste water is drained out with artificial drainage network. But there exists a short amount of drainage line. Survey of a large number of households in Khulna city shows that about 44 percent of the households have no planned drainage facilities in and round their premises while only 56 percent have some sort of drainage facilities. The length of various types of drainage line is given below:

Table 1: Length of existing drain in Khulna city

	Pucca (Km)	Cover Drain (Km)	Kutchha (Km)
547.27	466.81	38.2	42.71

Source: KDA, 2016

Thus, the existing drainage lines are not in a condition to serve well. Only 45% of the drains are well served where, 52% of drains are poorly served and 3% are in vulnerable condition (KCC, 2016). Existing drains have a capacity of draining out 10 to 15 mm of rain water per hour [1] which is not sufficient to drain water in rainy season. This low capacity of drainage system creates water logging. At present, many areas (i.e. Natun Bazar, Rupsha, Tutpara, Shipyard areas, East BaniaKhamar, Boyra, RayerMohal, Kan-A-Sabur road, Nodal Point of Khan Jahan Ali and KDA Avenue.) are suffering from water logging problem due to drainage congestion during moderate to heavy rainfall. 59% responder said that Unplanned and inadequate drainage system is one of the main cause for water logging.

Operational performance and maintenance of drainage systems: 72% of responder identified that poor operation performance and maintenance of drainage system are responsible for water logging in Khulna city. For high wind, sometime various particles like polythenes, plastics and other materials drop to drain and restrain the flow of water which decreases the drain capacity as the drains are not maintained properly. According to Municipal authority, lack of comprehensive and planned maintenance program, equipment's, adequate budget, staffing, proper monitoring program and shortage of man power are the main causes of inadequate maintenance of existing natural drains in Khulna.

Filling up the ponds and ditches: Along the side of Rupsha and Bhairab River, there exist a lot of water bodies. Most of these water bodies served as catchments of rain water and places of fish cultivation. But due to rapid urbanization, these water bodies are converted into build up area with a significant rate. Around 4.75% pond and ditches areas are filled up during last 20-year. [12] As a result, there exists a shortage of storm water discharge place and this creates water logging in many areas of Khulna. 61% of the respondents said that filling up the ponds and ditches are responsible for water logging in many areas of Khulna.

Siltation: 51 percent respondent mentioned that siltation in natural drainage system is one of the major problem for water logging in Khulna. Most of the canals of Khulna city are now dead due to siltation. In rainy season, Rain water carries out different construction materials like bricks, sands, and stones, leaves, household wastes, street sweepings etc. that reduces the depth and runoff capacity of natural drainage and creates favorable condition for water logging.

4.2. Impact of Water Logging:

Rapid urbanization, the fast-rising sea level, poor infrastructure, inefficiency of drainage system create water logging in the Khulna city. The associated problems of water logging create effects on social life, economic infrastructure, physical infrastructure and living environment adversely.

4.2.1. Social impact of water logging:

Disruption of Traffic Movement: In rainy season maximum roads of Khulna go under knee deep water which results in disruption on traffic movement and introduces traffic jam in city area. As a result, people loss their valuable time on road. 81% responder identified that, water logging creates a severe problem in traffic movement.

Disruption of normal life: 86 % inhabitants mentioned that water logging hampers their daily life. Especially poor class people are affected mostly due to water logging rather than high class. Due to disruption on traffic movement, construction materials cannot reach to construction site which leads authority to close their work. And it creates a negative effect on worker. Sometimes due to pollution of shallow ground water by Garbage mixed water, low class people don't have access to potable water. On the other hand, high class people have options to move relatively high land which may not water logged affected area or less polluted area.

4.2.2. Physical Impact on Water logging:

Damage of infrastructure: Prolonged water logging causes the damage of various infrastructure. Every year in rainy season water logging causes a huge amount of damages to various types of roads (both katcha and pacca). Besides these various types of utility services i.e. water, telephone, sewerage etc. are damaged due to long term water logging. 67% responder mentioned that water logging has an effect on damaging infrastructure.

Damage of structures: According to 77% responder water logging is one of the major causes for damaging structures in Khulna city. Due to corrosive effect of salinity, structures those are located in low lying area (especially Labanchara, West Tootpara, Sonadanga and Goborchaka) are damaged in a significant rate as most of the structure of these areas remains underwater due to water logging in monsoon period.

4.2.3. Environmental impact Water logging:

Water Pollution: Maximum waste disposal site of Khulna city is open dumping and maximum dustbins of Khulna city are located in road side with a highest distance of 25-meter from road. In Khulna city, the design of drainage network follows the layout of road network. So, in the time of rainy season when drains become unable to carry out storm water, then roads become flooded and this flooded water becomes contaminated by mixing with Solid waste, medical waste and domestic waste etc. And finally, receiving water bodies become contaminated due to runoff and infiltrate this flooded water.

Increase of water borne diseases: Water logging on roads and lanes of city localities are an open invitation of water-borne diseases due to water pollution is caused by Lack of proper drainage facilities, pipelines choked, water and garbage spilling on to the roads etc. 84 percent of the respondent replied that stagnant storm water increases the diseases as it becomes polluted in different ways. In maximum slum of Khulna, drainage systems are poor and these slums are located in low-lying area. Sometimes urban runoff mixes with sewage as overflowing of latrines and sewers and causing pollution and a wide range of problems associated with waterborne diseases occur in these low-lying areas. Stomach ailments such as jaundice, typhoid, gastroenteritis, cholera and diarrhea could pose major health concern are most common waterborne diseases in Khulna caused by water logging.

Breeding site of mosquito: Mosquitoes normally lay their eggs in standing water. In the period of monsoon Khulna city faces a prolonged water logging problem. This prolong water logging creates suitable breeding site for mosquitoes. 88 percent of the interviewers said that Khulna City has been suffering a lot from tremendous increase of mosquitoes and its associated diseases vectors, which is the ultimate result of water logging.

4.2.4. Economic Problem Water logging:

Increase of Construction and Maintenance Cost: Due to rapid urbanization, natural drainage systems are decreasing continuously. And for ensuring the efficiency of drainage system and due to expansions of city there need a huge amount of man-made drainage lines. As a result, authority has to build a huge amount of new drainage lines. This new construction and maintenance of new and older drainage line impose a huge amount of cost to the government every year.

Loss of Income Potential: Sometimes in Khulna city, water enters into shops and roads go under knee deep for long time in monsoon period and it creates an obstacle for timely supplying of goods. It leads to direct financial costs, loss of income potential, reduce production. 65 percent respondents mentioned that, water logging has a huge amount of direct and indirect impact on income potential of the citizen of Khulna.

5. Conclusion:

Water logging in Khulna city is a consequence of rapid urbanization and improper Planning, design, operation and maintenance and poor urban management of natural and artificial urban drainage systems. With the increasing rate of population and urbanization, storm water drainage has been filled up, encroached or diverted continuously and creates severe water logging during monsoon. Which incur a huge amount loss in terms of adverse social, physical, economic and environmental costs. In 2007 ward no 1, 5, 6, 14, 15, 20, 21, 23, 27 and 30 are most affected by water logging ([1]where in 2016 ward no 10, 14, 21, 22, 27, 30 and 31 were estimated as most affected waterlogged area. so, it is clear that water logging affected areas are increasing day by day. Now, we need an urgent long-term planning for efficient management of urban drainage system to overcome water logging problem in Khulna city. GIS technique might be very useful tools for overcome this problem in shortly.

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Annex I:

Questionnaire on waterlogging situation in Khulna city.

Name:	Designation:	Date:
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For General Public

1. Is the water logging problem is seen here? – Yes/ No. If yes mention the duration.
2. What are the community based problem that arise due to waterlogging?
3. What are the effects of waterlogging on traffic movement?
4. What are the main causes for water logging in Khulna?
 - a. Drainage system (inadequate/unplanned)
 - b. Excessive Rain fall
 - c. Disappearance of natural drainage system
 - d. Operational performance and maintenance of drainage systems
 - e. Development work during rainy season
 - d. Unplanned urbanization
 - e. Population growth
 - f. Siltation
5. What are the major impacts of Waterlogging in Khulna-?
 - a. Damage of infrastructure
 - b. Damage of structures
 - c. Pollution
 - d. Disease
 - e. Other
6. Which roads are badly affected by water logging?
7. Which areas are badly affected by water logging?
8. Is water overflowed to ground floor/plinth level of houses in the time of waterlogging?
9. Is economic activities hamper by waterlogging??

For Officials (KDA/KCC/BMD)

10. What is the total length of road that are effected by waterlogging?
11. What is the depth of flood at different place?
12. Is tidal flow create waterlogging?? If yes, where is the place and what is the depth of water causes by tidal flow?
13. What is the length of various types of existing drains?
14. Is topographic condition is one of the major causes of waterlogging in Khulna?
15. How waste mixes with flooded water during waterlogging and how is create various pollution?
16. What is the average drainage capacity existing drainage system? Is the capacity is decrease continuously? What is the reason behind it?