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Temporal and Spatial Changes of Wetlands in the Selected Areas of Dhaka City and Its Impact on Surrounding Environment

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Abstract: ***This study is an attempt to identify the urban wetlands, emphasize on the extent of the changes and subsequent impacts on surrounding environment of the selected areas of Dhaka city. For assessing the land use pattern of the city, topographical maps (Toposheet of 1995 and 2001) and GIS based software (e.g. Arc GIS) were used in this study. Statistical analysis has been earned out in order to process and analyze the data. From study it has been found that the wetlands of the selected area of Dhaka city are changing very frequently. In 1995, the total wetland areas as water bodies and lowlands were 132.95 ha and 248.46 ha, respectively. But in 2001, the total areas of water bodies and the lowlands were found 53.22 ha and 257.56 ha respectively. Statistics also shows that during that period (1995-2001) wetlands (water bodies and lowlands) reduced by 18.5%. This changing trend of wetlands makes the drainage system of Dhaka city vulnerable, creating water logging problems and their consequences.***

Keywords: Wetland, Topographic Map, GIS, Urbanization, Microclimate

1. Introduction

Dhaka city has been suffering from many environmental problems including flooding, water logging and other related problems. In the past the city was regarded as the Venice of the east or the city of channels. A few decades ago there were numerous lowlands, khals and channels within and around Dhaka that would drain the city efficiently (JICA, 1992). Canals of the city are used to be the connecting channels of the rivers surrounded by the greater Dhaka. But now-a-days, the situation is completely different. The city has spread over the years in all directions and such expansion has caused shrinkage of the natural drainage and wetland. Moreover, most of the canals have disappeared and banks of the surrounding rivers are encroached and/or grabbed gradually due to a number of reasons. The major causes are unplanned urbanization, encroachment, lack of co-ordination between government agencies, maintenance to the system and implement of pertinent laws. As a result each year the city dwellers suffer acute water logging problems during the rainy season. In a report on strategic environment assessment of Dhaka, water logging has been identified as one of the major problems of the city (World Bank, 2007). During monsoon rains, many areas of Dhaka go under water, because canals, being the primary drainage system of the city are blocked, cannot carry the huge volume of storm water. The situation has turned very severe in recent years, and main streets now go under a meter of water after heavy monsoon shower (Islam, 2005).

There is no single authority for the management of wetlands in Dhaka city, thus creating a lack of coordination among the concern organizations. Because water logging is one of the major problems of the city, there is an immediate need to implement land use regulations and strict enforcement mechanisms, restrictions to the land encroachment on the bank of the khals in the city and implementations of cities urban and drainage master plans (Khan, 2001). On the other hand, there is no specific map or well documented records of wetlands of the city.

Welcome fallout of the environmental crisis, at the global and local levels, has been the debates that it has generated on the mainstream development model. Industrialization, urban sprawl, irrigation, large dams, green revolution all the cornerstones of the development paradigm is today subjects of discussion and critique (Ramaet al., 2004). It is in this context that the present paper attempts to trace the impact of rapid urban growth on water bodies using Dhaka as a reference point. In merely 35 years, the urban agglomeration of Dhaka has grown from 2.2 million inhabitants (1975) to 14.65 million (2010). Today, Dhaka is the ninth largest city in the world and according to UN projections, it will become the world's 5th largest city by 2025 with a population of 20.94 million (UN 2008, UN population division 2010).

According to Dhaka water and sewerage authority (DWASA), there were once 43 canals in Dhaka. Seventeen of them have disappeared completely. The remaining 26 are in bad condition, while DWASA is presently recovering 15 of them. Eight of the disappeared canals have been replaced by box culverts—a hollow concrete box section under the ground and consequently covered by important roads. Other canals exist but are rarely seen, because of the encroachment and filling in either by developers, squatters or the governments itself (Alamet. al., 2007).

The objectives of the study area are as follows: to investigate the changes of wetland in the study area, to assess the relation between the wetland destruction and its impacts on surrounding environment and to investigate the causes of wetland destruction.

1.1 Significance of the Study

The significance of the study is related to know about the geographic features of the study area, which is essential for the identification of the natural drainage system. It also identifies the present situation of drainage system. The study investigates how the wetland changes creating problems to the surrounding environment. It helps to measures the

potentiality of hazards due towetland changes. The study identifies the problem solving process in the consequences of wetland change. It also identifies the present status of wetland management programs which can be more helpful for its betterment.

2. Literature Survey

According to Ramsar Convention 'Wetland includes a wide variety of habitats such as marshes, peat ponds, floodplain, rivers and lakes and coastal areas such as salt marshes, mangroves, and sea grass beds but also coral reefs and others marine areas no deeper than six meters at low tide, as well as human made wetlands such as waste water treatment ponds and reservoir" (Ramsar Convention, 1971). Islam et al., 2010 published "Changes in wetlands in Dhaka city: trends and physico-environmental consequences" where they studied an attempt to identify the urban wetlands, emphasizing on the extent of their changes and subsequent impacts on physical environment of the area. Sultanaet al., 2009 titled "Pre- and Post-Urban Wetland Area in Dhaka City, Bangladesh: A Remote Sensing and GIS Analysis" where Pre- and post-urban changes of water bodies in the city were studied using aerial photographs and SPOT images in GIS environment. Mahmudet al., 2011 mentioned Remote Sensing & GIS Based Spatio-Temporal Change Analysis of Wetland in Dhaka City, Bangladesh in which they evaluated wetland changes in Dhaka Metropolitan Area (DMA), Bangladesh, between 1978 and 2009.

3. Materials and Methods

3.1 Study Area

Dhaka city is bounded by the Buriganga River in the south, the Balu River in the east, the TongiKhal in the north and the Turag River in the west. These rivers are connected to the Ganges Brahmaputra River system (locally known as the Padma, Meghna, Jamuna River system and also include the Old Brahmaputra river). The study area is closely dissected by rivers and khals which are hydrologically connected to these major rivers. Dhaka city has huge wetland area and in the eastern part of the Dhaka faces huge changes of wetlands. So, we select this area as our study area. This area covers MerulBadda, Rampura, Banasree, Khilgaon and Bashabo area of Dhaka city.

Figure 3.1: Red box area showing the study area. (Source: Banglapedia, 2006)

3.2 Research Design

In this study, both primary and secondary data have been used. To fulfill the objective of this study, the wetland maps of 1995 and 2001 were derived using topographic map. The detail information of used maps for this study are listed in to derive the wetlands from the topographic map, digital image processing technique was performed. The wetlands areas of 1995 were digitized edited and leveled from the Toposheet. Afterwards, wetlands were extracted from the classified maps of 2001. In supervised classification, first training samples were given for each of the water cover classes. Then maximum likelihood classifier was used for final water cover classification. This study is to detect and analyze the wetlands changes in the selected areas of the Dhaka city.

3.3 Sample Survey

For this study, the primary data have been collected using observation and field survey questionnaire. For questionnaire survey, some areas were selected purposively form the changed areas of wetland. On the other hand, secondary data have been collected from various government, semi government and non-government organizations. After completion of primary data collection from the field, the interviewed questionnaires were processed using Statistical Package for the Social Sciences (SPSS) and Microsoft Excel for Windows. The secondary data used in this research were included after checking their acceptability carefully.

In this paper an implementation procedure for the construction of a spatial attribute table from scratch by digitizing the wetland area map and generating topologically collected data set is derived. At first, scanned map was taken as a base map. Then the map was digitized by using Arc GIS and saved the digitized data into attribute tables.

3.4 Collection of Map

To conduct the temporal analysis of the wetlands, two maps of different years were used. So, two topographic maps of Dhaka city of 1995 and 2001 were collected from the Survey of Bangladesh (SOB).

Table 3.1: Maps used in the study area

Types of data	*Scale*	*Year*
Dhaka City guide map of Survey of Bangladesh	1:20000	1995
Dhaka City Topographic map of Survey of Bangladesh	1:20000	2001

3.5 Software Used

The study has been earned out under the frame work of Geographic Information System (GIS). Data on wetland features has been extracted by Arc GIS software. However, GIS task have been carried out using Arc GIS 3.3 version and the outputs have been generated using Arc View 3.3 software.

3.6 Questionnaire Survey and Informal Interview

A questionnaire survey was conducted using a pre-tested questionnaire to find out the importance of wetlands in this area and also to know its impacts on the surrounding

environment. Informal interview and open discussion were also conducted with the people living in eastern parts of the Dhaka City.

4. Results and Discussion

4.1 Wetland changes during 1995-2001

Using topographical map of the stipulated time frame it was observed from the analysis that the wetland of Dhaka city changed dramatically. In 1995, the total area of water bodies and lowlands were 132.95 ha (hectares) and 248.46 ha respectively (Table 4.1). But in 2001, the total areas of water bodies and the lowlands were found 53.22 ha and 257.56 ha respectively. So, from this analysis it is clear that the areas under both categories (water bodies and lowlands) of wetlands changes sharply (during the study period). Statistics also shows that 60% of the water bodies decreased but 0.04% of lowlands increased from 1995 to 2001 in the study area (Table 4.1).

Table 4.1: Spatial changes of wetlands during 1995-2001

Categories of land use/cover types	Area (ha) in1995	Area (ha) in2001	Changes in area (ha) during1995-2001	Changes (%)
Water bodies	132.95	53.22	-79.73	-60.0%
Lowlands	248.46	257.56	+9.1	+0.04%
Total	381.41	310.78	-70.61	-18.5%

4.2 Temporal Change in Land Use

Figure 4.1: Land use map of the study area in 1995

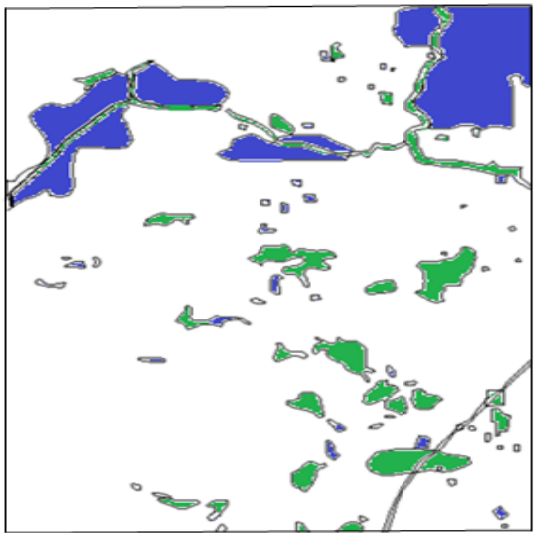

Figure 4.2: Map of wetland in the study area in 1995

Map Legend: Water body Low land

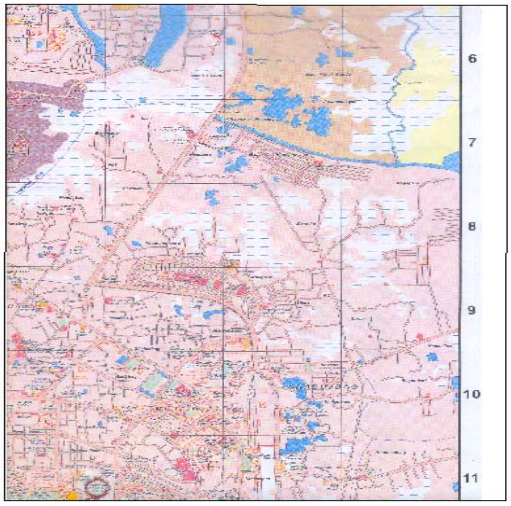

Figure 4.3: Land use map of the study area in 2001

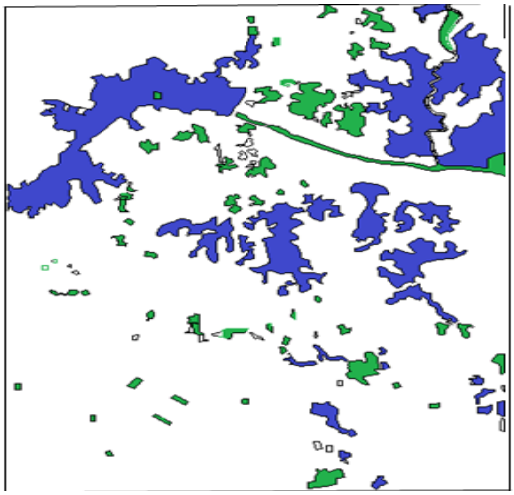

Figure 4.4: Map of wetland in the study area in 2001

Map Legend: Water body Low land

From figure 4.1 and 4.2, it was found that in 1995 most part of the study areas were dominantly covered by the khals, rivers low lands, and other kind of water bodies. But in 2001 most of the water bodies or low lands were encroach by the

land grabbers to establish their own housing projects. (Figure 4.3 and 4.4)

From the analysis of the map of 1995 (Figure 4.1 and 4.5) and 2001 (Figure 4.3 and 4.6), it has been found that some areas also encroached by the government activities such as construction of bridges, roads, offices etc.

From the study, it was found that, most of the low lands were also encroach by different housing companies, and water bodies were continuously converted into low lands. That's why the increase of low land was found while water bodies decreased.

Land grabbers generally first encroaches the low lands not the water body. Low lands are relatively less expensive than the water bodies in case of land filling. The encroachment process begins with the conversion of water bodies into low land by some activities like, building structures along the bank of the wetlands, dumping of garbage, land filling etc. According to this process rows and bamboo posts are first positioned on main bed of the bank of the wetland. Then small shops, slums are built on these sites. Then the owners start reclaiming the land by earth filling, and garbage disposal. Then the land development companies and housing companies play a significant role in this encroachment process. These companies try to fill up all the wetland within their boundaries.

4.3 Existing Land Use and Temporal Changes

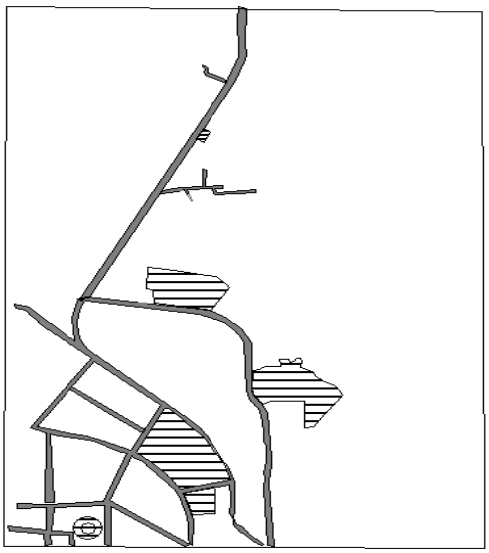

Figure 4.5: Land use map of the study area in 1995

Figure 4.6: Land use map of the study area in 2001

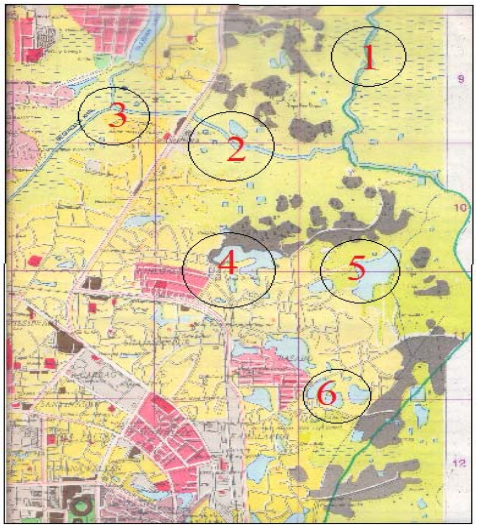

Figure 4.7: Land use map of the study area in 1995

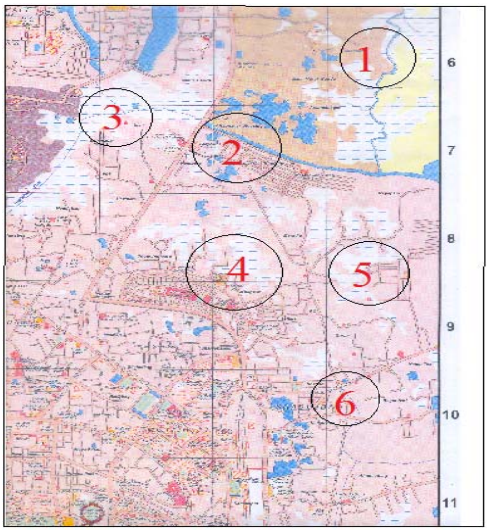

Figure 4.8: Land use map of the study area in 2001

The present situation is very worsening than that of the previous. The making of roads along the bank of the water body has shrunk the main bed of water bodies. The area beside the main flow which have become low or marsh land these are also demolishing by the land encroachers. Now a day's some of the low land can't be identified easily. It is

because of the eutrophication fueled by pollutants and increasing land filling and introduction of slums. The main flow of the river is also obstructing by sluice gate and construction of roads by the governments. It has been found that in the previous year there were open spaces around the water body, now they are under construction of new infrastructures. Some government offices have also been built along this type of wetland. The important example of this kind of infrastructure is the BGMEA office. So there is huge lack of consciousness and co-operation among administration of the country.

To analyze and compare the spatial changes in land use pattern, two maps of the study area of 1995 and 2001 presented in the figure 3.7 and 3.8 respectively. For the better understanding, 6 zones were considered to observe the changes.

Table 4.2: Spatial and temporal analysis of land use change in the study area

Zone	*Status*
Zone 1	From the comparison of two maps, study found the reduction of low lands in remarkable changes and also decreases the width of river.
Zone 2	It was also observed that there was shrinkage of water bodies and the existing water shifted to the adjacent agrarian area. This agrarian area and the bank of water body were converted into residential area and also decrease the width of river.
Zone 3	For the better management of wetland, government takes some steps in this area but this step demolishes the existing river totally and converted this area into stagnant low lands.
Zone 4	In this area water body changed into low lands for the housing activities.
Zone 5	In this zone the water body shifted to low lands and which attracted the land grabbers for encroachment.
Zone 6	In this area the water body is totally demolished and encroached by the land grabbers to perform housing activities.

4.4 Causes of wetland destruction

According to the outcome of the questionnaire survey in the study area, it was found that most of the people (about 99%) living in this area opined that wetland of this area is decreasing day by day. When 19% respondents opined that government agencies do not take care of the wetland which is the main cause of wetland destruction, 12.1% think encroachment of wetland by the land grabbers is also the cause of wetland destruction, another 19% opined that wetland is destroyed day by day only because of illegal land filling or unplanned garbage disposal, 3.4% think others like the pollution by the industry, tannery etc. and 46.6% respondents belief that above all are the causes of wetland destruction.

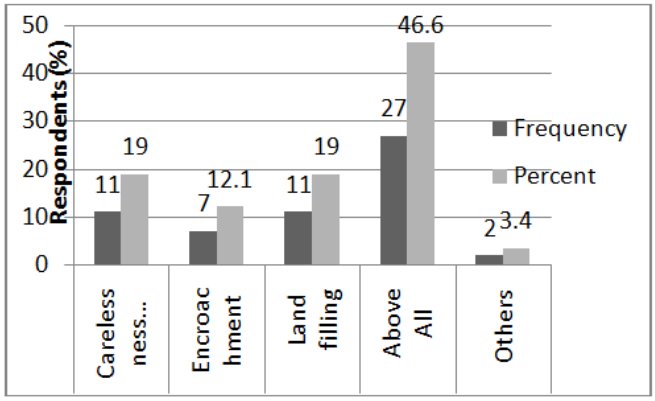

Figure 4.9: Respondent's opinion about the causes of wetland destruction. (Field survey, 2012)

4.5 Consequences of Wetland Losses

Ecologically wetland has a great importance and loss of wetlands in an area can create a large number of environmental problems. Some of them are identified through the questionnaire survey. These are discussed below.

4.5.1 Water logging problem due to wetland loss

According to the outcome of the questionnaire survey in the study area, it was found that 93.1% of the respondents mentioned water logging problem arises due to losses of wetland in their area, followed by 1.7% respondents don't think so and 5.2% having no idea about the causes of water logging.

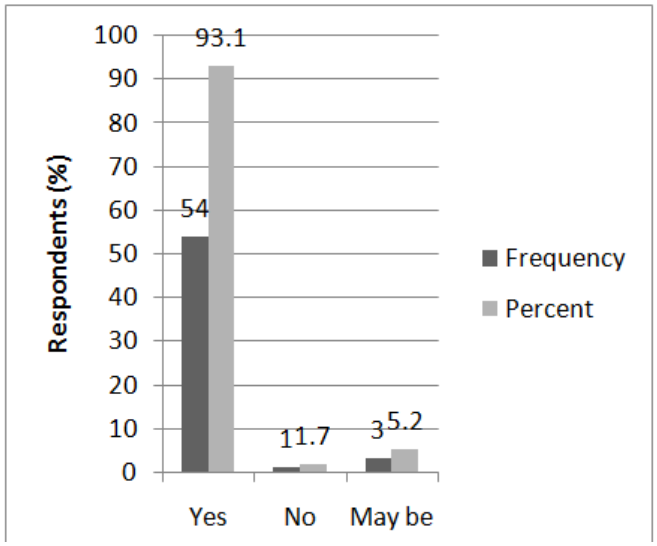

Figure 4.10: Respondent's opinion about the water logging problem. (Field survey, 2012)

4.5.2 Reduced Ground Water Recharge

It is revealed that, 60.3% respondents opined, there is a relation between the wetland destruction and ground water depletion or ground water recharging capacity, followed by 1.7% opined ground water depletion has no relation with the wetland destruction and 37.9% having no idea about the ground water recharge process.

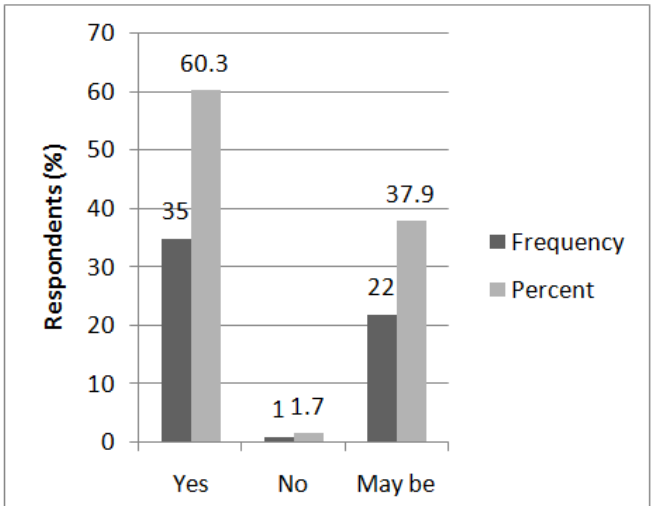

Figure 4.11: Respondent's opinion about the ground water recharging capacity. (Field survey, 2012)

4.5.3 Changes in Temperature

The study depicts that according to 86.2% respondents, temperature rises due to wetland destruction (most of them think that free flow of air, loss of vegetation cover occur because of wetland destruction), followed by 3.4% don't think so and 10.3% have no idea about changes in temperature.

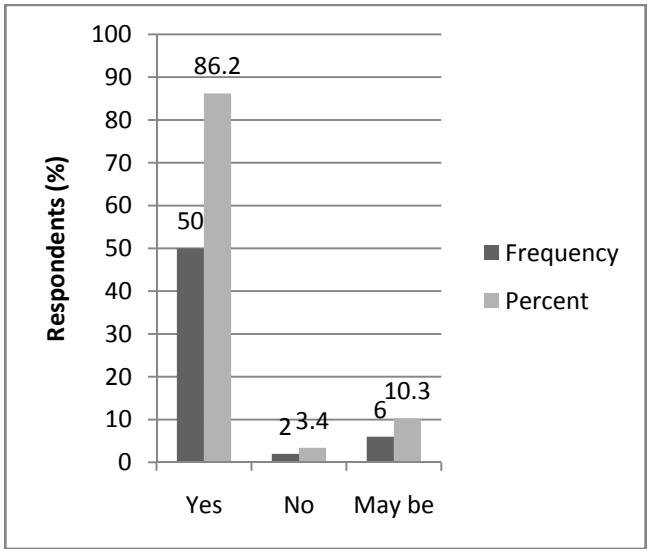

Figure 4.12: Respondent's opinion about the temperature rises. (Field survey, 2012)

4.5.4 Reduces the number of biodiversity

According to the outcome of the questionnaire survey in the study area, it was found that 75.9% respondents opined that due to conversion of wetland to the other purposes the number biodiversity decreases, followed by 3.4% think that biodiversity is decreasing but not just only because of wetland destruction and 20.7% have no clear idea about the reduction of biodiversity because of wetland destruction.

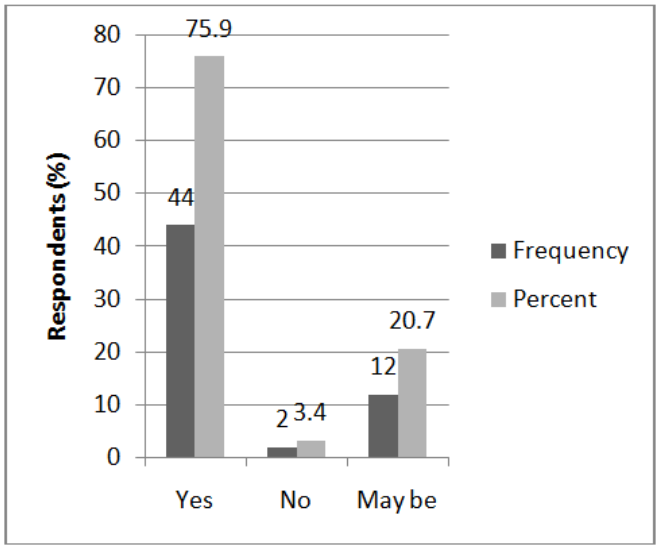

Figure 4.13: Respondent's opinion about the biodiversity reduction. (Field survey, 2012)

4.5.5 Destruction of Aesthetic beauty

Wetlands within the city are mostly in depression areas, marshes and natural canals. These wetlands are typically ill maintained and sites for shanty dwellers and dumping site of liquid waste. On the other hand vast floodplain areas at the periphery of the city are aesthetically pleasant and well visited recreational sites (JICA, 1992).

4.5.6 People's opinion about the conservation of wetlands

Most of the respondents (about 97%) in survey opined that conservation of wetland is necessary. They want a better conservation strategy for the better environment such as making of embankments by the side of the river, proper management of khals and ponds, construction of bench beside the lakes etc.

4.5.6.1 People's opinion about the conservation steps taken by the government

According to the outcome of the outcome of the questionnaire survey in the study area, it was found that 55.2% respondents opined that government takes some steps to protect the wetlands and also take some proper management plan but among them 62.7% opined that steps are not sufficient, followed by 13.8% opined that government don't take any proper steps to protect or manage the wetlands and when 31% have no clear idea about the government's activity about the wetland management.

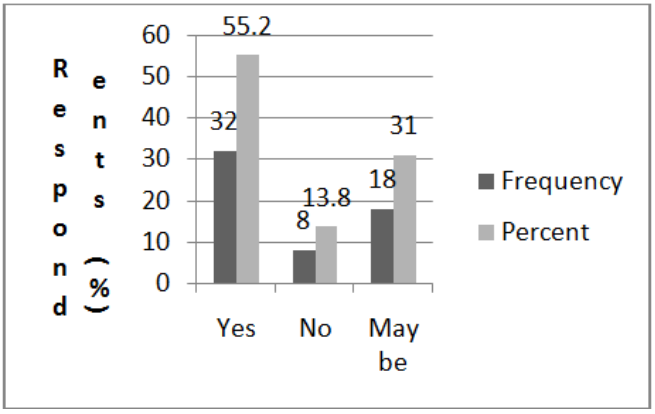

Figure 4.14: Respondent's opinion about the government's activity about the wetland management. (Field survey, 2012)

4.5.6 .2 People's opinion about the role of the mass media

According to the outcome of the questionnaire survey in the study area, it was found that 55.2% respondents opined that mass media plays a vital role to protect the wetlands among them 58.9% opined that coverage of mass media about wetland is satisfactory, followed by 15.5% give negative answer about mass medias activities and 29.3% have no clear idea about the role of mass media with the wetland management process.

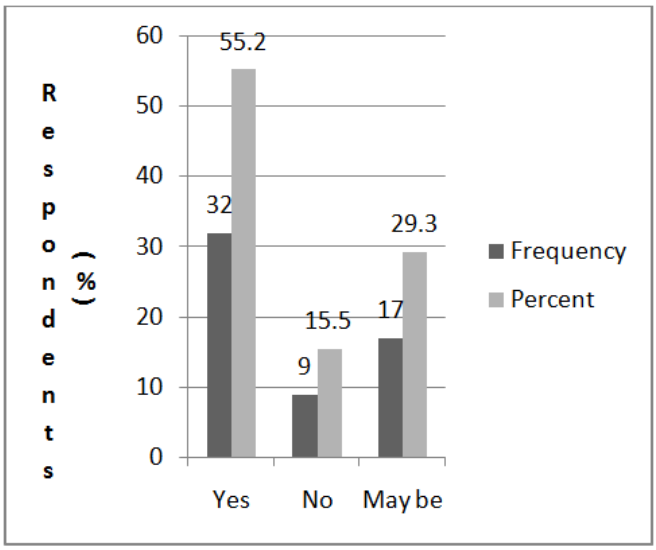

Figure 4.15: Respondent's opinion about the role of mass media. (Field survey, 2012)

5. Conclusion and Recommendations

5.1 Conclusion

Dhaka city is expanding in an unplanned and uncontrolled manner. Rapid population growth creates extra pressure on the land of already overcrowded Dhaka city. For this reason urbanization is stretching along towards the wetlands. Though it is found that the main causes of wetland loss are unplanned urbanization and earths filling for construction of infrastructure, wetlands are randomly being filled up or encroached by mainly real estate housing companies and government organizations. It is revealed that in 1995, the area under wetlands was the dominant, the landfill areas were the lowest and the built up areas were the second lowest land cover types in the study area that period. But in 2001, the situation changed and the built up areas became the dominant land cover types. From 1995 to 2001, the study area had lost 18.5% of wetland area. On the other hand, field survey results revealed that drainage congestion and water logging are the main physical consequences of wetland loss. Severe water logging creates every year in this area during monsoon incurring huge loss in terms of adverse social, physical, economic and environmental losses. The remaining wetlands are crucial for this area to keep the ecological balance, especially to reduce the water logging impacts.

5.2 Recommendations

Bangladesh Water Development Board (BWDB) should identify or define all the wetland to have a better understanding on it, which will help Rajdhani Unnayan Kartripakkha (RAJUK) and Dhaka City Corporation (DCC) to develop plans. Illegal structure should be eradicated by Rajdhani Unnayan Kartripakkha (RAJUK) and Department of Environment (DoE) from the wetland area to protect them. Re-excavation of canals and dredging of river is necessary and it should be done by Bangladesh Water Development Board (BWDB) to retrieve the natural flow of the water body. DWASA should close all the outlet of sewerage pipe line or industrial effluent pipe line into the wetland to save it from pollution. Government should make embankments beside the rivers or khals, which can be influenced by Bangladesh Water Development Board (BWDB), City Corporation and Department of Environment (DoE) to protect it from land filling. Better management should be adapted to the wetland and its embankments for the recreational purposes by Dhaka City Corporation (DCC) and Rajdhani Unnayan Kartripakkha (RAJUK). Government should introduce effective law enforcement to the land encroachers immediately. Department of Environment (DoE) should undertake various conservation strategies for surrounding biodiversity. Local people need to be aware of wetland conservation and awareness building programs can be done by the mass media and other field work by NGO's.

5.3 Scope of the Study

The study was conducted in the selected area of Dhaka city where the destruction of wetland is severe. This study will help the respective authority to take the necessary steps to protect the wetlands. Hopefully this study will be helpful for the further studies in this area.

Acknowledgement

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