Trends of Permanent Wetland Change in Detailed Area Plan of Dhaka

K.H. Razimul Karim[*]

Center for Environmental and Geographic Information Services (CEGIS), Gulshan 1, Dhaka, Bangladesh
*Corresponding author: razimulseye@gmail.com

Abstract Degradation of wetland creates adverse impact on natural environment, ecosystem and on drainage congestion. The situation is more alarming in case of urban areas especially for detailed area plan (DAP) of Dhaka Considering the issues, the study has taken the initiative to rapid asses the Rate of Reduction of Wetland around DAP. Available satellite images from archive have been used to compare the areal extent and statistics of degradation of wetlands. Satellite images of 1967, 1977, 1989, 1999, 2009 and 2010 have been used for preparing permanent wetland maps. For permanent wetlands, images have been selected dated between January to March as permanent wetlands can only be identified in dry season. For finding the trend of changes of permanent wetland, images from Landsat2 MSS, Landsat4 TM, Landsat5 TM (all of 80 m resolution) and Corona Space photo Sensor (12 m resolution) have been acquired. From image, wetland is delineated by unsupervised classification method to get the real situation of DAP. The study shows that due to the unplanned rapid urbanization and increased population, permanent wetland is degrading. Study reveals that Permanent wetland has been reduced from 14% to 4% during 1967 to 2010.

Keywords: degradation, satellite images, wetland, urbanization

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1. Introduction

Wetlands cover 6% of the world's land surface and contain about 12% of the global carbon pool, playing an important role in the global carbon cycle [1]. In a world of global climate change, wetlands are considered one of the unknowns of the near future regarding element dynamics and matter fluxes [2]. The expansions of agriculture and subsequent conversion for settlement and infrastructure development along with the rising population have put immense pressure on wetlands and shrinking it alarmingly. Bangladesh is estimated to have seven to eight million hectares of wetlands in the form of permanent rivers and streams (480,000 hectares); estuarine and mangrove swamps (610,000 hectares); shallow lakes and marshes (120,000-290,000 ha); large reservoirs (90,000 ha); small ponds and tanks (150,000-180,000 ha); shrimp ponds (90,000-115,000 ha); and seasonally flooded floodplains (577, 0000 hectares) [3]. Climate change is recognized as a major threat to the survival of species and integrity of ecosystems worldwide [4]. Pressures on wetlands are likely to be mediated through changes in hydrology, direct and indirect effects of changes in temperature, as well as land use change [5]. Under currently predicted future climate scenarios, the spread of exotics will probably be enhanced, which could increase pressure on watersheds and ecosystems [6]. Moreover, climate change will make future efforts to restore and manage wetland more complex. Wetlands cover 6% of the world's land surface and contain about 12% of the global carbon pool, playing an important role in the global carbon cycle [5,7,8]. The expansions of agriculture and subsequent conversion for settlement and infrastructure development along with the rising population have put immense pressure on wetlands and shrinking it alarmingly.

Dhaka city is one of the largest cities in the world regarding its population density and has developed it infrastructure in unplanned way without considering the adequate drainage system as well as conservation of wetland for future. As a result the city is facing massive water logging problems frequently with moderate to heavy rainfall. The rapid urbanization and population pressure in and around Dhaka city has degraded many of the wetlands since 1960 and the process is still ongoing. However, the environment and the ecosystem of particular areas are directly interlinked with its natural wetland system and its sustainability. So the study area has been selected in and around Dhaka city to assess the extent of wetland reduction in terms of area. This study has attempted to indentify the actual extent of degradation, rate and present status of wetlands. Within limited scope of work, the main objective of the study is to: (i) determine the status of wetland reduction in Dhaka city in terms of extent of area; and (ii) Identify the causes for wetland reduction.

2. Methodology

2.1. Description of Study Area

The Detailed Area Plan (DAP) is last tier of Development Plan for Dhaka City i.e. Dhaka Metropolitan Development Plan (DMDP). DAP is developed based on detailed surveys, studies and analysis which also allowed community participation to make the planning more people oriented. Total area under DAP is around 1438 sq. km which covers the total Rajdhani Unnayan Katripakka (RAJUK) jurisdiction area. The jurisdiction of DAP Planning Area is Gazipur Pourashava to the North; Dhaleshawri River to the south; Bangshi and Dhaleshawri River to the west; and Shitalakkhya and Meghna River to the East. The study area is shown in Figure 1.
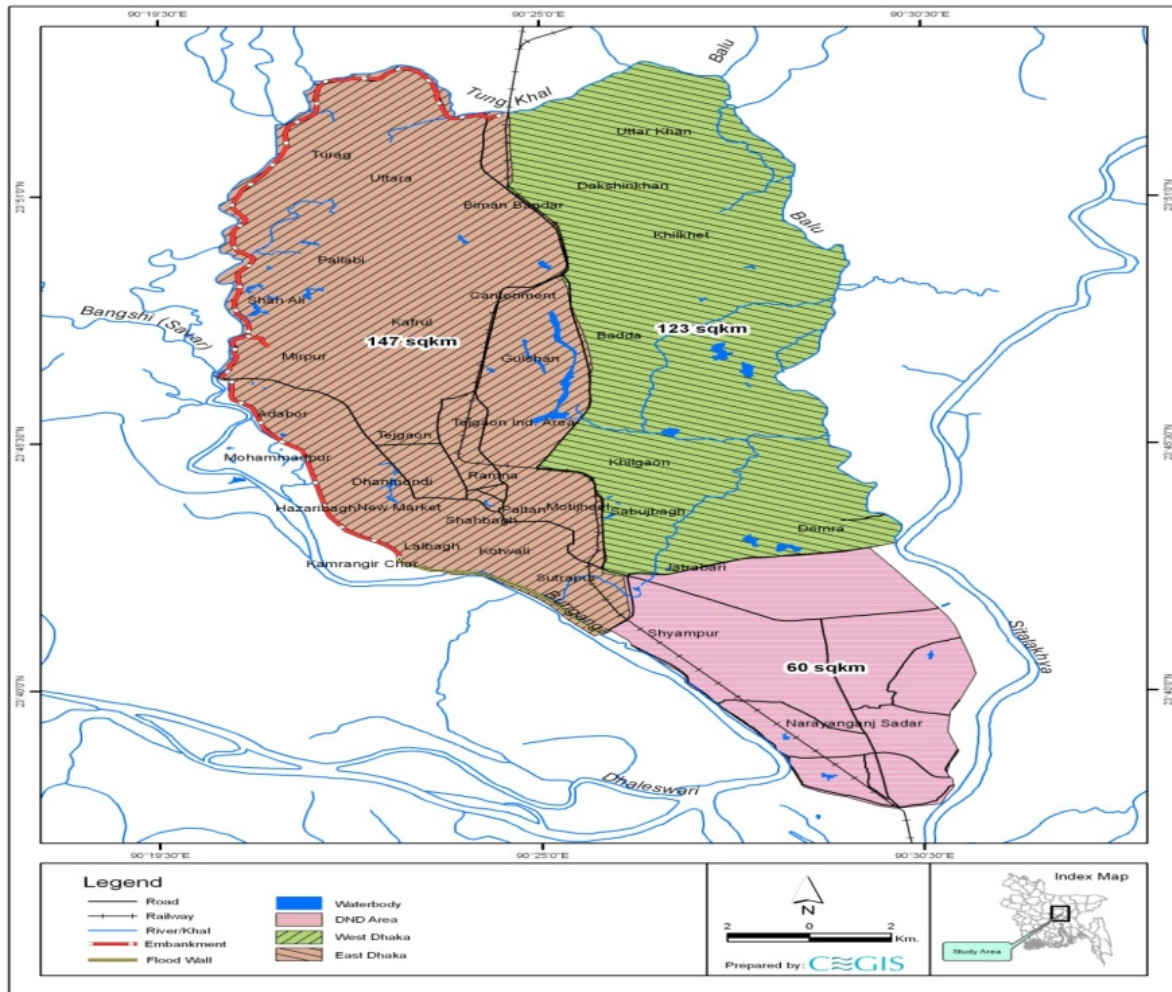

Figure 1. Location Map of the Study Area

2.2. Satellite Image Collection

Available multi-dated satellite images are used in this study which shown in Table 1.

Table 1. List of satellite images for permanent wetland mapping

Sl No.	Sensor	Date	Resolution
1	Corona Space photo	01 March 1967	12 m
2	Landsat2 MSS	03 January 1977	80 m
3	Landsat4 TM	12 January 1989	30 m
4	Landsat5 TM	01 February, 21March 1999	30 m
5	Landsat5 TM	30 January 2010	30 m

For permanent wetlands, images between January to March as permanent wetland can only be identifiable in dry season images. Whilst for seasonal wetland, images between July to October have been considered. In order to avoid cloud hazard RADARSAT ScanSAR narrow beam satellite image have been used in this study. This type of image is very much useful for identifying area extent of seasonal wetlands during monsoon. However four frames of Corona Arial photographs were acquired to cover the study area. Arc GIS 9.2 and EDRAS 9.1 have been used as analysis tool in this study.

3. Results and Discussion

3.1. Permanent Wetland Mapping

Major classes like Permanent Wetlands, Settlement and urban developing area, Agriculture land/ Vegetation/ Fallow/ Bare land were extracted from the Corona Space Photo 1967 by unsupervised classification technique (Figure 2). Statistics generated from analyzed Corona Space Photo of 1 March shows that in 1967, permanent wetland covered 14% of the area (20686 Ha), Settlement and Urban developing area covered 37% of the area (53727 Ha) and Agriculture land/ Vegetation/ Fallow/ Bare land covered 49% of the area (69667 Ha). To identify the permanent wetlands, settlement and urban developing area, agriculture land/vegetation/fallow/bare

land of 1977 Landsat2 MSS satellite images were used (Figure 3). From the analysis it is seen that permanent wetland covered 14% of the area (20503 Ha), Settlement and Urban developing area covered 38% of the area (54869 Ha) and Agriculture land/Vegetation/Fallow/Bare land covered 48% of the area (68708 Ha). Similarly from the analysis of images of 1989 (Figure 4) it is seen that permanent wetland reduced to 10% of the total area from 14% (as per 1967 and 1977) covering 14784 Ha, Settlement and Urban developing area covered 39% of the area (55921 Ha) and Agriculture land/ Vegetation/ Fallow/ Bare land had an increase to 51% from 48% of the total area covering 73376 ha.

In 1999 (Figure 5), from the analysis it is seen that permanent wetland reduced to 4% from 10%, covering 6298 Ha, Settlement and Urban developing area increased to 42% from 39% covering 60702 Ha and Agriculture land/Vegetation/Fallow/Bare land had an increase to 54% from 51% covering 77080 ha. In 2010 (Figure 6), from the analysis it is seen that permanent wetland is about 4%, covering 5520 Ha, Settlement and Urban developing area increased to 47% from 42% covering 68144 Ha and Agriculture land/Vegetation/Fallow/Bare land had a decrease of 49% from 54% covering 70417 Ha.

3.2. Analysis of Permanent Wetland Degradation

A comparison has been made based on the area statistics that were extracted from the Permanent Wetlands maps of different years. Figure 7 shows the statistical comparison between different years for the Permanent Wetland degradation. In 1967, about 20686 hectares of total 144080 hectares area were Permanent Wetlands. Settlement and Urban developing area was 69667 hectares and Agriculture land/Vegetation/Fallow/Bare land cover was about 69667 hectares. In 1977, there was no significant change in wet land in comparison to 1967. However, Agriculture land/Vegetation/Fallow/Bare land decreased moderately. On the other hand, from 1989 to 2010 wetland sharply decreased (from 14784 to 5520 hectares) mainly due to settlement and urban developing area expansion but Agriculture land contribute a little.
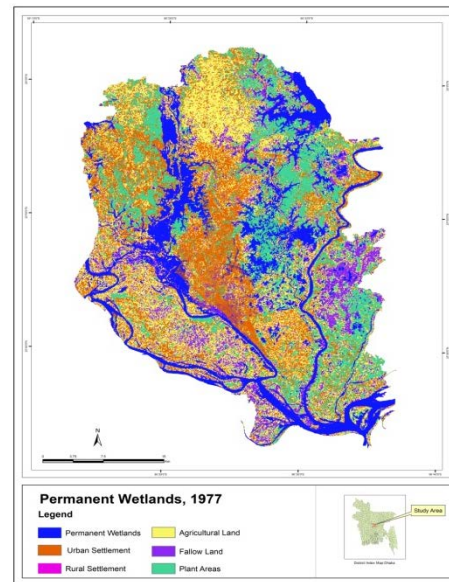

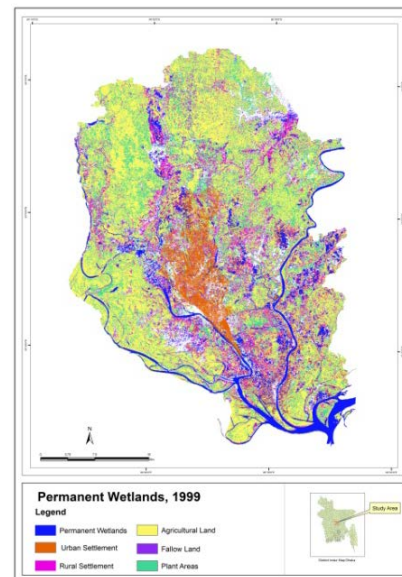**Figure 3.** Permanent wetlands of 1977 derived from Landsat2 MSS satellite images

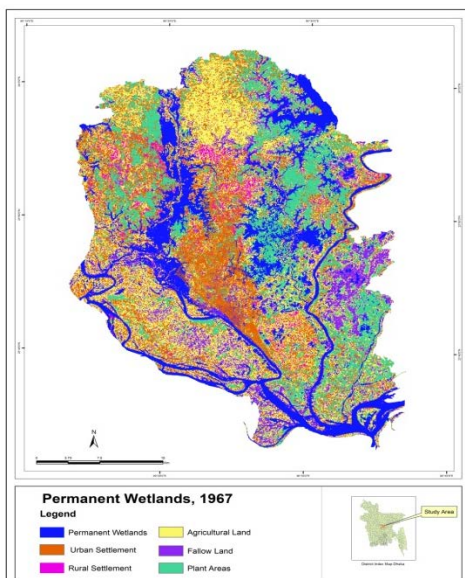**Figure 4.** Permanent wetlands of 1989 derived from Landsat4 TM

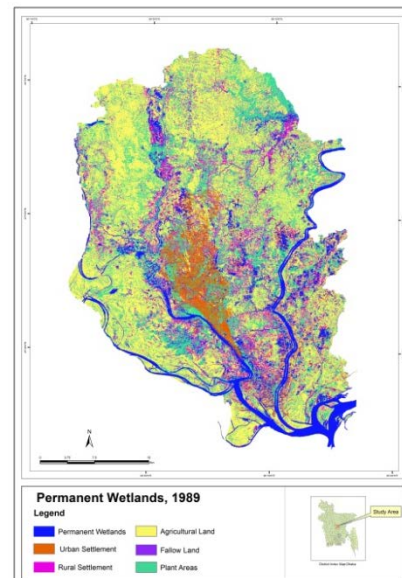**Figure 2.** Permanent wetlands of 1967 derived from Corona Space Photo

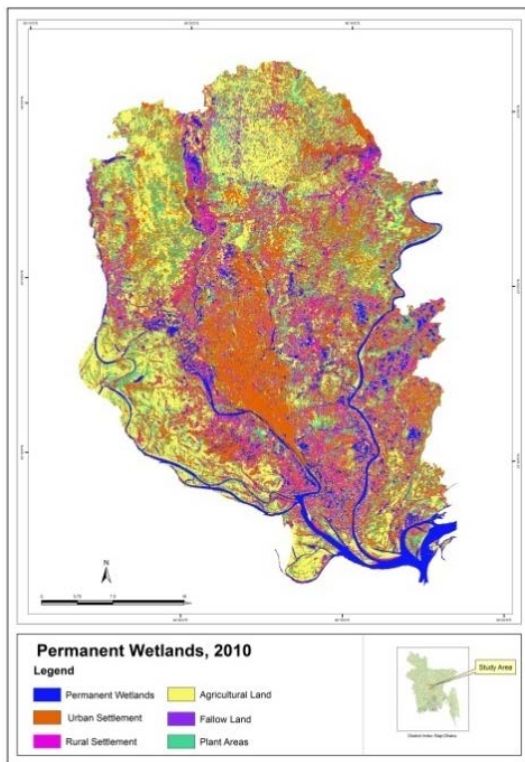**Figure 5.** Permanent wetlands of 1999 derived from Landsat5 TM

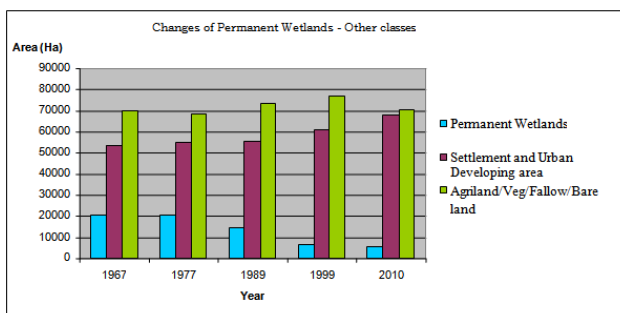**Figure 6.** Permanent wetlands of 2010 derived from Landsat5 TM

Figure 7. Scenario of how Permanent Wetlands degraded by other classes from 1967-2010

4. Conclusion

Rapid urbanization with incremental population pressure has been forced for expanding the Dhaka city urban area and consequently it has been created tremendous pressure on invaluable wetlands around the city. The study indicates that permanent wetlands are degrading. The wetlands are continuously transforming into settlements, and other commercial purposes, which is neither sustainable nor environmental friendly. It is reveled from the study that the Permanent wetlands reduced from 14% to 4% from 1967 to 2010. The rate of permanent wetland reduction is 353 ha/year.

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