POND FILLING LOCATIONS IDENTIFICATION USING LANDSAT-8 IMAGES IN COMILLA DISTRICT, BANGLADESH

A.A. Kafy[1*], [*]& L. Ferdous[1]

[1]*Department of Urban & Regional Planning, Rajshahi University of Engineering and Technology, Rajshahi-6204, Bangladesh. Email:* lamiaferdous127030@gmail.com

*Corresponding Author Email: sunnykafy@gmail.com

ABSTRACT

Ponds are an important place for biodiversity. Collectively, they support more species and more scarce species, than any other freshwater habitat. According to Bangladesh Bureau of Statistics (BBS), the number of ponds in the year 2011 is 73,532 thousand in Comilla district. It's very much noticeable in recent few years that ponds are being filled up to meet up rapid urbanization in Comilla District. The study aimed at understanding the phenomenon of filling up ponds with the help of Landsat-8 images and also find out the causes for pond filling in Comilla district. Landsat 8 images contain 15m resolution and these satellite images have been used to identify the loss of ponds in every year starting from November, 2013 - November, 2017. Geographic Information System (GIS) and Erdas Imagine software have been used to perform a supervised classification and change detection technique to identify the locations of ponds fill up in every year. This study makes an attempt to find out the root causes of filling up the ponds and analyze the trends of pond fill during 2013-2017 years. The result shows us that in year 2017 the number of pond is 61,426 thousand which indicates almost more than 10,000 thousand ponds are being fillip in space of only 6 years. The pond filling will make the drainage system of Comilla district vulnerable which increases urban flooding, water logging and temperature rises to an unexpected extent. The conservation of ponds is crucial to keep a perfect ecological balance in Comilla District.

Key words: Pond filling, Geographic Information System (GIS), Causes, Supervised classification, Landsat-8, Comilla District

INTRODUCTION

Ponds are very useful for maintaining the environment and balancing of the land use. Ponds are natural or manmade shallow water bodies which hold water permanently or temporarily (Céréghino et al., 2010). Ponds are small in sizes varies between 1 m² to about 5 ha (Akhtar et al., 2017). Ponds are important to place for biodiversity. Collectively, they support more species, and more scarce species, than any other freshwater habitat. The protection of ponds is much essential because they are playing a very crucial part in conserving our biodiversity. The type of life in a pond is generally determined by a combination of factors including water level regime (particularly depth and duration of flooding) and nutrient levels (Meester et al, 2005). Other factors may also be important, including presence or absence of shading by trees, presence or absence of streams, effects of grazing animals and salinity (Paul, 2010).
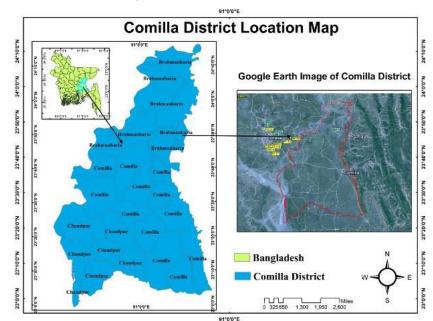
Bangladesh experienced a fast increase of urban population in the recent decades like other developing countries. In the year 2011 the total population lives in the urban area is about 29% and the annual rate of urbanization is 2.96% (CIA, 2015).Because of unplanned urbanization and haphazard situation present in earth-dumping, a total 4000 ponds have been filled in the last five decades. In Comilla district, the urbanization is increasing significantly with the increase of population from in from 3.4 million to almost 5.4 million in the year 1981 to the year 2011(Bangladesh Bureau of Statistics, 2013). The increase in urbanization will hamper the present water body like ponds and ponds have been diminishing frequently to meet up the increasing urbanization. In the year 2011, the number of ponds in Comilla district is 73,532

thousand (Bangladesh Bureau of Statistics, 2013) which significantly decrease to 61,426 thousand. It is very much noticed that the study area can be severely suffered from ecological degradation through rapid urbanization and harmful changes (Akhtar et al., 2017).

The present work implies upon the trend of pond fill in Comilla district with the help of satellite images and identifies the causes behind it. High-resolution satellite imagery can be used for monitoring and advocacy of land use changes in any region. Remote sensing data from Landsat-8 satellite images to identify the ponds as well as locations of ponds filling in Comilla district from the year 2013 to 2017.This study aimed to understand the causes of pond filling and explore the rate of pond filling in context Comilla district.

METHODOLOGY

Comilla City stands on the bank of the river Gumti .Comilla District is bounded on the north by Brahmanbaria District, on the east by Tripura State of India, on the south by Feni and Noakhali Districts and on the west by Narayanganj District, Munshiganj and Chandpur Districts [Fig. 1]. It lies between 23°02' and 23°48' north latitudes and between 90°38' and 91°22' east longitudes. The total area of the district is 3146.30 sq. km. (1214.79 sq. miles) with an estimated population of 5387288 people (Bangladesh Bureau of Statistics, 2013).

Fig. 1: Location Map of Study area

The present work was conducted using both primary and secondary data. The primary data were collected from a structured questionnaire, and interviews and focus group observations in major ponds filling locations in different upazilas. The questionnaire survey was conducted based on random sampling which includes 250 respondents. The primary data were analyzed by IBM SPSS 20 software. The secondary data were collected from satellite images. Landsat-8 OLI images (in the form of both surface reflectance) at 15 m spatial resolution are freely available in United States Geological Survey (USGS) websites (Bartsch et al., 2016). For this study, these images covering the study area and within the time frame of 2013 to 2017 have been collected Landsat 8 operational land imager (OLI) images dated 13 October 2013, 25 November 2015 and 21 November 2017 were downloaded from the global visualization viewer of the United States Geological Survey (USGS). Images are collected from late autumn (October and November) since this season is cloud free and trees are not in leaf-off condition(Rahman et al., 2017).

Images for three different years are collected within one month to avoid the season variation in this area. These images were acquired with a combination of path-row 136-44, 137-43 and 137-44 as this cover the study area. Upon acquiring all the required datasets, we performed the following set of pre-processing steps for Landsat-8 OLI. Those included: (i) re-projecting the images into Universal Traverse Mercator (UTM) Zone 46 N with World Geodetic System 1984 (WGS84) datum, (ii) clipping the images to represent the study area (iii) Supervised classification in three years 2013,2015 and 2017 to identify the water body iv) extract the water body which is less than 5 hectors from classified images. V) Matrix Union to identify the conversion of ponds in different land uses. Only visible and near-infrared bands of the Landsat scene are considered for the supervised classification to prepare decadal land cover maps of the Comilla District. For easy understating of the study, four broad land cover categories are selected and mapped for the study area: waterbody, buildup area, vegetation which include agricultural land and bare soil (Kafy et al., 2017).Two change maps are prepared based on the post-classification land cover change between 2013 and 2015 as well as between 2015 and 2017. Since three types of changes such as ponds to buildup, ponds to vegetation and ponds to bare soil provide a favorable condition for how the ponds are converted in different land uses.

RESULTS AND DISCUSSIONS
Land use Change assessment
Figure 1 shows the land cover map of three different years. Increase Urbanization might have observed from the map (Fig. 2). Diminishing of water bodies for different land use activities have been significantly noticeable between years 2013 - 2017. In land cover changes, major changes are noticed in Built-up areas which were 556 km^2 in 2013 and increase almost double to 1006.89 km^2 in the year 2017. Fig. 1 indicates that Comilla District had 8 percent of its area as Built-up area which is significantly increased to 15 percent. Also, noticeable change in vegetation land which is 3520 km^2 and 2751.55 km^2 in 2013 and 2017 respectively. Between 2013 and 2017 there is very little change in bare soil condition. Waterbody change also noticeable which is 1127 km^2 (17%) in the year 2013 and significantly reduce to 887.949 km2 (13%) in the space of 5 years [Fig. 2].
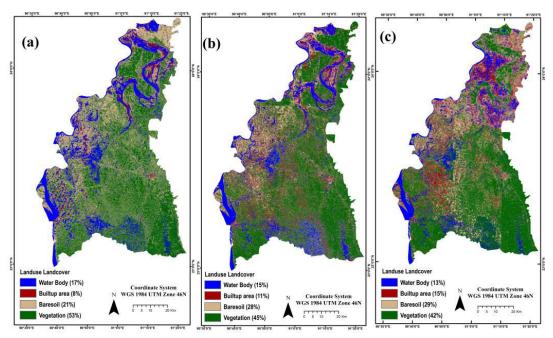

Fig. 2: Land cover map of Comilla District in year 02013(a), 2015(b) and 2017(c)

Ponds Filling Change assessment

The number of ponds in Comilla district in year 2011 is 73,532 thousand (Bangladesh Bureau of Statistics, 2013) which is decrees significantly in every year interval. From fig. 3 the number of ponds in year 2013 is 71523 thousand which achieve after processing the satellite images. With the increase in rapid urbanization the number of ponds are decreed in 61426 thousand in year 2017. Almost 12677.08km^2 ponds area have lost in the space of only six years which is very much alarming for Comilla district at present. Rapid loss of ponds (7426 thousands) happen between years 2013-2015 (Table 1).

Table 1. Diminishing of Ponds area in Comilla district, 2011-2017

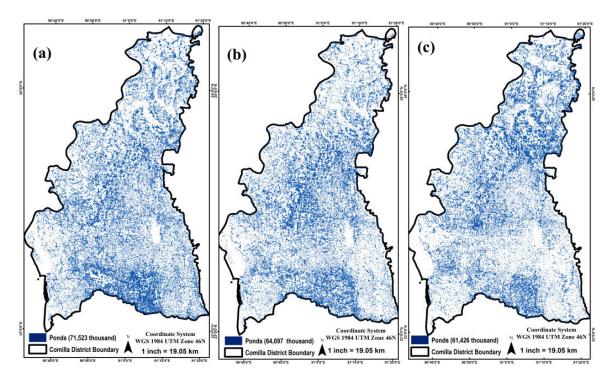| Year	Number of Ponds	Area(km^2)
2011	73532	23876.07
2013	71523	21575.05
2015	64097	14727.15
2017	61426	11198.99

Fig. 3: Ponds of Comilla District in year 2013(a), 2015(b) and 2017(c)

Conversion of ponds to different land uses

Major conversion of ponds to build up area happen between years 2013-2015. 104.55 km^2 and 9.65 km^2 area of ponds are fill up to build urban areas in year 2013-2015 and 2015-2017 respectively. Similarly the agricultural activities increase mostly in year 2015-2017 which diminish almost 130.27 km^2 area of ponds. People fill up the agricultural lands and ponds to meet the rapid urbanization and for this reason the bare soil area is increase from 79.76 km^2 to 86.96 km^2 in year 2015-2017 (Fig.4). The figures describe that ponds have been fill up across the Comilla district to meet the rapid urbanization as well as increase demand is vegetation and agricultural products.
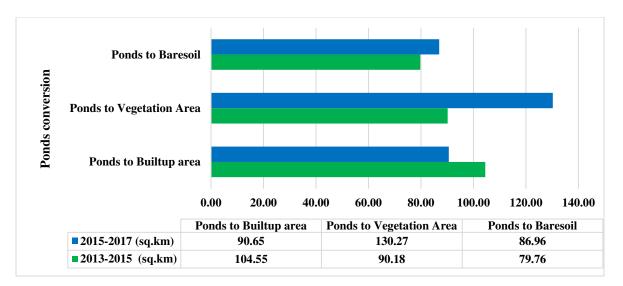
	Ponds to Builtup area	Ponds to Vegetation Area	Ponds to Baresoil
■ 2015-2017 (sq.km)	90.65	130.27	86.96
■ 2013-2015 (sq.km)	104.55	90.18	79.76

Fig. 4: Ponds Conversion to different land use in Comilla District, 2013-2017

Causes of Pond Fill

In last 7 years more ponds and wetland have been filled in Comilla district. Since then, extensive losses have occurred, with many of the original ponds were filled and many of them were converted to farmland. Activities resulting in pond fill loss and degradation include: urban (commercial and residential) area development, agriculture activities, land filling, encroachment and huge political and institutional support ignoring the rules and laws. The main causes of pond fill are shown in the Fig. 7 below.
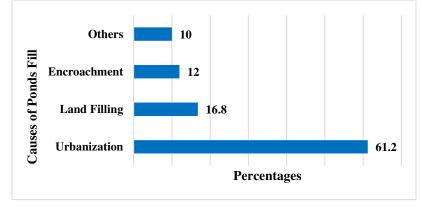

Fig. 5: Reasons for ponds fill up in Comilla District

Urbanization is a major cause of impairment of ponds. Urbanization has resulted in direct loss of pond areas as well as degradation of ponds. Construction activities are a major source of suspended sediments that enter ponds through urban runoff. According to the survey in major ponds fill up locations in Comilla district, 61% of pond fill happened due to urbanization. Shopping Centre, Market, high rise building, restaurant are the main causes of pond fill in Comilla district. Land filling is the second most important causes of pond fill in Comilla district. About 17% respondent said that land filling is the one of the causes for pond fill in Comilla district. Most of the respondents said that encroachment mostly happens where pond owner has his house near the pond. From the survey data it can be said that 12% pond fill happens due to encroachment. The first step of encroachment is to build structures along the surroundings of ponds and further out on the ponds itself. To do this, rows and bamboo posts are positioned and fixed on the water body bed along the bank and extending into the main body of the pond. Then huts and shops are

built on these stilts. The owners of these structures are then start reclaiming land by earth fills and dumping garbage. Pond filling has some other reason as well. Such as, political pressure in unlawful land grabbing, unplanned urbanization and district expansion, unplanned constructing of government building etc. [Fig.5].

CONCLUSIONS

In space of 7 years, 12677.08 km2 area of ponds in Comilla district has been filled. There will be no pond in Comilla district area if the current trend continues for next 90 years. The study identifies the number of ponds in three different years using 15m resolution Landsat-8 images and also Observes he main causes for pond fill of Comilla district. The study finds that the main reasons are urbanization, encroachments, land filling etc. The critical effects of the pond fill are the loss of biodiversity, serious environmental degradation, Water logging, urban flooding, and loss of valuable water resources. To improve the beautification of Comilla district measure should be taken like conserve ponds and develop scenic view around the ponds to create more attraction to the district dwellers. The conservation of ponds is crucial for Comilla district to keep the ecological balance, especially to reduce the urban flooding. Necessary measures should be taken like social awareness, maintain of strict law and the Local government could play an important role in pond fill restriction.

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