EXPLORING THE ASSOCIATION OF SURFACE WATER BODY CHANGE AND RAPID URBANIZATION IN RAJSHAHI CITY CORPORATION (RCC) AREA USING RS AND GIS

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ABSTRACT

Water body extraction is an important task in evaluation of water resources disciplines of developing country especially in Bangladesh. In Rajshahi metropolis, there were 729 ponds and canals in 2002, but the figure had been fallen to 393 in 2013 because of indiscriminate land filling and unplanned urbanization. Therefore, the aim of the study is to explore the association of decadal changing pattern of decreasing surface water body in 30 years (1996, 2006 and 2016) of Rajshahi City Corporation (RCC) area and to identify the persistence where water bodies are filled up because of rapid urbanization activities. Decadal Land Cover and Water Body Maps of the study area have been prepared for 1996, 2006 and 2016 using Landsat satellite images. A change detection technique which gives automatic water body extraction and mapping of the location, scarcity and morphometric of water body has been applied to extract the water body changes by integrating Remote Sensing (RS) and Geographic Information System (GIS) applications. The association has been established by the locations of rapid urbanization areas. The study finds that most of the water bodies are filled up due to rapid urbanization where people used to fill up the surface water bodies for residential and commercial settlements which affects climate change, biological diversity and human wellbeing. The study describe a national problem named urbanization which increases rapidly and damages our biodiversity and climate. The findings will help the concerned authority who can use this information for further planning and strategy making policy about better management of water bodies in future.

Keywords: Extraction; Persistence; Remote Sensing; Land Cover Maps; Morphometry; Urbanization; Strategy Making Policy.

INTRODUCTION

Urbanization now-a-days is occurring very fast and one of the most principle demographic development especially in developing countries. Due to urbanization, environmental sustainability would be wrecked down continuously (Brookfield, 1988). These urban growth causes adverse effect on water land which is not only land but also a worthy resource for any country. Urbanization results declination of water bodies by increasing impervious layer as well as built-up area (Faridatul, 2017). Obtaining Remote Sensing and GIS environment, changes of wetland can be quantified through image classification algorithm (Faisal and Khan, 2017). Remote Sensing (RS) has been used for classifying land cover whereas it covers larger

scale and also supervised classification techniques can help to detect the particular land cover like water bodies and built-up areas (Ozesmi, 2002).

Rajshahi is the fourth largest metropolitan city of Bangladesh. Rajshahi City Corporation (RCC) stands on the bank of Padma River covering 96.72 km^2 area. The number of total ponds in the year of 2011 was 373 including 1 deghee (BBS, 2011). The number of water bodies was also decreased from year after year due to urbanization. Most of the wetland area was converted to built-up area which negatively affected the environmental suitability.

Many studies used to find and moderate spatial resolution multispectral images from different sensors and to extract land cover information like water bodies (Kafy et al., 2017)). This study aims at an integration of RS imageries and GIS Application for decadal changes of RCC water bodies and can find the area which is converted from water body to built-up area. It is a modern technology for analyzing land covers and its nature. The study illustrates the extraction of the persistence of water body over time using Remote Sensing (RS) image and Geographic Information System (GIS) applications to understand the decreasing pattern of water body which help to solve complex planning and decision making policies.

METHODOLOGY

Rajshahi is the fourth largest metropolitan city of Bangladesh which lies between 24°07′ to 24°43′ north latitudes and between 88°17′ to 88°58′ east longitudes (BBS, 2011). It was one of the first Municipalities in Bangladesh, established in 1876 and declared as a City Corporation in 1987. The region consists of Barind tract, Diara and Char lands. Rajshahi town (City Corporation) stands on the bank of the river Padma. The area of the Rajshahi City Corporation is 96.72 sq. km (BBS, 2011). The location of RCC area shown in fig.1.

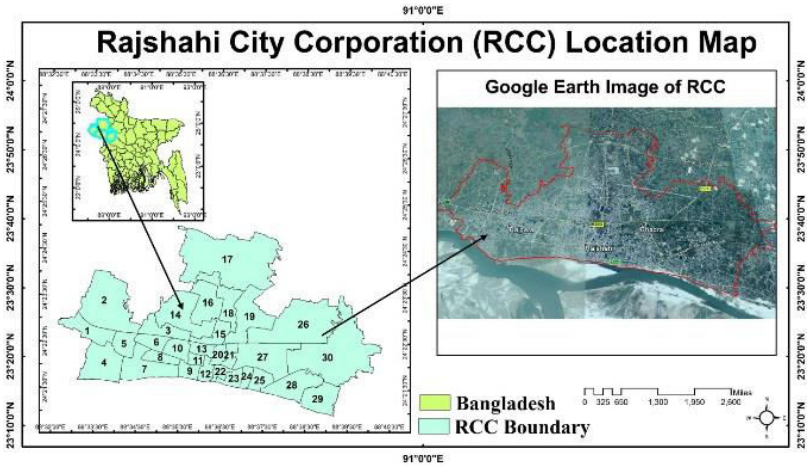

Fig. 1: Location map of study area

The land cover maps of RCC were prepared for 1996, 2006, and 2016 using supervised classification technique to identify the decadal land-cover change. Landsat 4–5 thematic mappers images-dated 13 October 1996 and 25 November 2006 and Landsat 8 operational land imager (OLI) images dated 21 November, 2016 were downloaded from the global visualization viewer of the United States Geological Survey (USGS). The Images are collected from late autumn (October and November) since this season is cloud free (Kafy et al., 2017). Images for three different years are collected within one month to avoid the season variation in this area. To cover the whole study area one Landsat scenes path-row 138-43 was required. For preparing decadal land cover maps for RCC area with supervised classification techniques, only visible and near infrared bands of the Landsat scene are considered (Kafy et al., 2017). On the knowledge of local geography and purpose of the study, four broad land cover categories are selected and

mapped for the study area: waterbody, buildup area, Agricultural land and Vegetation and bare soil. Each classified map thus evaluated with available field data and Google earth image over randomly selected points for accuracy assessment (Kafy et al., 2017). To identify the location of water body reduction for the purpose of rapid urbanization which is identified as built up area in image classification classes, a post classification change detection might be appropriate for this kind of study. Two decadal change maps are prepared based on the post-classification land cover change between 1996 and 2006 as well as between 2006 and 2016. Since identification of one type of changes which is water body to buildup occurrence will be the aim of this paper, the locations of water body fill up location because of urban area expansion will be estimated using matrix union in ERDAS imagine software which is described with the help of two changes maps.

RESULTS AND DISCUSSIONS

Land use Change assessment

Fig. 2 shows the land use images of 1996, 2006 and 2016 of the study area. Changes of urban land use can be easily determined by the image. During the urbanization process of Rajshahi city, water body is reducing day by and replaced by urban area. With the growth of Rajshahi city and increasing population rate, demand for urban area is increasing and as a result, water body is transforming into urban area.

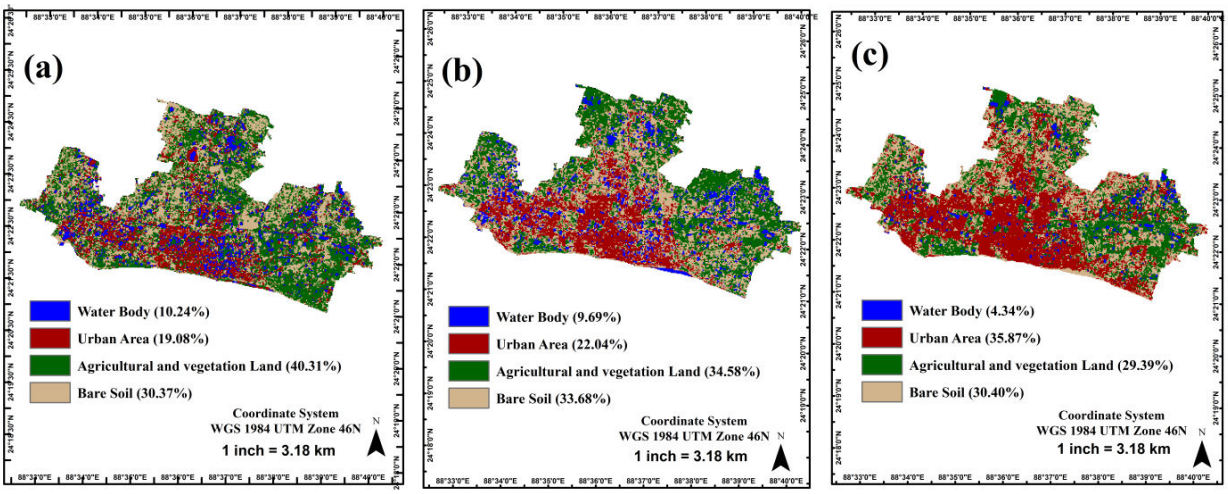

Fig. 2: Land use map of Rajshahi City Corporation in 1996(a), 2006(b), 2016(c)

In 1996, total amount of waterbody in Rajshahi was 4.7547 sq.km. Urban area was 8.8542 sq.km. In 2006, a little change over the waterbody would be noticed. Waterbody reduced to 4.4991 sq.km. and turned into urban area, which results increase in urban area from 8.8542 sq.km to 10.2294 sq.km. A significant change occurred in last decade. Population and human settlement forced upon waterbody and reduced it to 2.0151 sq.km. Noticeably, urban area increased 16.6716 sq.km, which is double than the year of 1996.

Table 1 Decadal Land use change year 1996-2016 in RCC

Land use	1996(km^2)	2006(km^2)	2016(km^2)
Waterbody	4.7547	4.4991	2.02
Urban Area	8.8542	10.2294	16.67
Agricultural & Vegetation land	18.711	16.0533	13.66
Bare Soil	14.0976	15.6357	14.13

Water body fill up assessment for urbanization

Fig. 3 shows the direct association of water body filled up occurrence with rapid urbanization. In figure 3(a), blue dots indicate waterbody which remained unchanged from 1996 to 2006 and red dots indicate change of waterbody to urban area. 0.423 sq.km of area has changed from waterbody to urban area. In figure 3(b), it shows the change of 2006 to 2016. In this decade 1.03 sq.km of waterbody has changed to urban area. The most important finding is that, in the last decade, change of waterbody to urban Area is about double and it has a side effect on the environment as well as.

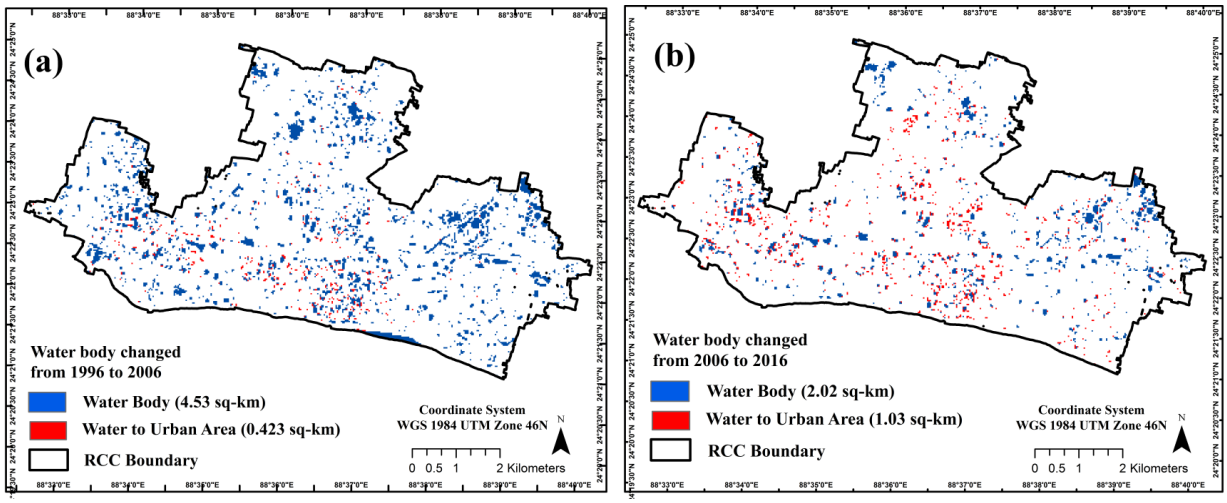

Fig. 3: Association of water body fill up occurrence with urbanization in RCC a) 1996-2006 b) 2006-2016

Table 2 describe the loss of surface water bodies in year 1996-2006 and 2006-2016.The water body loss increasingly in very alarming way. About 9% of water bodies was fill up in year 1996 and 2006. The parentage of loss of water bodies is very high (51%) which indicated very alarming situation for environmental degradation in RCC area.

Table 2 Loss of water bodies in RCC within 20 years

Year	Total surface water bodies (km^2)	Area (km^2)	Percentages of loss
1996-2006	4.5315	0.423	9.33
2006-2016	2.0196	1.0314	51.06

This situation occurred because of haphazard and unplanned growth of urbanization in RCC area in recent few years. People are willing to fill up the water bodies and developed residential as well as commercial areas. Planned urbanization might meet the demand of increasing population as well as protect the water bodies from the massive destruction.

CONCLUSIONS

Although there are diversified reasons behind the water bodies fill up in the study area, this study finds the rapid urbanization is the primary causes for water body fill up. Urbanization is a major cause of damage of water bodies. Urbanization has resulted in direct loss of water bodies as well as degradation of water bodies. Construction activities are a major source of suspended sediments that enter into the water bodies through urban runoff. Water bodies fill happen also due to encroachment. The first step of encroachment is to build structures along the surroundings of water bodies and further out on the water

bodies 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. Water bodies fill up 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. The serious effects of the Water bodies fill up are the damage of biodiversity, serious environmental humiliation, Water logging, metropolitan flooding and loss of valuable water resources. To improve the enhancement of RCC area measure should be taken like conserve surface water bodies and develop scenic view around the water bodies to create more attraction to the city dwellers. The conservation of surface water bodies is crucial for RCC 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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