Importance of Surface Water Bodies for Sustainable Cities: A Case Study of Rajshahi City Corporation

Abdulla - Al Kafy

GIS Analyst, Rajshahi Development Authority, Bonolota Commercial Area, Rajshahi, Bangladesh

Graduate Student, Department of Urban & Regional Planning, Rajshahi University of Engineering and Technology, Rajshahi, Bangladesh.

Urban Planner, Associate Member, Bangladesh Institute of Planners (BIP), Membership ID: 1428.

Email : sunnykafy@gmail.com Contact Number: +8801771411138

Abstract

Water Bodies are an essential element of biodiversity. Water Bodies provide support to more species than any other freshwater habitat. According to the Rajshahi Master Plan, 2004 total number of the area for surface water body was 3. 42sq.km and Bangladesh Bureau of Statistics (BBS) showed that in the year 2011 the number of pond in RCC area was 393. The aim of the present study is to investigate the demolishment of the surface water bodies in the last 20 (1996-2016) years. Also, the paper tries to describe the importance of water bodies for a sustainable city. 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 water bodies fill up in every year. This study makes an attempt to find out the root causes of filling up the water bodies and describe the importance of water bodies for future sustainable cities in Bangladesh. The result shows us that in the year 2016 the total number of surface water bodies in RCC area is only 2.02 km2 which indicate almost 1.4 km2 water bodies are being filled up in space of only 12 years. The water bodies conservation will make the drainage system more functional which will help to reduce urban flooding, water logging and control temperature rises of RCC area vulnerable which increases urban flooding, water logging and temperature rises to an unexpected extent. The conservation of water bodies is very crucial to keep a perfect ecological balance which reduces future vulnerability and make Rajshahi City more sustainable in near future.

Keywords: Water Body, Demolishment, Sustainable City, Ecological Balance, Rajshahi City

1. Introduction:

The sustainable city can be defined by 'The development of a city which meets the needs of the present without compromising the ability of future generations to meet their own needs' (Hunter & Haughton, 2004; Mazmanian & Kraft, 2009). Sustainable development of cities and communities requires the integration of economic and ecological considerations in decision-making.one of the main ecological element for sustainable communities is water resources and water services which are able to satisfy the changing demand placed on them, now and into the future, without system degradation (Burton, Jenks, & Williams, 2003; Hunter & Haughton, 2004; Portney, 2005). Water is a public good and has a social and economic value in all its competing uses. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels (Biswas, 1991; Mazmanian & Kraft, 2009).

Due to the rapid urbanization because of the demographic development especially in developing countries many natural resources facing difficulties. This urban growth causes an adverse effect on surface water bodies and environmental sustainability. Urbanization results declination of water bodies by increasing impervious layer as well as built-up area (Faridatul & Jahan, 2014). Remote Sensing (RS) has been used for classifying land cover and can help to detect the water bodies demolishment because of the major influences of other land use (Mahmud, Masrur, Ishtiaque, Haider, & Habiba, 2011; Sawaya, Olmanson, Heinert, Brezonik, & Bauer, 2003).

This study aims at an integration of RS imageries and GIS Application for decadal changes of RCC water bodies and describes the importance of surface water bodies to establish Rajshahi City more sustainable in near future. The study illustrates the extraction of the persistence of the water body over time using Remote Sensing (RS) image. The application of Geographic Information System (GIS) helps to understand the decreasing pattern of a water body which support in decision making and achieve sustainable communities in Bangladesh.

2. Study Area

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 and lies between 24°07′ to 24°43′ north latitudes and between 88°17′ to 88°58′ east longitudes (Statistics, 2013). The region consists of the Barind tract, Diara and Char lands. Rajshahi town (City Corporation) stands on the bank of the river Padma. The number of total ponds in the year 2011 was 373 including 1 deghee (Clemett, Amin, Ara, & Akan, 2006; Working Paper on Transport, 2003). The number of water bodies also decreased in every year due to the rapid urbanization. Most of the wetland area was converted to the built-up area which negatively affected the environmental suitability. The location of the RCC area shown in fig.1.

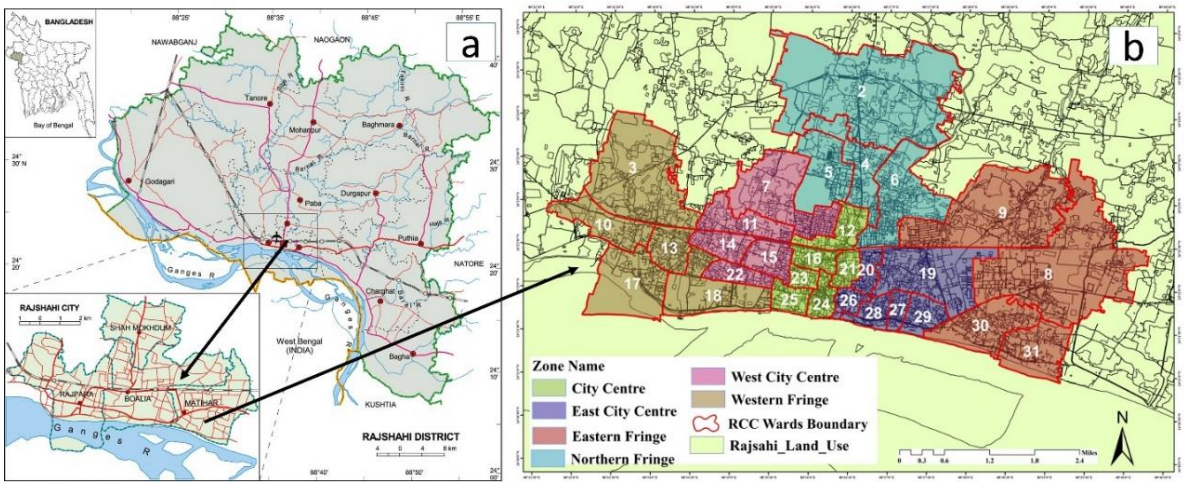

Figure 1 Location of Rajshahi City Corporation (RCC) area (a) in Bangladesh and in Rajshahi District b) RCC ward boundary, Land use and Zoning boundary Source: (a) Banglapedia, National Encyclopedia of Bangladesh, 2012, and (b) Rajshahi Development Authority (RDA),2004

3. Methodology

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 surface water body filling locations in different wards of RCC. 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. The land cover maps of RCC area 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, Ferdous, Faisal, Khan, & Sheel, 2018; Kafy et al., 2015; Kafy, Rahman, & Ferdous, 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., 2018). To identify the location of surface 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 the identification of most influential land use parameter which effects the water body reduction and identifies the importance of water body for the sustainable city will be the aim of this paper, urban area expansion will be estimated using matrix union in ERDAS imagine software.

4. Results and discussions

Kafy et al.,2018 describe the land use deviation and water body fill up assessment for rapid urbanization in his research for RCC area. The information helps to identify the water body fill up assessment which is much suitable to identify the importance of water bodies for sustainable cities in near future to make RCC area more sustainable (Kafy et al., 2018).

4.1 Deviation in Land use

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

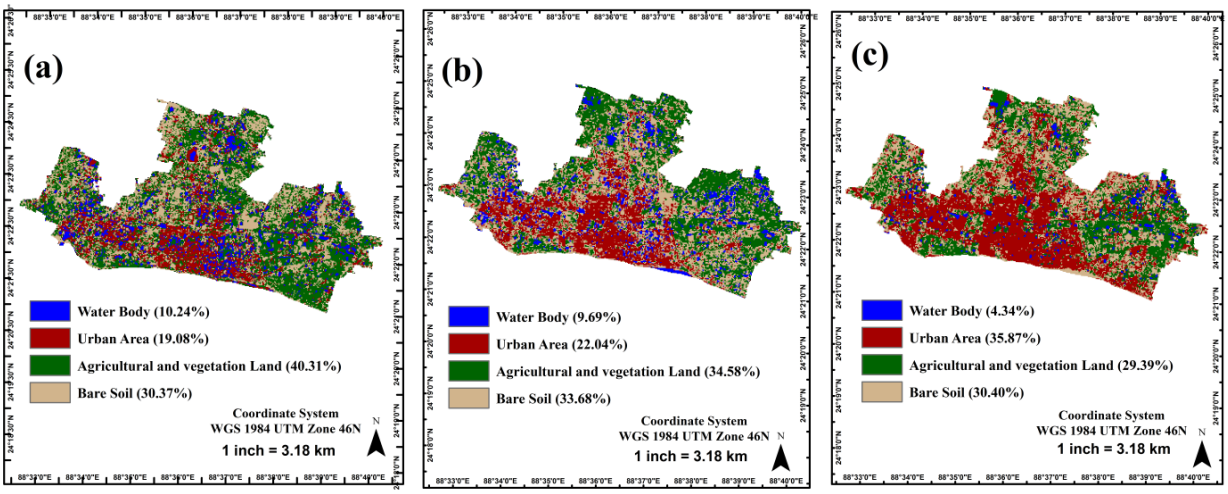

Fig. 2: Land use map of Rajshahi City Corporation in 1996(a), 2006(b), 2016(c) (Kafy et al., 2018)

In 1996, the 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 3.3891 sq.km. and turned into an urban area, which results in an increase in urban area from 8.8542 sq.km to 10.2294 sq.km. A significant change occurred in the 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 (Kafy et al., 2018)

Land use	1996(km^2)	2006(km^2)	2016(km^2)
Waterbody	4.7547	3.3891	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

4.2 Water body demolishment assessment

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 from 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.

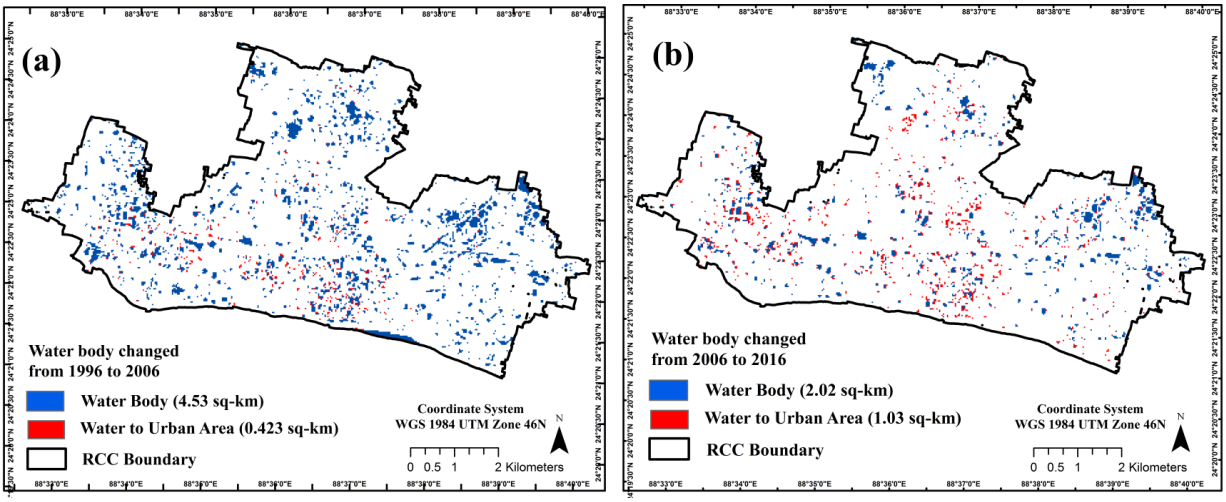

Fig. 3: Association of water body fill up occurrence with urbanization in RCC a) 1996-2006 b) 2006-2016 (Kafy et al., 2018)

Table 2 describes the loss of surface water bodies in the year 1996-2006 and 2006-2016. The water body loss increasingly in a 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 (Kafy et al., 2018)

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.

4.3 Causes of water body Fill up

In the last 20 years more water bodies and wetland have been filled in RCC area. Activities resulting in water bodies loss and degradation include urban (commercial and residential) area development, agriculture activities, landfilling, encroachment and huge political and institutional support ignoring the rules and laws(Kafy et al., 2018; Kafy et al., 2015; Serageldin, 1995). The main causes of water bodies fill-up are shown in Fig. 4 below.

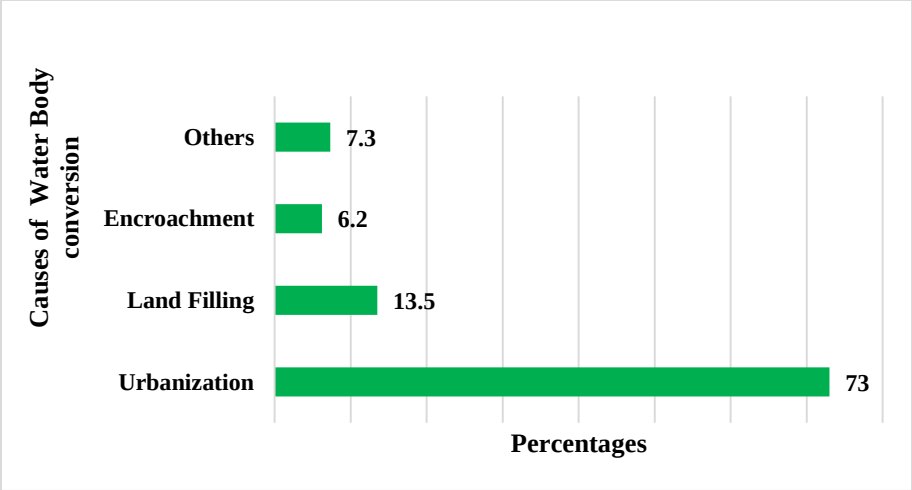

Fig. 4: Reasons for water bodies fill up in RCC area

Urbanization is a major cause of damage to water bodies. Construction activities are a major source of suspended sediments that enter water bodies through urban runoff. According to the survey in major water bodies fill up locations in RCC area, 73% of water body fill-up happened due to rapid urbanization. Shopping Centre, Market, high rise building, restaurant are the main causes of water body fill-up in RCC area. Landfilling is the second most important causes of fill-up fill in RCC area. About 14% respondent said that landfilling is one of the causes for fill-up a water body in RCC area. 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 surrounding water bodies and further out on the water body 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 water. Then huts and shops are built on these stilts. The owners of these structures are then starting reclaiming land by earth fills and dumping garbage. Waterbody fills 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. [Fig.4].

5. Conclusion

Water is essential to achieve sustainable development, including social needs, economic development and environmental limits, and a cross-cutting driver. We have to move from a sectoral approach towards a holistic one, which captures interconnections between food, energy, health, trade, the environment and water is necessary. The water body preservation is essential because the world warms day by day and the climate change threaten ecosystems but water resources can be limiting access to this threatening elements. climate change will affect rainfall patterns, as a result, it causes unexpected urban flooding. The preservation of water bodies will help to reduce the urban flooding and make our cities for sustainable in future. According to the 2014 Nature Conservancy study, one in four large cities is water stressed. Every day, cities across the world move 504 billion litres of water across 27,000 km to hydrate their populations and industries (Biswas, 1991; Hunter & Haughton, 2004; Jenks, 2002; Mazmanian & Kraft, 2009; Serageldin, 1995). Water sustainability is, therefore, at the core of achieving sustainable development goal. Failure to address unsustainable use of water now will mean greater struggles in the future to achieve goals in a myriad of other areas. It's our prime duty to Protect the environment for the coming generations begins with more effective water management today.

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