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APPLICATION OF GEOSPATIAL TECHNOLOGY TO DETECT THE CHANGING PATTERN OF WATER BODIES OF RANGPUR DISTRICT, BANGLADESH

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ABSTRACT

Water is an integral part of our lives; we cannon think a day without water. The aim of the study is to evaluate the changing pattern of water bodies from 1995 to 2017 in Rangpur district with the help of remotely sensed data and GIS techniques. NDWI method has been used for extracting water bodies. From the study, it is clear that the surface water in Rangpur district is shrinking day by day. From 1995 to 2017, in the result it is found that, surface water in Rangpur decrease from 67.11 sq.km to 17.03 sq.km. The protection, development and the management of water bodies is highly essential to maintain a stable condition of the environment.

KEYWORDS: Climatic Change, Landsat Image, NDWI, Tista River, Threshold Value.

1. Introduction

Monitoring of changes using remote sensing technology is widely used in different applications, such as land use/cover change, disaster monitoring, forest and vegetation change, urban sprawl, and hydrology [Rokni et al., 2014]. At present, there are many water indices which are used to find out change of existing water condition. For example, NDWI (Normalized Difference Water Index). NDWI can enhance the water information effectively in most cases, but it is sensitive to built-up land and often results in over-estimated water bodies [Yun et al., 2016]. The normalized difference water indexes (NDWIs), calculated from various band combinations (green, near-infrared (NIR), or shortwave-infrared

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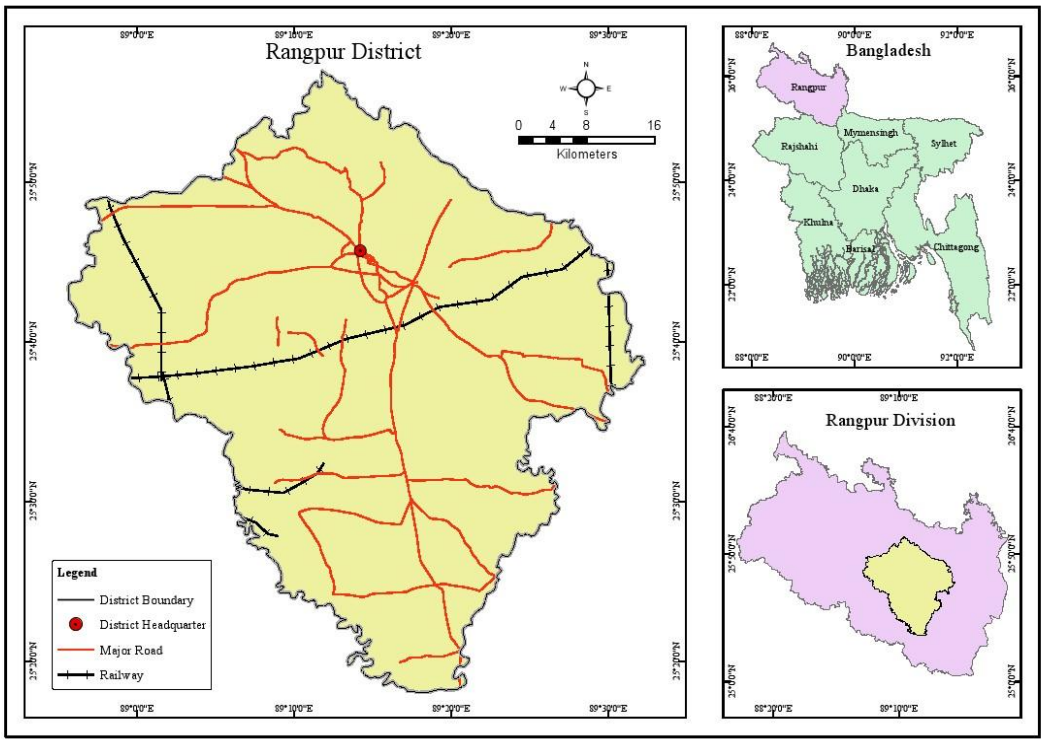
(SWIR)), have been successfully applied to LSW mapping [Li et al., 2013]. The NDWI was developed primarily to delineate water bodies and enhance its presence in remotely sensed imagery while simultaneously eliminating soil and vegetation features (McFeeters, 1996). Bangladesh has a high proportion of wetland areas, which have been declining in recent years. In the Ganges-Brahmaputra floodplain alone, approximately 2.1 million ha of wetlands have been lost due to flood control, drainage and irrigation development. Wetlands are being continuously lost or degraded primarily because of various recent developments, such as shrimp culture, which reflect a lack of community awareness of wetland functions and values. The exploitation of the haor wetland ecosystem began due to ever-expanding agrarian settlements. The beels are being drained, and embankments built to save crops from flash floods. Swamp forests that were once extensively distributed, are now on the verge of extermination [UNEP, 2001].

Rangpur district is one of the oldest parts of the Bengal basin. It is situated in the northern part of Bangladesh. It is bounded by Nilphamari and Lalmonirhat districts on the north, Gaibandha district on the south, Kurigram district on the east and Dinajpur district on the west. Rangpur district is enriched with many water bodies, some of which are Tista, Jamuneshwari, Ghaghat, Karatoya, Chikali, Akhira etc. The reduction of wetlands in the Northern part of Bangladesh will further enhance drought and environmental degradations in the study area. This research work has been carried out to determine the changes of the water bodies in Rangpur district of Bangladesh during the period of 1995 and 2017, using Landsat images and GIS tools.

2. Study area

Rangpur is a district in Bangladesh under Rangpur division. It is located in between 25°18' and 25°57' north latitudes and in between 88°56' and 89°32' east longitudes. Nilphamari, Larmonirhat, Kurigram, Gaibandha and Dinajpur are five neighboring districts which bound this district .Here, main source of water is Tista River. In dry season, farmers are completely dependent on this river for irrigation purpose. In recent decade, water crisis is considered as the main problem for this district. It is assumed that, Tista is drying up day by day.



Map 1.1 Study Area

3. Materials and Methods

To find out the changing pattern of water bodies and river in Rangpur, Landsat MSS image of Landsat TM image of 1995, 2000, 2005, 2010, 2014 and 2017 were extracted from USGS (Earth Explorer). Spatial resolution of all of these images was 30m. Wet season are not preferable to see the situation of the study area in normal condition. That is why, all the images were captured from March to April, which is considered as humid summer in Bangladesh. For the study purposes, Arc GIS 10.3 and ERDAS IMAGIEN 2014 and Google Earth Pro were used. In addition, Microsoft Office Excel 2007 was used for data processing.

Table 1.1 Metadata

Year	Landsat	Total Band	Resolution
1995	L4-5 TM	7	30 x 30 m
2000	L4-5 TM	7	30 x30 m
2005	L4-5 TM	7	30 x30 m
2010	L4-5 TM	7	30 x 30 m
2014	L8 OLI/TIRS	11	30 x30 m
2017	L8 OLI/TIRS	11	30 x30 m

After extracting, all the images were projected to WGS_1984_UTM_Zone_45N projection, geometrical correction was done by using a georeferenced image of the study area, where RMS error were less than 0.5 pixels. Moreover, Images were spatially adjusted before georeferencing. Subset of these images were made using ERDAS IMAGINE. In order to remove the unwanted black background MASK tool was used in Arc Map10.3. After that, water bodies and rivers were extracted by NDWI (Normalized Difference Water Index), where the following equations were used-

$$1)\ NDWI = \frac{Green - NIR}{Green + NIR}$$

$$2)\ NDWI = \frac{BAND\ 3 - BAND\ 5}{BAND\ 3 + BAND\ 5} \text{(For Landsat 8)}$$

$$3)\ NDWI = \frac{BAND\ 2 - BAND\ 4}{BAND\ 2 + BAND\ 4} \text{(For Landsat 4-5)}$$

All the images were classified into two categories, namely, “Water bodies” and “others”. For the assessment accuracy, some sample points were drawn on the classified images and these points were converted from shape to KML file to place them on Google Earth pro and to compare the classified images with actual ground. Overall accuracy of these images was 90 to 92%.

4. Results and Discussion

As mentioned earlier, in this study, Remote Sensing and GIS techniques were used to detect the changing patter of Water bodies. The final result shows significant changes of manmade and natural water bodies from 1995 to 2017.

By using spectral water indexes, which was acquired using the Landsat satellite Image. These images were classified into two classes:

1. Water
2. Land.

Spectral water index (NDWI) has been applied to differentiate water and non-water areas. The NDWI Values separates water and non-water objects. The values of water bodies are greater than zero and other land cover areas having strong negative values. After NDWI

classification, non-water areas were masked from the resultant images because the study focuses on water body areas.

The threshold values of NDWI are different in different years.

Table 1.2 NDWI Threshold Values

Year	Threshold Value for Water	Threshold Value for Land
1995	0.12 - 0.59	-0.38 - 0.12
2000	0.17 - 0.64	-0.31 - 0.17
2005	0.17 - 0.51	-0.18 - 0.17
2010	0.18 - 0.55	-0.22 - 0.18
2014	0.14 - 0.47	-0.15 - 0.14
2017	0.15 - 0.45	-0.26 - 0.15

The Water bodies have lost about 75% of its surface area from 1995-2017. The highest rate of changing water bodies was observed in the North part. In 1995 the total Area under water bodies was 67.111508 (km2), whereas, in 2000, the figure was only 44.540146 (km2). In the year of 2005, water decreased to 39.221202 (km2). In 2014, a huge number of water bodies have lost and it has reached in an alarming condition, as it decreased to 24.600257 (km2). In the current year 2017, Water bodies are still decreasing day by day. The present status shows that there are only 17.038469 (km2) of water bodies are remaining. It is clear, that surface water in Rangpur is decreasing at an alarming rate. Smaller water bodies are at a higher risk. Present scenario suggests that small water bodies are more vulnerable compare to large water bodies. (Figure 1.1, Map 1.2, 1.3 and 1.4)

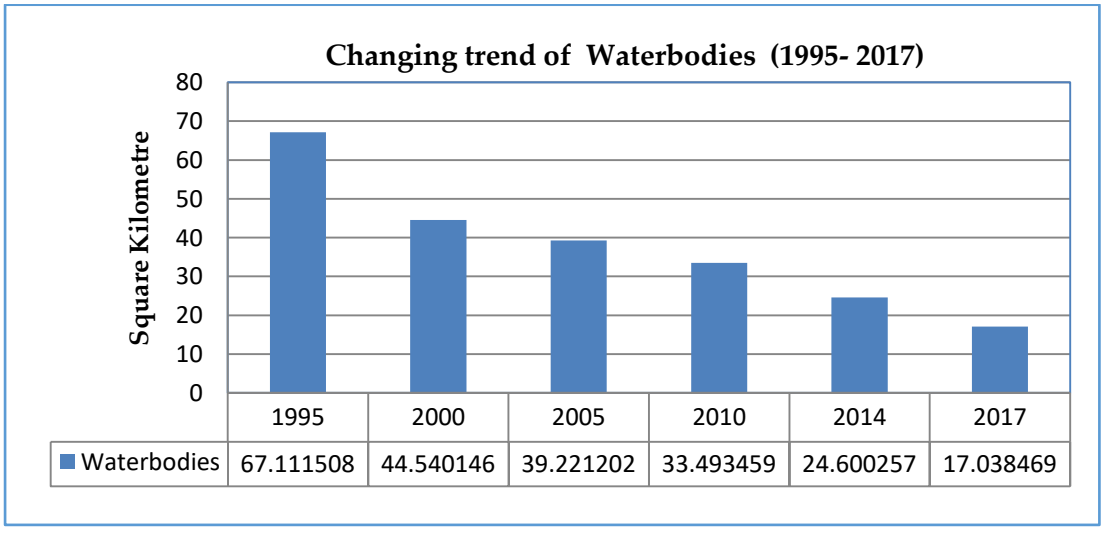
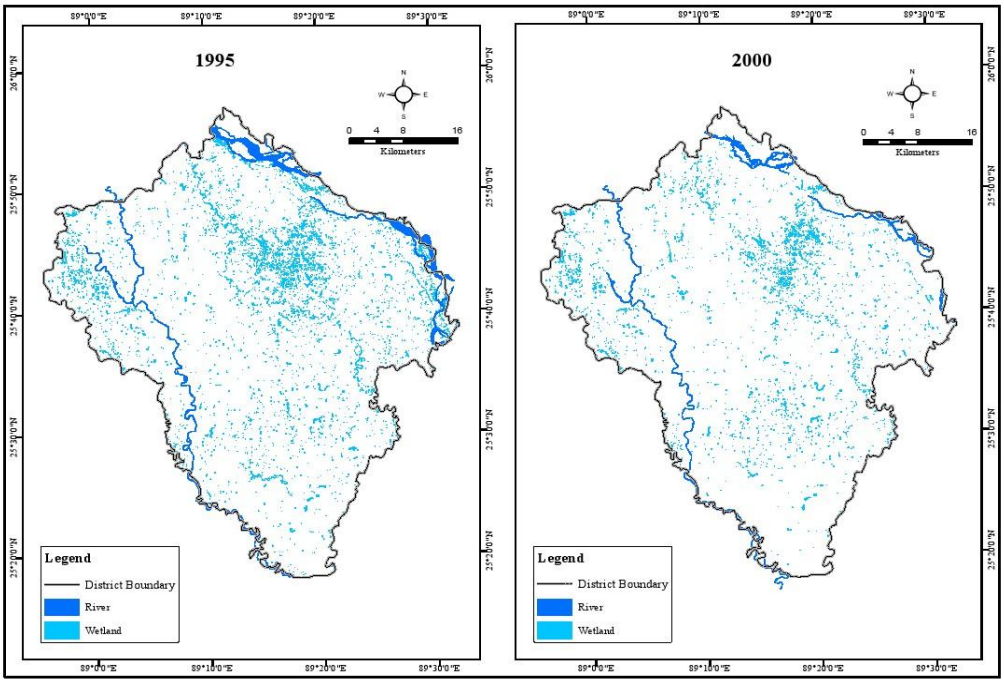
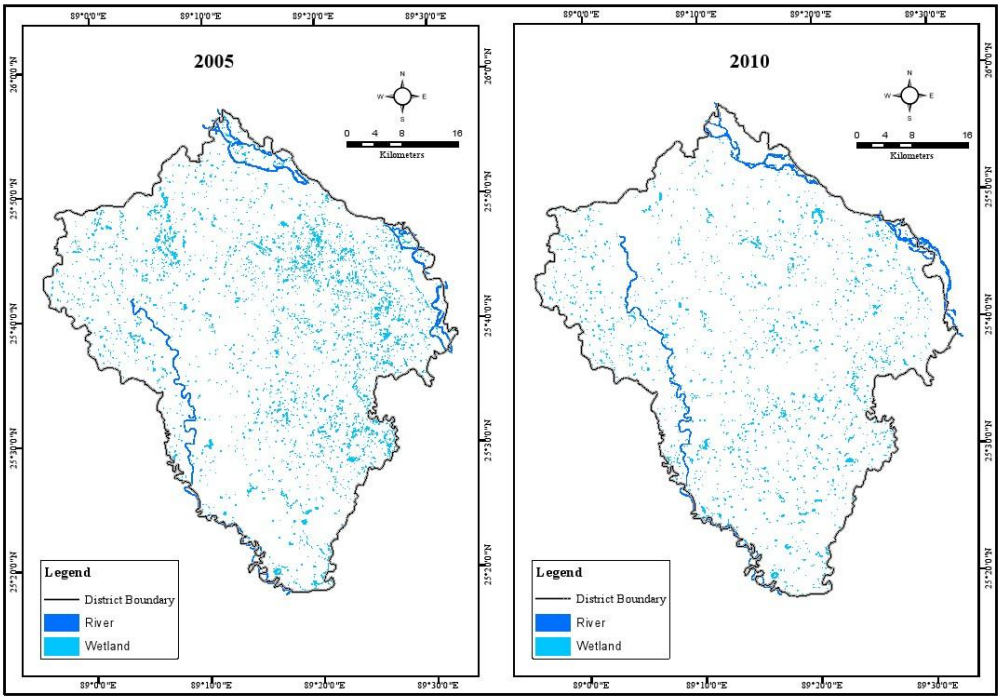


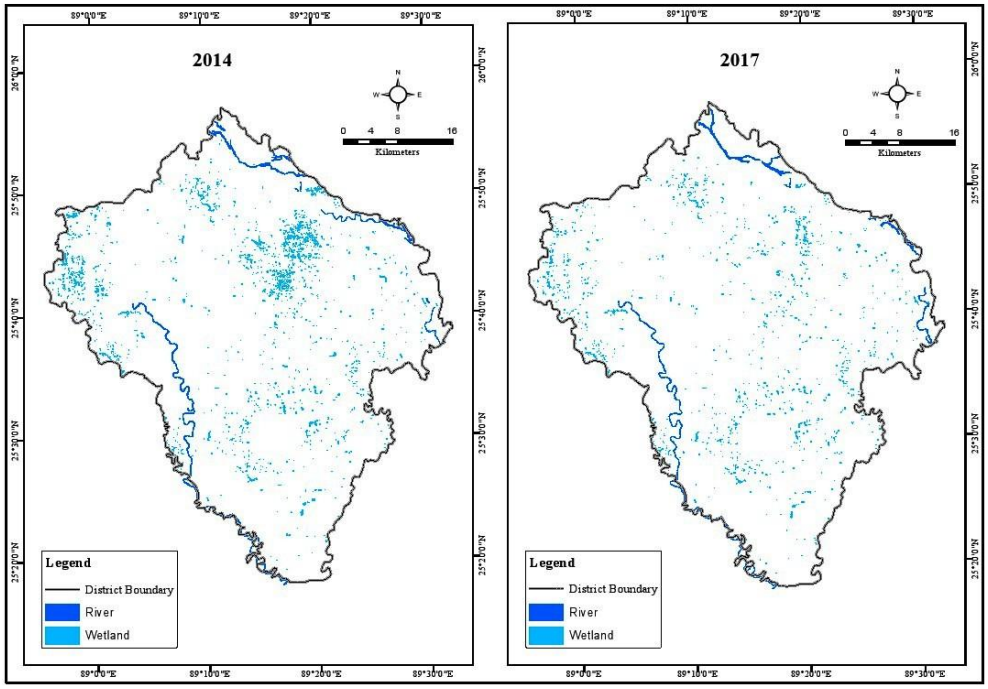
Fig 1.1 Changing trend of Water bodies (1995- 2017)



Map 1.2 Water bodies in 1995 and 2000



Map 1.3 Water bodies in 2005 and 2010



Map 1.4 Water bodies in 2014 and 2017

According to figure 1.2, the highest rate of water bodies decreased from 1995 to 200, about 22.5 square kilometer water bodies were lost within this period of time. On the other hand, this trend of decreasing water bodies was almost same within the time period of 2000 to 2005 and 2005 to 2010. However, huge amount of water bodies were disappear within the period of 2010 to 2014 and 2014 to 2017.

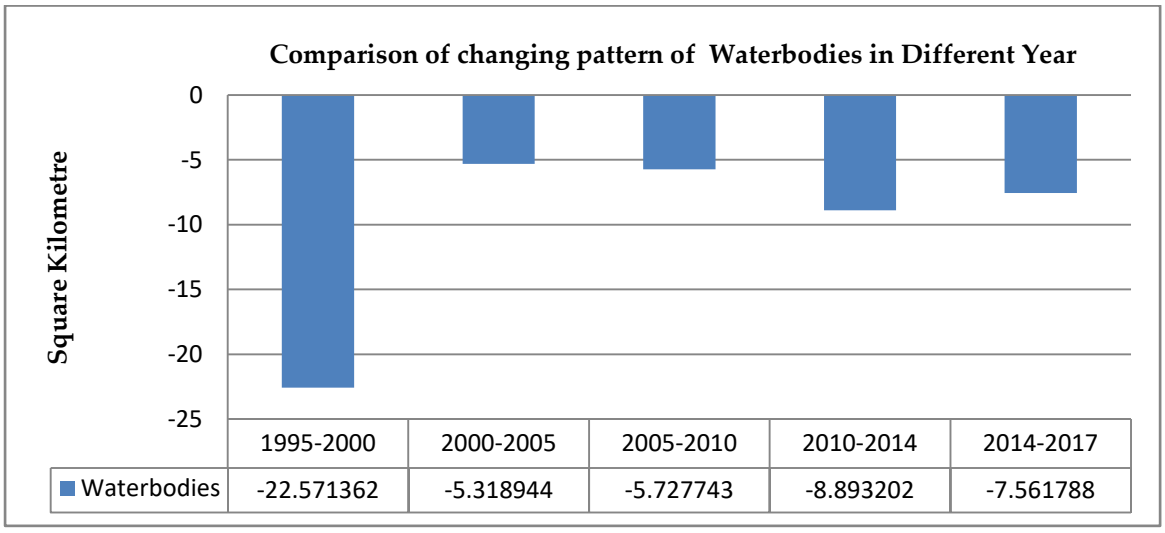
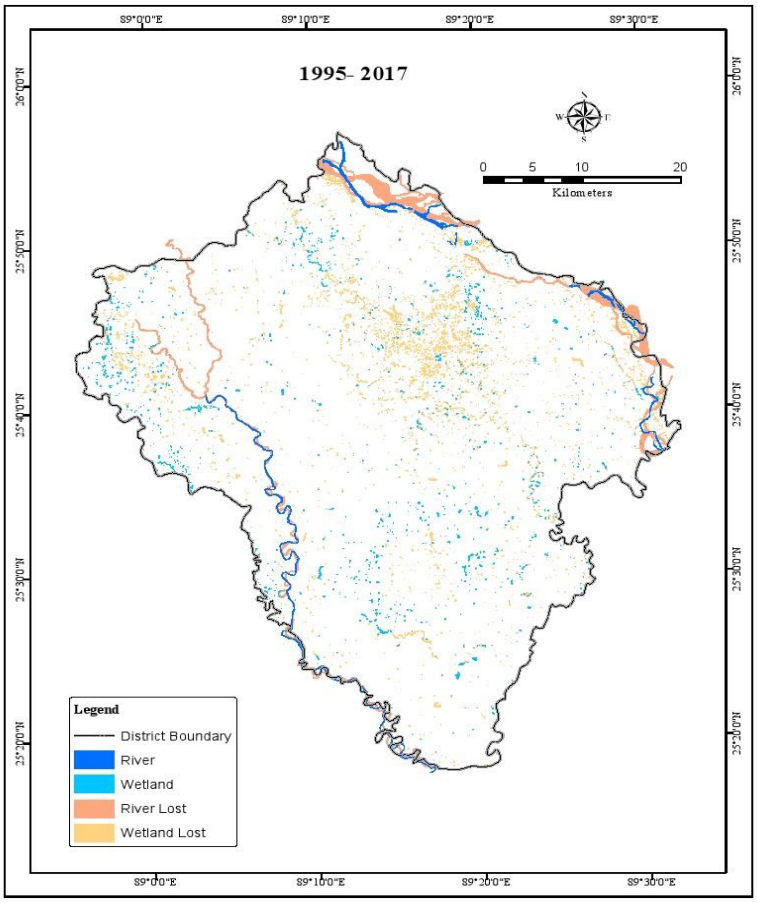


Fig 1.2 Changing Pattern of Water Bodies in Different Year.

In the map 1.5, we can see that, both river and manmade water bodies are disappearing year by year. There is a rapid change of water along Tista River. Tista barrage is one of the main reasons of draying condition of Tista River. Manmade water bodies like pond, khal, and bill have lost because of climatic changes (Temperature increase, less Rainfall), as a result, land has lost its fertility.



Map1.5 Over All Condition of Water Bodies from 1995 to 2017

However, disturbing wetlands and other water bodies can be resultant adverse impacts such as sedimentation, loss of aquatic and other wildlife habitats, changes to down or upstream ecosystems, changes in water quality or quantity, and a reduction or loss of the important functioning of these natural systems.

5. Conclusions

Bangladesh is enriched with agricultural productions. A big portion of national income of the country comes from agriculture. Contribution of Rangpur in agricultural production and national income cannot be overstated. In dry season, water is a major concerning issue in this

area, there is a scarcity of water in dry season as the farmers do not get sufficient supply of water for irrigation and to cultivate their arable land. Day by day this scenario is becoming more complex. Proper management of water bodies is essential for this area as the sources of water is becoming unavailable day by day.

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