

## SPATIO-TEMPORAL CHANGE ANALYSIS OF WETLAND IN CHITTAGONG CITY CORPORATION BY REMOTE SENSING AND GIS TECHNIQUE

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### ABSTRACT

Recurrent change in the water body due to rapid urbanization is a very common phenomenon now-a-days. Chittagong, the commercial capital of Bangladesh facing unplanned urbanization in recent couple of decades. Changing of land use has become common phenomenon and changing of water body into other is one of its examples. In this study the change of wetland of Chittagong city corporation area has been identified. Remote sensing and GIS based technique is applied between the years 1980 to 2018 to identify the change. Remote sensing datasets and GIS have been used to analyze the trend change with Normalized Difference Water Index (NDWI) and Post-classification change detection methods. The potential causes of wetland loss were analyzed after the classification. It has been found that around 28.92% wetland and river, canal & pond decrease significantly over the last 38 years. This change makes the city vulnerable for water logging and drainage system as its consequence. Increase temperature is also a consequence of this change which is affecting the environment and climate change. The main cause of reducing wetland is indiscriminate land filling and encroachment to the wetland for constricting high rise building for various purposes. So, it is necessary to revive these wetland and water body to make the drainage system functional.

Keywords: Wetland, Land use/Land cover changes, Satellite images, NDWI

### INTRODUCTION

Due to anthropogenic activity of human across the earth surface, sea-level rise, climate change, increasing temperature and other unknown potential effect of global environment have been arising (Coomes et al., 2001; Hassan & Nazem, 2015). Which are mostly driven by the human and the resultant modification of landscape configuration at global, regional and local level (Weng, 2014). And these change is happening by diminishing forest area agricultural land and filling water body for the expansion of impervious surface alongside human settlement (Yin, Stewart, Bullard, & MacLachlan, 2005). These changes have so many negative impacts on water quality, ecosystem, aquatic life etc. In recent decades, accelerated population growth coupled with rapid urban growth triggered these phenomena (Hassan & Nazem, 2015).

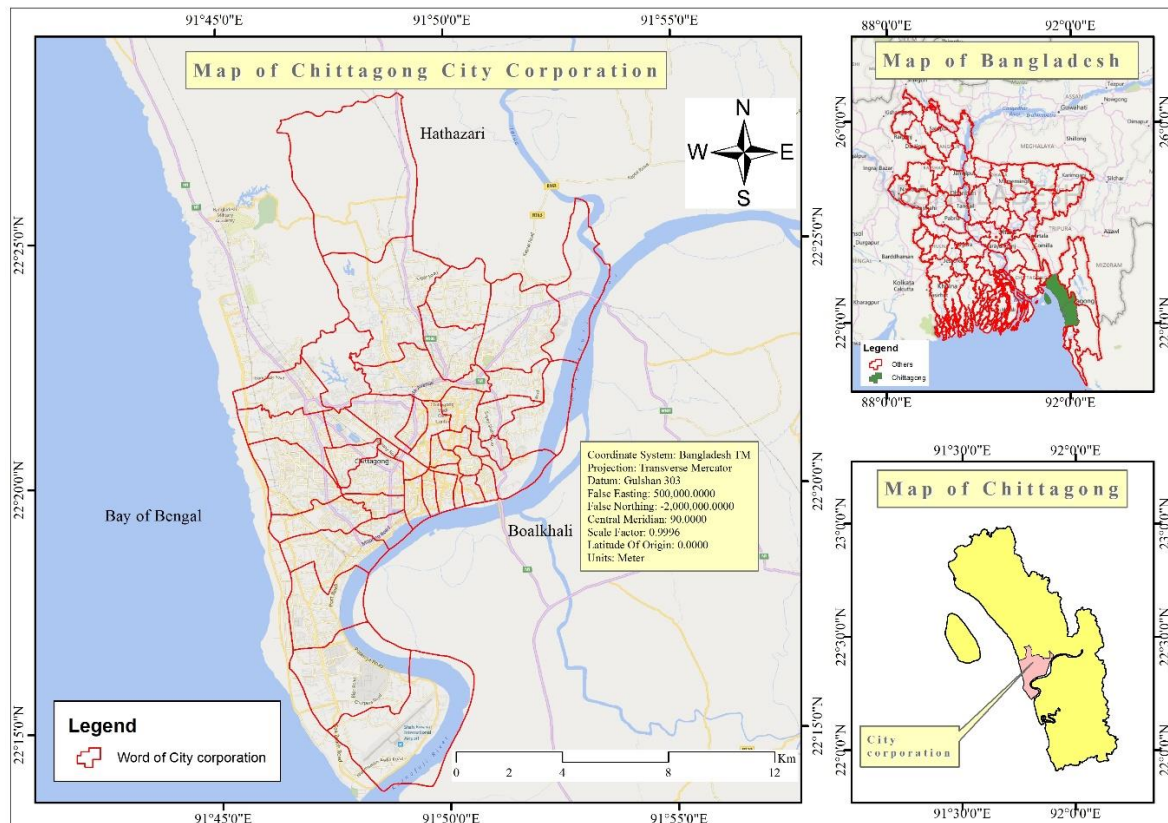
In recent practice, remote sensing in conjunction with GIS technology help to monitor these change and its advance tool aid in better understanding and analyzing these change because of having multiple characteristics of satellite image like temporal resolution, spectral resolution, spatial resolution etc. The use of Landsat satellite to monitor these change has become a common approach in recent years (Hassan & Nazem, 2015; Turner II, Lambin, & Reenberg, 2010; NASA, 2016)

Bangladesh is a developing country and one of the most populated in the world and the study area Chittagong is the second largest metropolitan city in Bangladesh sharing 19.7% GDP of the country

(BBS, 2011; Hassan & Nazem, 2015). Due to huge population pressure the area is being urbanized haphazardly day by day and the result is altering land use which is decreasing the number of hill, forest or vegetated area, water body etc. and subsequently increasing impervious urban area. Especially water body of this city decrease drastically due to urbanization. In this study the definition of water body is lake, ponds, lagoon, river, aqua fishing, and vast sea water. These change also putting negative impact on the environment and function of the city like water logging (Hassan & Nazem, 2015; Rana, 2011). Therefore, the aim of this study is to monitor the wet land or water body change of Chittagong City Corporation (CCC) area and make a comparison & analyze these change.

## METHODOLOGY

Chittagong is the second largest city and prime sea port and the heart of commercial and business activities in Bangladesh (Ahmed et al., 2014). It is lies within 22°14' and 22°24' N Latitude and between 91°46' and 91°53' E Longitude (Chittagong city-Banglapedia, 2018). Chittagong city corporation area (CCC) has an area of 160.99 sq. km and it is divided into 41 wards for administrative purpose. Chittagong city is located towards south-east of the capital city of Dhaka on the bank of Karnaphuli River and surrounded by rich natural resources like green hilly terrain, sea etc. (Ahmed et al., 2014).



*Fig. 1: Location Map of Chittagong City Corporation area*

To find out the amplitude of the water bodies of Chittagong City Corporation area, Landsat images of 1990 (TM), 2005 (TM), 2018 (OLI-TRS) were used. Spatial resolution of these images was 30m and these images were captured within June-August (during rainy season). Band 2 & 4 for TM and Band 3 & 5 for OLI-TRS were used to calculate NDWI. The study was conducted under the framework of Geographic Information System (GIS) and Remote Sensing. The satellite images were processed by (Earth Resource Data Analysis System) ERDAS IMAGINE 14 and the wetland change was detected by ArcGIS 10.5 software. The wetlands were identified by unsupervised classification which was conducted by NDWI. The equation used for calculating NDWI given by Mcfeeters (2007) as follows

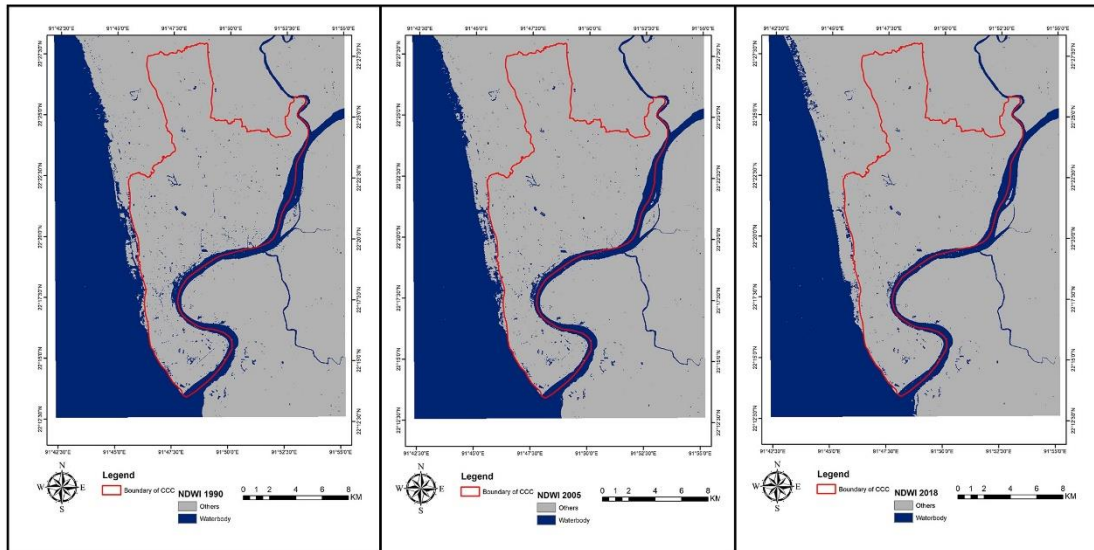
$$NDWI = \frac{Green - NIR}{Green + NIR} \quad (1)$$

Justification of the classified images was performed by calculating accuracy assessment with 60 Ground Control Points which are dispersed throughout Chittagong City Corporation area. Finally, the images

for wetland of Chittagong City Corporation of different years were used to detect the change by contingency matrix analysis in ArcGIS.

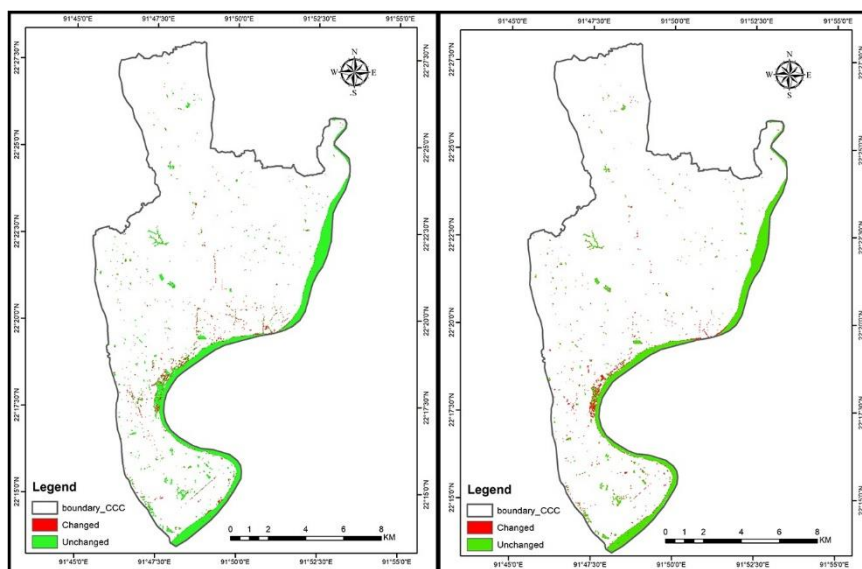
## RESULT AND DISCUSSION

This research aims at deriving the change of waterbody of Chittagong city of a duration of 28 years. As because of different physical change waterbody is decreasing and the rate is alarming. [Fig. 2] is representing the land use of Chittagong City Corporation Area using Water index NDWI for 1990, 2005 and 2018 respectively using remote sensing data. The land use of the area is divided into water body and other land use. from the map. It can be said that there is a decrease in waterbody in 2018 than 1990 & 2005.



*Fig 2: Land use of Chittagong City Corporation Area using NDWI*

In 1990 area covered with water is higher than other year. The reason of waterbody reduction is waterbody is replaced by other land use in this time period. [Fig. 3] showing the change in waterbody for the time period of 1990-2005 & 2005-2018 respectively. From the map it can be said that the change of waterbody is higher for time period 2005-2018 than 1990-2005.



*Fig. 3: Waterbody Change Map of Chittagong city for 1990-2005 & 2005-2018 respectively*

Table 1 is representing the change of the area of waterbody in Chittagong City Corporation Area in the year 1990,2005 & 2018. In the year 1990 the waterbody of city corporation was 39.81 sq.km. which was 23.15% of the total city corporation area. In 2005 it was reduced to 34.98-acre area which was

20.33% of the total area and in 2018 it is further reduced to 28.31-acre area which was 16.46% of the total area. From 2005 to 2018-time period percentage of change of water body is -28.92% which is higher than 1990-2005-time period where percentage of change is -12.15% and all the value of percentage of change is indicating reduction of waterbody. From 1990 to 2005 waterbody is reduced to around 12% whereas the reduction increased to around 16% from 2005 to 2018. It is due to the rapid urbanization and population growth as waterbody of CCC area is replaced by other land use. There is huge impact of land use change in the reduction of waterbody in the study area. Waterbody of the Chittagong City Corporation area is converted forcefully into other land use like residential, commercial, industrial area etc.

*Table 1: Change of the Area of Waterbody in CCC for Different Year*

Year	Waterbody area(in acre)	Percentage of Total Area	Percentage of Change
1990	39.81	23.15	-
2005	34.98	20.33	-20.15%
2018	28.31	16.46	-28.92%

Conversion of waterbody to other land use affect greatly the environment. With the reduction of waterbody, temperature is increasing day by day at a higher rate (Hassan & Nazem, 2015).

*Table 2: Summary of accuracy assessment*

Year	User Accuracy		Producer Accuracy		Overall Accuracy
	Water	Other	Water	Other	
1990	65.63	76.25	72.58	79.25	70.58
2005	74.82	82.76	76.58	81.23	76.01
2018	80.87	87.85	75.00	83.33	79.21

Accuracy assessment of the overall classification of is described in table 2. In this table overall accuracy, producer accuracy and user accuracy is shown. Minimum overall accuracy for the classification of remote sensing data is 60%. From the analysis it can be seen that accuracy assessment for different year's classification is greater than 70% which justify the overall analysis.

## CONCLUSION

Land use and land cover change affects a wide range of socioeconomic, biological, climatic, and hydrologic systems. Besides understanding land use and land cover changes is essential not only for biodiversity monitoring but also for land planning, food security, economic policy, and climate change. This study reveals the change of wetland during 1990-2018 (28 years) in Chittagong City Corporation area concluding with a decrease of wetland during this time period. Due to uncontrolled land use and land cover change the Chittagong City is losing its' wetlands mostly along with other land uses like open space, vegetation etc. So proper measures should be taken to preserve the existing waterbodies and also to restore the declined wetlands to its' original condition.

## REFERENCES

- Ahmed, B., Rahman, M. S., Rahman, S., Huq, F. F., & Ara, S. (2014). *Landslide Inventory Report of Chittagong Metropolitan Aea, Bangladesh*. Dhaka-1000.
- BBS. (2011). *No Title*. Dhaka: GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH.
- Coomes, O. T., Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., ... Xu, J. (2001). The causes of land-use and land-cover change : Moving beyond the myths The causes of land-use and land-cover change : moving beyond the myths Helle Sk a. *Global Environmental Change 11*,

11(December 2001), 261–269. [https://doi.org/https://doi.org/10.1016/S0959-3780\(01\)00007-3](https://doi.org/10.1016/S0959-3780(01)00007-3)

Chittagong city-Banglapedia. (2018, 09 02). Retrieved from [http://en.banglapedia.org/index.php?title=Chittagong\\_city](http://en.banglapedia.org/index.php?title=Chittagong_city)

Hassan, M. M., & Nazem, M. N. I. (2015). Examination of land use/land cover changes, urban growth dynamics, and environmental sustainability in Chittagong city, Bangladesh. *Environment, Development and Sustainability*, 18(3), 697–716. <https://doi.org/10.1007/s10668-015-9672-8>

Mcfeeters, S. K. (2007). The use of the Normalized Difference Water Index ( NDWI ) in the delineation of open water features. *International Journal of Remote Sensing*, 1161, 1425–1432. <https://doi.org/10.1080/01431169608948714>

NASA. (2016). *Landsat 8 (L8) Data Users Handbook*. Department of the Interior U.S. Geological Survey.

Rana, M. M. P. (2011). Urbanization and sustainability: Challenges and strategies for sustainable urban development in Bangladesh. *Environment, Development and Sustainability*, 13(1), 237–256. <https://doi.org/10.1007/s10668-010-9258-4>

Turner II, B. L., Lambin, E. F., & Reenberg, A. (2010). The emergence of land change science for global environmental change and sustainability. *Proc. Natl. Acad. Sci. USA*, 104(2007), 20666–20671. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3001449&tool=pmcentrez&rendertype=abstract>

Weng, Q. (2014). A remote sensing – GIS evaluation of urban expansion and its impact on surface temperature in the Zhujiang Delta , China. *International Journal of Remote Sensing*, 22(10), 1999–2014. <https://doi.org/10.1080/713860788>

Yin, Z. Y., Stewart, D. J., Bullard, S., & MacLachlan, J. T. (2005). Changes in urban built-up surface and population distribution patterns during 1986-1999: A case study of Cairo, Egypt. *Computers, Environment and Urban Systems*, 29(5 SPEC. ISS.), 595–616. <https://doi.org/10.1016/j.compenvurbsys.2005.01.008>