Observation of Green Space at Selected Cities in Bangladesh

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Bachelor of Science in Civil Engineering

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CERTIFICATION

This is to certify that this thesis entitled "**Observation of Green Space at Selected Cities in Bangladesh**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratory of the Department of Civil Engineering of Daffodil International University in partial fulfilment of the requirements for the degree of Bachelor of Science in Civil Engineering. The presentation of the work was held on February 2022.

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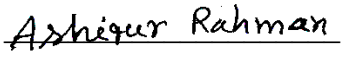

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This thesis paper titled "**(Observation of Green Space at Selected Cities in Bangladesh)**" submitted by Tain Razzak Shovon (182-47-129), M. Shahanshaazam Sifat (182-47-140) and Ashiqur Rahman (182-47-136) has been accepted as satisfactory in partial fulfilment of the requirement for the degree of Bachelor of Science in Civil Engineering at February 2022.

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Dedicated

To

Our Beloved Parents

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ACKNOWLEDGEMENT

All praise is for almighty Allah who graced us to complete this thesis paper properly. The author wishes to express deepest gratitude to Md. Masud Alom, Assistant Professor, Department of Civil Engineering, Daffodil International University for his continuous guidance, invaluable suggestions, constructive comments and endless encouragement throughout the research work and the preparation of this thesis. Many people helped us in various ways. We are also thanking them from our heart. Finally, the authors record with deep appreciation, the patience, understanding and encouragement shown by their parents throughout the period of his studies.

ABSTRACT

Enough green area is must needed for healthy and quality life of humans and animals. Not only physical health but also mental health has relation with Green Areas around. Various resources in past has examined relationships between green space and a variety of health outcomes with many researchers finding benefits in terms of levels of physical activity and relationships with levels of obesity, mental health, and other health conditions. Green area survey is important and should be done in regular period. With the help of GIS Software green area can be calculated accurately and quickly. For the years 2012, 2016, and 2020, multi-temporal Landsat TM/OLI satellite pictures were used to categorize Land Use/Land Cover (LULC) classes in Rajshahi City Corporation, Chattogram City Corporation and Rangpur City Corporation, a shift from Green Areas to an urban region, and the directional distribution of urban areas and Green Areas. All Landsat pictures were downloaded at a maximum of one-month intervals to eliminate seasonal variations. The LULC maps were classified using the supervised maximum likelihood classification technique. **ArcMap 10.6.1** software was used to prepare the maps and MS Excel software was use to do the analyses. The classified maps show a drastic decrease in green areas in each of the selected city corporation and a rise of urban land use. Rajshahi City Corporation, Chattogram City Corporation and Rangpur City Corporation has seen 12%, 17% and 36% decrease in green areas accordingly in the 8 years' (2012-2020) time span.

Keywords: Land use/land cover, Urban areas, Green areas, Supervised maximum likelihood classification

CHAPTER I

INTRODUCTION

1.1 General

Green area is inevitable for humans as well as for animals. Having a healthy green area is essential for healthy living and for sustainable development. Almost every research has examined relationships between accessibility to green space and a variety of health outcomes with many researchers find the benefits in physical activity and relationships with levels of obesity, mental health. As urbanization is growing rapidly in worldwide, constructions are replacing green areas. There are some serious effect of deforestation and decreasing green area has already shown. World temperature is going higher, ices are melting, sea water level is rising. By the help of modern technology it is easier to calculate green area. GIS (Geographic Information System) software can determine green area accurately. Despite having not so wide range of studies on physical accessibility by govt. or privet sectors on green space, but focusing on perception and preferences of people about GIS are very few specially in Bangladesh. Green space can easily monitor With GIS software.

1.2 Background of the Study

Green areas are regional space composed of outdoor green area and other ecological lands such as water and farmland (Pol. J. Environ. Stud. Vol. 31, No. 1 (2022). Trees, Vegetables, flowers are also included in green area. So green area is inevitable human, animals and most of the living things. Green space effectively maintains urban ecological environment, improves life quality, and promotes sustainable development. Urbanization is growing rapidly in Bangladesh as well as population is also increasing for that the demand for more land used for development can be intense, which makes green space concede to construction land. Based on the land use data from remote sensing interpretation, this study used a combination of mathematical statistics and GIS spatial analysis methods to analyse the evolution of green spatial patterns. A large

number of studies have quantitatively investigated the spatiotemporal changes of green space and mainly focused on three aspects: scale changes, land-use transitions and landscape metrics. Green space scale changes and type shifts are usually based on land use/cover changes. Satellite remote sensing has the advantages of macroscopic, dynamic, and continuous spatial coverage, which can obtain ground information intuitively and dynamically. It can effectively monitor the changes in land use/cover data, which is an absolute advantage. It has gradually become an important tool for analysing changes in green space (Pol. J. Environ. Stud. Vol. 31, No. 1 (2022).

It is very frustrating that there are too few patches of open spaces in Chattogram city among three. Greenery is essential for human beings to survive. Unfortunately, the limited green space has been declining further because of the unruly land grabbers. This must not be allowed to continue and whatever open space should be preserved with utmost care. The other big cities of the world, we find plenty of open spaces, gardens with trees and walkways. Sadly, the once known cities of a well-watered, well fruited and a green country, is now left with very little open space. A city should ideally have 25% of its area (UN-HABITAT 2019) covered with greenery, but in today's Chattogram hardly 19% of area is green and open which is grossly inadequate and unhealthy for its citizens. As a result of lack of greenery, temperature remains higher than normal. While it is apparent that the number of trees in cities are gradually declining, protecting the cities from further loss of trees is a must. Restoration of the city's atmosphere should be done by preventing further deforestation and create new green spaces and preserve the existing ones so that we can lead a healthy life and reverse the damages done to our environment over the years (The Financial Express 20 Nov 2017).

1.3 Objectives of the Study

The objectives of the study are down below

i. To determine and compare green space of selected cities (Rajshahi, Chattogram, Rangpur) in Bangladesh.

ii. To find the possible ways to maintain and increasing green area.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The percentage of green space in people's living environment showed a positive association with the perceived general health of residents. People with a greener environment within a 1 km or 3 km radius around their homes have better self-perceived health than people living in a less green environment. The effects inside a 1 km or 3 km radius were equally strong, and it is only in the very strongly urban areas that the proximity of green space becomes more important. The amount of agricultural and natural green in the living environment was positively related to perceived general health.

Our analyses show that health differences in residents of urban and rural municipalities are to a large extent explained by the amount of green space. The coefficients of urbanity are strongly reduced and no longer significant when the amount of green space is considered. Our analyses show that green space is important in explaining the health differences between urban and rural residents. Furthermore, the analyses show that the amount of green space is more strongly related to perceived general health than urbanity. (J Epidemiol Community Health. 2006 Jul; 60(7): 587–592.)

2.2 Study Area Maps

Fig. 2.1 Rajshahi City Corporation

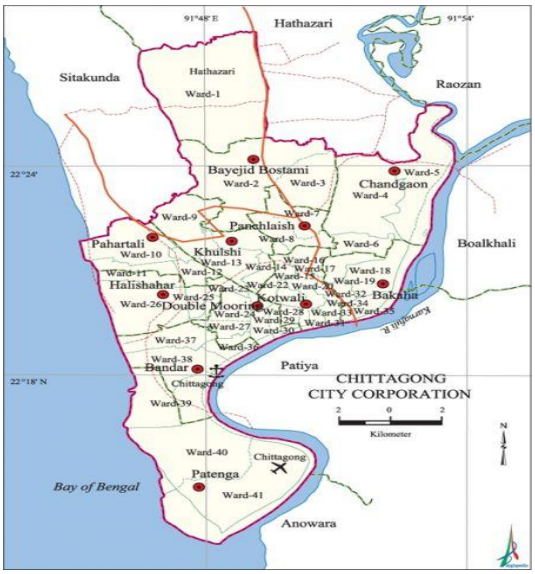

Fig. 2.2 Chattogram City Corporation

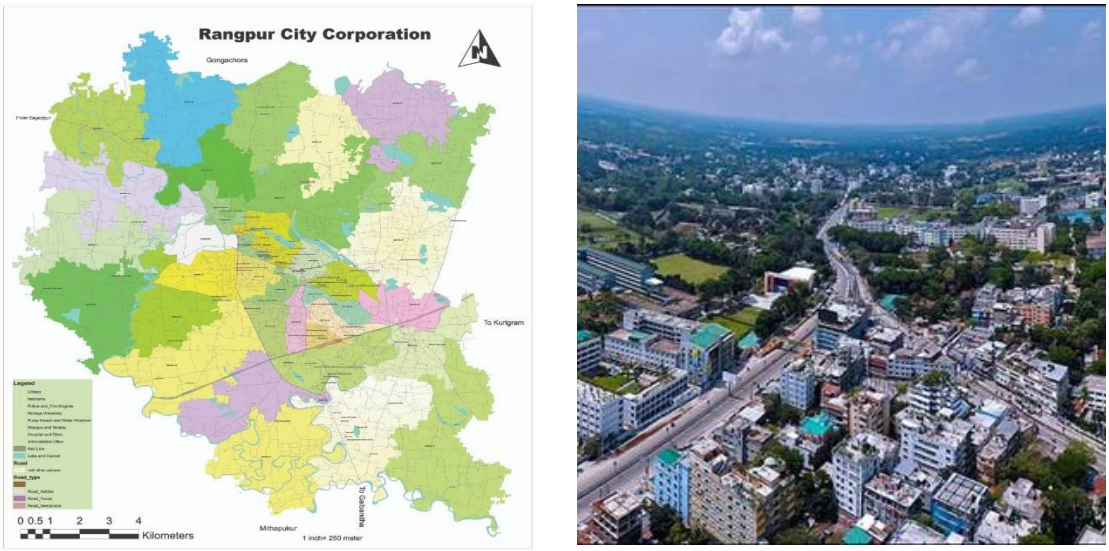

Fig. 2.3 Rangpur City Corporation

2.3 Uses of GIS to Investigate Green Area

Over the years, the use of a combined method of Remote Sensing (RS) and Geographic Information System (GIS) technologies to monitor LULC fluctuations in urbanized environments has increased. (Ahmed, 2011; Balogun and Ishola, 2017; Lilly Rose Devadas, 2009) GIS and RS applications are used to investigate ecosystem change, biodiversity, and global climate change. (Al-Hathloul and Rahman, 2003; Celik et al., 2019; Li and Zhao, 2003; Streutker, 2003). Direct field visits for LULC change identification spatial distribution assessment are time-consuming, labor-intensive, and error-prone. (Hart and Sailor, 2009; Lilly Rose Devadas, 2009). Combining RS with GIS technologies enables LULC fluctuations easier to evaluate, monitor, and simulate.(Fu and Weng, 2018; Niyogi, 2019; Thapa and Murayama, 2009). Furthermore, thanks to advances in statistical techniques for remotely sensed data, spatiotemporal evaluation of LULC dynamics has brought substantial smart solutions to the temperature rise concerns caused by haphazard land cover change. (Ahmed et al., 2013; Celik et al., 2019; Fu and Weng, 2018; Gaur et al., 2018; Rahman, 2016; Tewolde and Cabral, 2011). The use of thermal remote sensing technologies to estimate the urban heat island (UHI) is thought to be a good way to

assess the unfavourable effects of human activities on local climate over the previous several decades. High spatial resolution satellite thermal data acquired during the daytime has been regularly used to detect surface UHIs on broad scales as the RS method improves. (Kafy et al., 2020c; Naim and Kafy, 2021; Roth et al., 1989). Researchers studied LULC features for different LULC categories in different urban environments using accessible thermal infrared sensors with varying spatial resolutions. (Ahmed, 2011; Celik et al., 2019; Rahman et al., 2017). Bangladesh, like other developing countries, is undergoing rapid urbanization as a result of a large rural-to-urban migratory flux. Rapid LULC transforms natural features into man-made environments, jeopardizing the environment's long-term viability. Several studies in Bangladesh, particularly in Dhaka, focused on the consequences of fast urbanization on LULC, noting population increase and human activities as driving factors in the change of various LULCs, such as vegetation and water bodies, to urban settlements. (Ahmed, 2018; Byomkesh et al.,
2012; Corner et al.,2014; Dewan et al.,2012; Dewan and
Yamaguchi, 2009; Faisal et al., 2019; Kafy et al., 2021a; Nilufar, 2010; Ummai et al., 2011). When population growth accelerates and has a direct impact on the environment and ecosystems, LULC variations in other Bangladesh regions are also directly affected and hastening climate change concerns. (Al Rakib et al., 2020a; Kafy et al., 2021c, 2020a, 2020c).

CHAPTER III

METHODOLOGY

3.1 Introduction

Landsat 4-5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) satellite photos provided from the US Geological Survey (USGS) were used for the years 2012, 2016 and 2020 in this study. All the photos have a spatial resolution of 30 meters. Images were captured from cloud-free environment in late December or early January to prepare the land use classifications for each of the area. Image processing, image classification, area calculation and map preparation was done using ArcMap 10.6.1 software.

3.2 Flow Diagram of Methodology

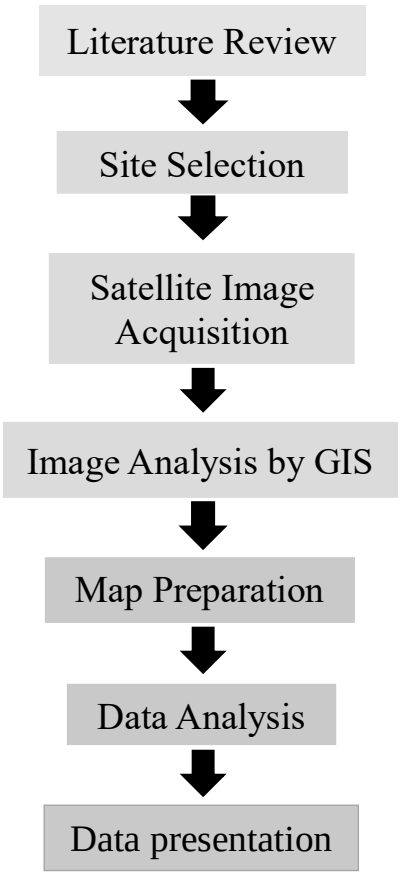

Fig. 3.2 Flow diagram of methodology

3.2.1 Literature Review: As the study is based on secondary data, literature review was an important part if the study. Related studies on land use land cover classifications were reviewed to get an idea about the study. Impacts of land use land cover changes were studied and similar processes were included.

3.2.2 Site Selection: Site selection for this study was done by selecting three city corporations and study the changes of green area by the years. Three different kind of city corporation areas were taken. (I). A new city corporation in Rangpur, (ii). A developing city corporation in Rajshahi, (iii). A developed city corporation in Chattogram.

3.2.3 Satellite Image Acquisition: Landsat 4-5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) satellite photos provided from the US Geological Survey (USGS) website were used for the study.

3.2.4 Image Analysis by GIS: ArcMap 10.6.1 software was used for the analysis in this study. Supervised Maximum Likelihood Classification was used to make land use classification.

3.2.5 Map Preparation: Three maps of three years of three city corporations each was made in the ArcMap software. The classified land uses in the maps were labelled accordingly.

3.2.6 Data Analysis: Microsoft Excel software was used to analyses the data. Pie charts, bar charts and trend lines were used for visual representation of the data.

3.2.7 Data Presentation: Data was presented in the Microsoft word file for research paper and in the Microsoft PowerPoint for presentation.

3.3 Analysis Process

Landsat 4-5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) satellite photos provided from the US Geological Survey (USGS) website (https://earthexplorer.usgs.gov) were used for the years 2012, 2016 and 2020 in this study. All the photos have a spatial resolution of 30 meters. The Landsat images (Level 1 Terrain Corrected product) were projected to UTM zone 46 North projection using WGS-84 datum for Chattogram. For Rajshahi and Rangpur, the Landsat images (Level 1 Terrain Corrected product) were projected to UTM zone 45 North projection using WGS-84 datum. All Landsat pictures were downloaded at a maximum of one-month intervals to eliminate seasonal variations. Images were captured from cloud-free environment in late December or early January to prepare the land use classifications for each of the area. Image processing, image classification, area calculation and map preparation was done using ArcMap 10.6.1 software.

CHAPTER IV

RESULT & DISCUSSION

4.1 General

Green area in Rajshahi, Chattogram & Rangpur in 2012, 2016 & 2020 has analysed. It has been seen a drastic decrease in green area in cities.

4.2 Rajshahi

For Rajshahi City Corporation classified images of 2012, 2016 and 2020 was analysed. From the analysis, it was found the in 2012, Rajshahi had 8.78 sq. km bare land of 48.03 sq. km of total land area which is about 18% of the total land area. 26.36 sq. km land was covered by green areas which is about 55% of the total land area. 11.8 sq. km land was developed which is about 25% of the total land area and 1.09 sq. km of water bodies which is about 2% of the total land area.

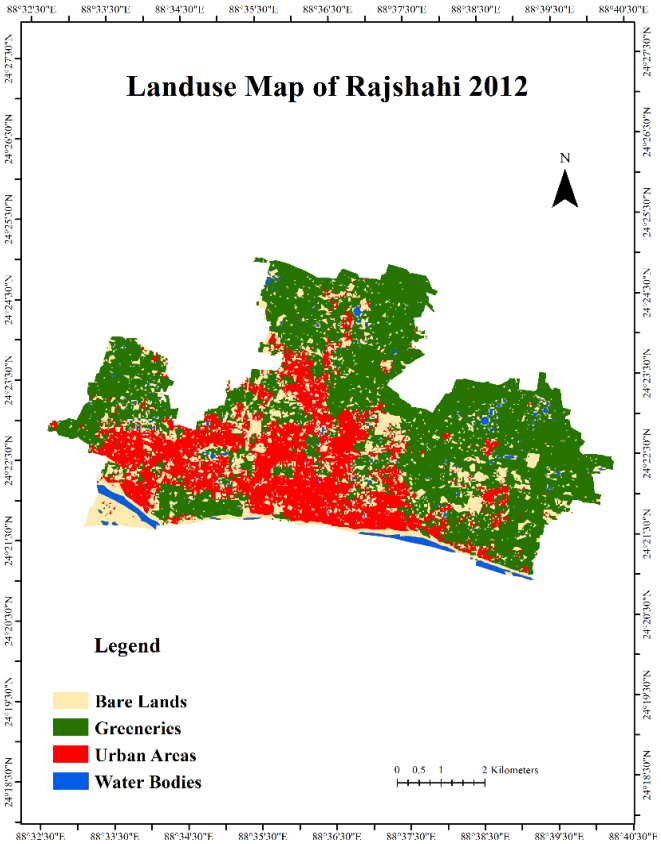

Fig. 4.1 Landuse Map of Rajshahi 2012

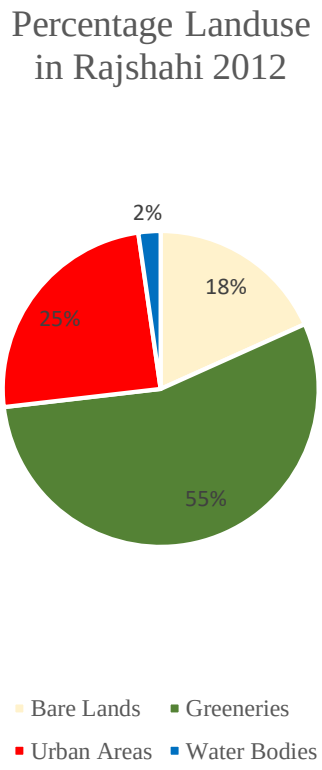

Fig. 4.2 Percentage Landuse in Rajshahi 2012

Table 4.1 Landuse of Rajshahi 2012

2012			
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	8.78	18	
Green Areas	26.36	55	25
Urban Areas	11.8	25	
Water Bodies	1.09	2	

(Standard as per UN-HABITAT 2019)

From the analysis, it was found the in 2016, Rajshahi had 5.34 sq. km bare land of 48.03 sq. km of total land area which is about 11% of the total land area. 24.59 sq. km land was covered by green areas which is about 51% of the total land area. 16.27 sq. km land was developed which is about 34% of the total land area and 1.83 sq. km of water bodies which is about 4% of the total land area.

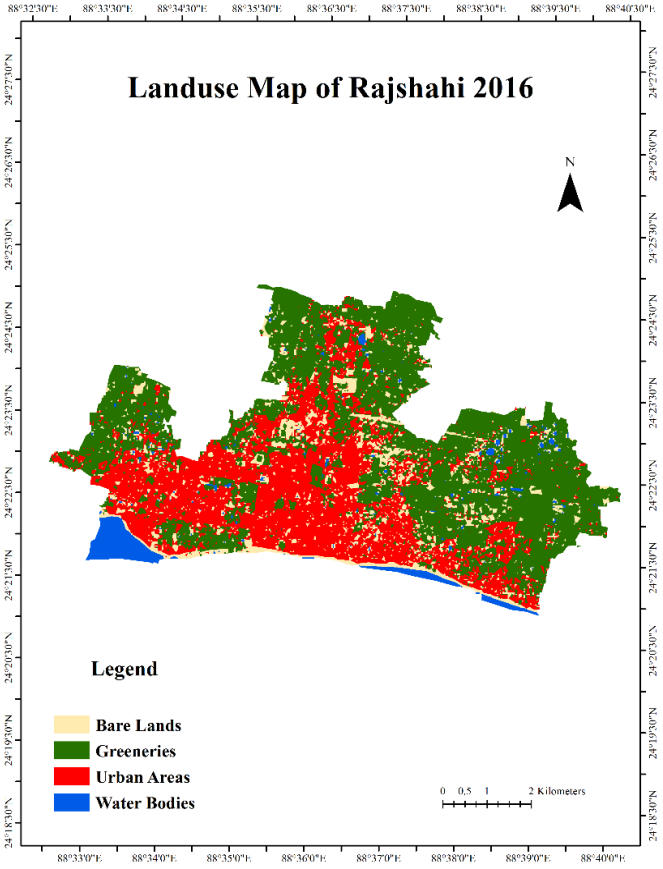

Fig. 4.3 Landuse Map of Rajshahi 2016

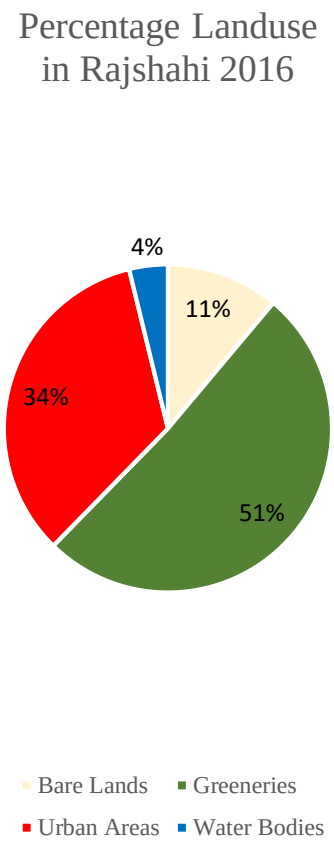

Fig. 4.4 Percentage Landuse in Rajshahi 2016

Table 4.2 Landuse of Rajshahi 2016

	2016		
Land use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	5.34	11	
Green Areas	24.59	51	25
Urban Areas	16.27	34	
Water Bodies	1.83	4	

(Standard as per UN-HABITAT 2019)

From the analysis, it was found the in 2020, Rajshahi had 6.83 sq. km bare land of 48.03 sq. km of total land area which is about 14% of the total land area. 20.82 sq. km land was covered by green areas which is about 43% of the total land area. 19.07 sq. km land was developed which is about 40% of the total land area and 1.29 sq. km of water bodies which is about 3% of the total land area.

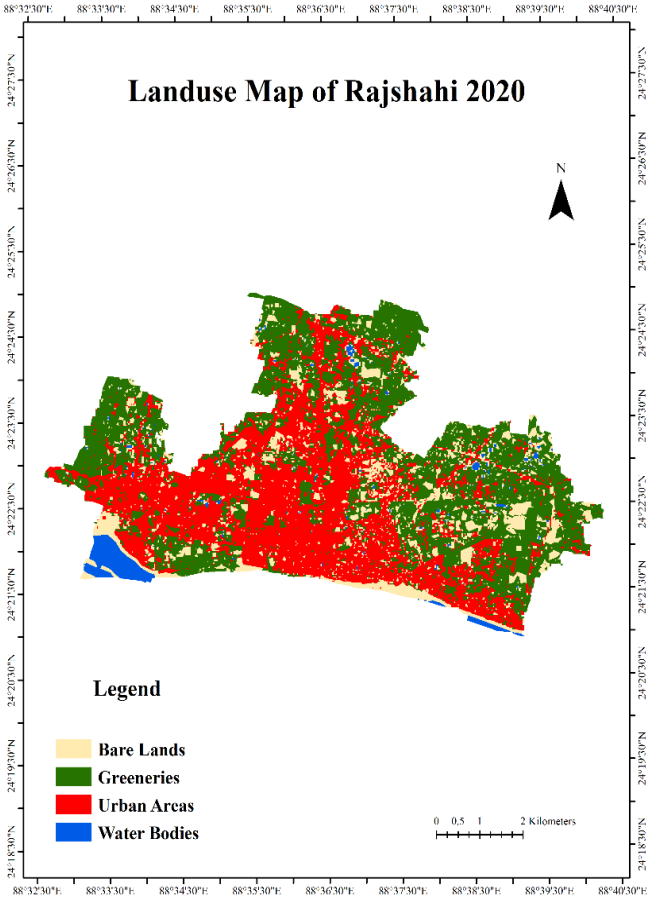

Fig. 4.5 Landuse Map of Rajshahi 2020

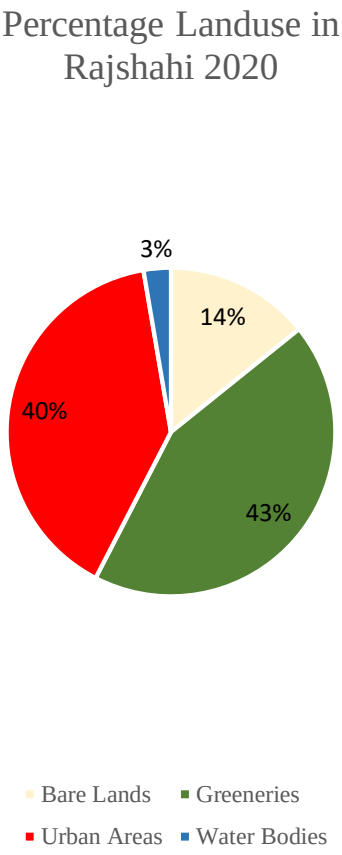

Fig. 4.6 Percentage Landuse in Rajshahi 2020

Table 4.3 Landuse of Rajshahi 2020

	2020		
Land Use Class	**Area (sq. km)**	**%**	**Standard (%)**
Bare Lands	6.83	14	
Green Areas	20.82	43	25
Urban Areas	19.07	40	
Water Bodies	1.29	3	

(Standard as per UN-HABITAT 2019)

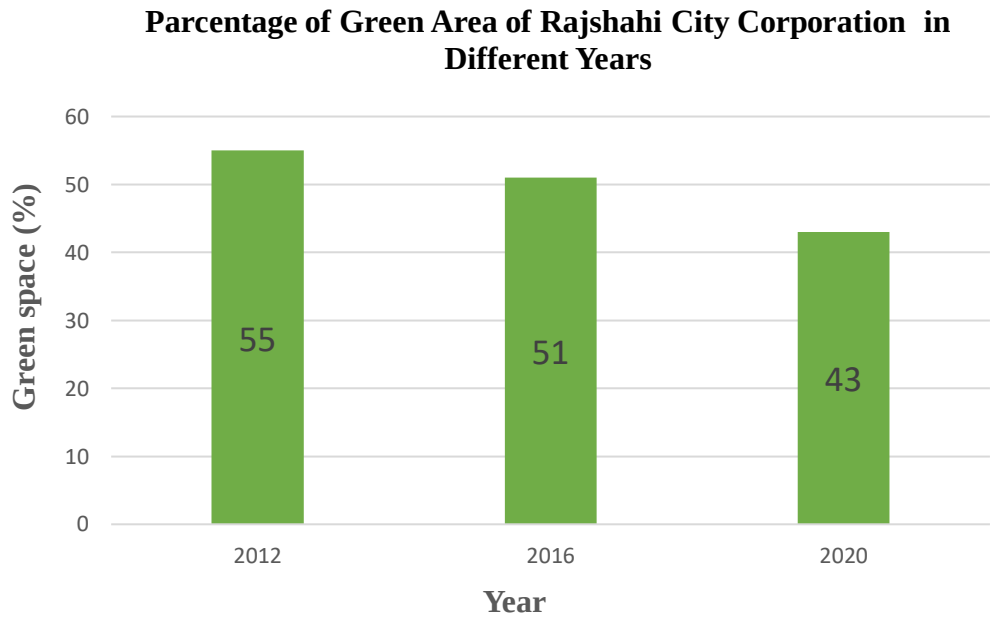

Fig. 4.7 Percentage of Green Area of Rajshahi City Corporation in Different Years

4.3 Chattogram

For Chattogram City Corporation classified images of 2012, 2016 and 2020 was analysed. From the analysis, it was found the in 2012, Chattogram had 37.11 sq. km bare land of 184.27 sq. km of total land area which is about 20% of the total land area. 65.92 sq. km land was covered by green areas which is about 36% of the total land area. 60.39 sq. km land was developed which is about 33% of the total land area and 20.87 sq. km of water bodies which is about 11% of the total land area.

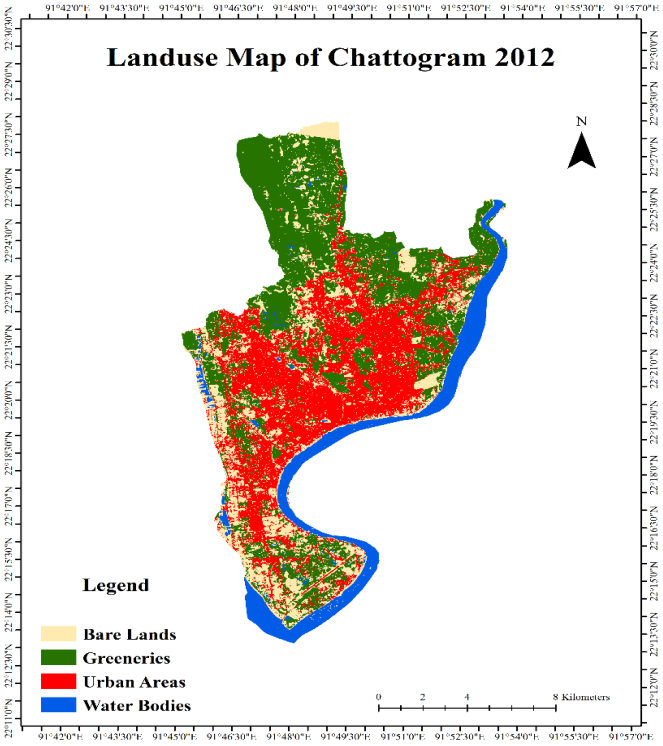

Fig. 4.8 Landuse Map of Chattogram 2012

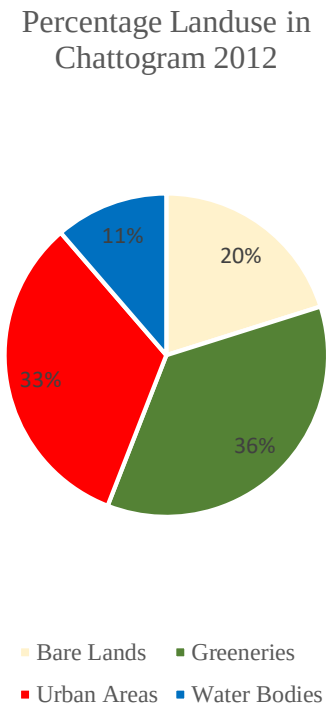

Fig. 4.9 Percentage Landuse in Chattogram 2012

Table 4.4 Landuse of Chattogram 2012

	2012		
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	37.11	20	
Green Areas	65.92	36	25
Urban Areas	60.37	33	
Water Bodies	20.87	11	

(Standard as per UN-HABITAT 2019)

From the analysis, it was found the in 2016, Chattogram had 58.27 sq. km bare land of 184.27 sq. km of total land area which is about 32% of the total land area. 42.59 sq. km land was covered by green areas which is about 23% of the total land area. 63.69 sq. km land was developed which is about 34% of the total land area and 19.72 sq. km of water bodies which is about 11% of the total land area.

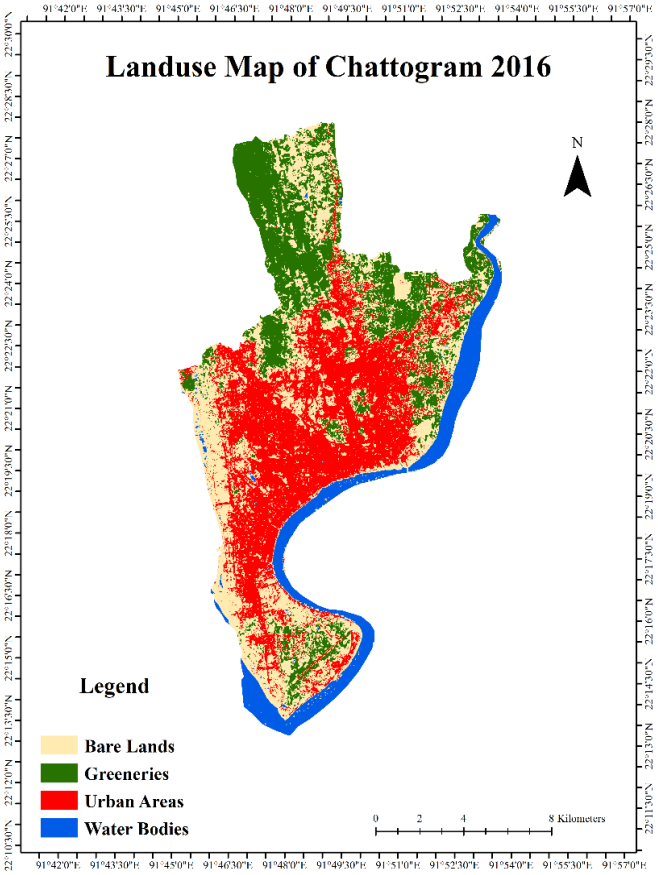

Fig. 4.10 Landuse Map of Chattogram 2016 2016

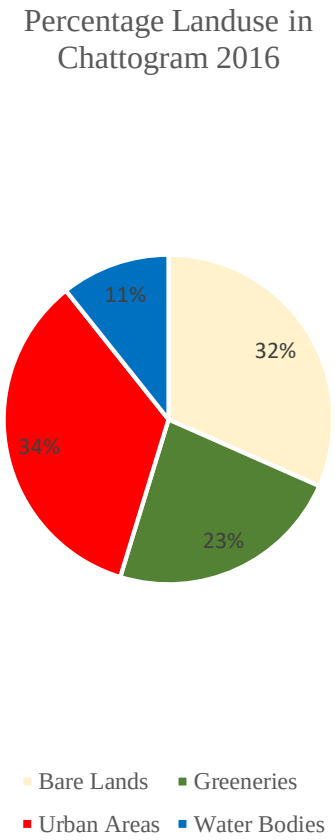

Fig. 4.11 Percentage Landuse in Chattogram 2016

Table 4.5 Landuse of Chattogram 2016

	2016		
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	58.27	32	
Green Areas	42.59	23	25
Urban Areas	63.69	34	
Water Bodies	19.72	11	

(Standard as per UN-HABITAT 2019)

From the analysis, it was found the in 2020, Chattogram had 39.35 sq. km bare land of 184.27 sq. km of total land area which is about 22% of the total land area. 35.28 sq. km land was covered by green areas which is about 19% of the total land area. 92.35 sq. km land was developed which is about 50% of the total land area and 16.69 sq. km of water bodies which is about 9% of the total land area.

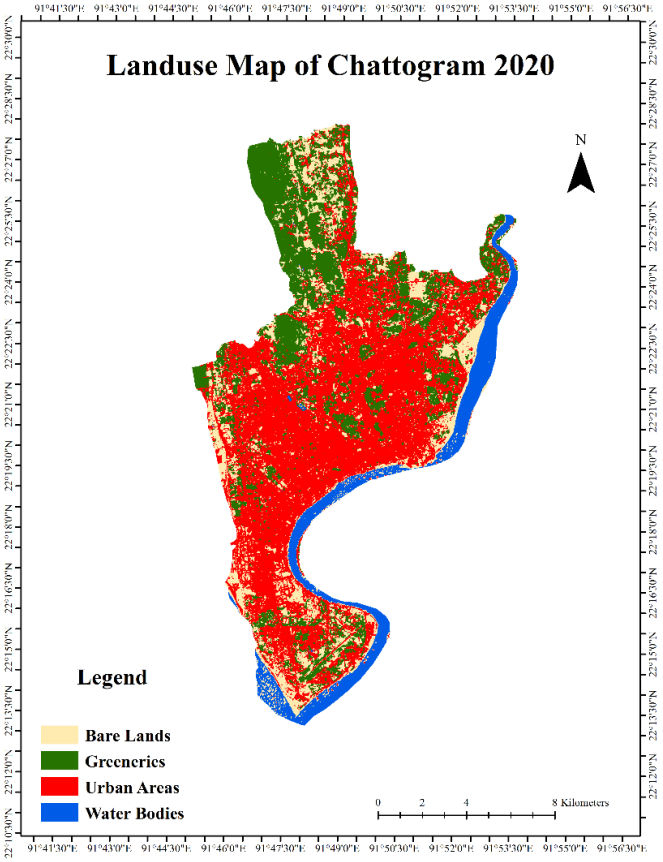

Fig. 4.12 Landuse Map of Chattogram 2020

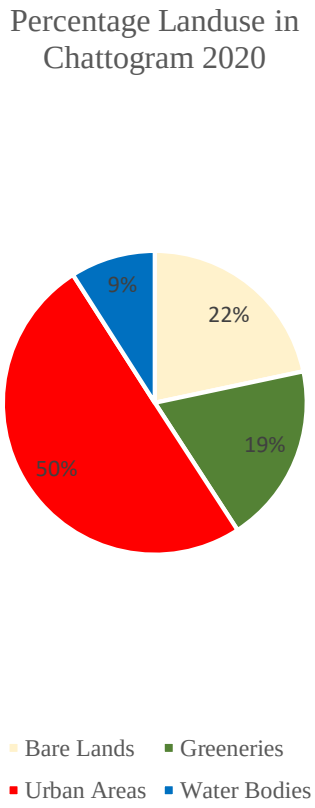

Fig. 4.13 Percentage Landuse in Chattogram 2020

Table 4.6 Landuse of Chattogram 2020

	2020		
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	39.95	22	
Green Areas	35.28	19	25
Urban Areas	92.35	50	
Water Bodies	16.69	9	

(Standard as per UN-HABITAT 2019)

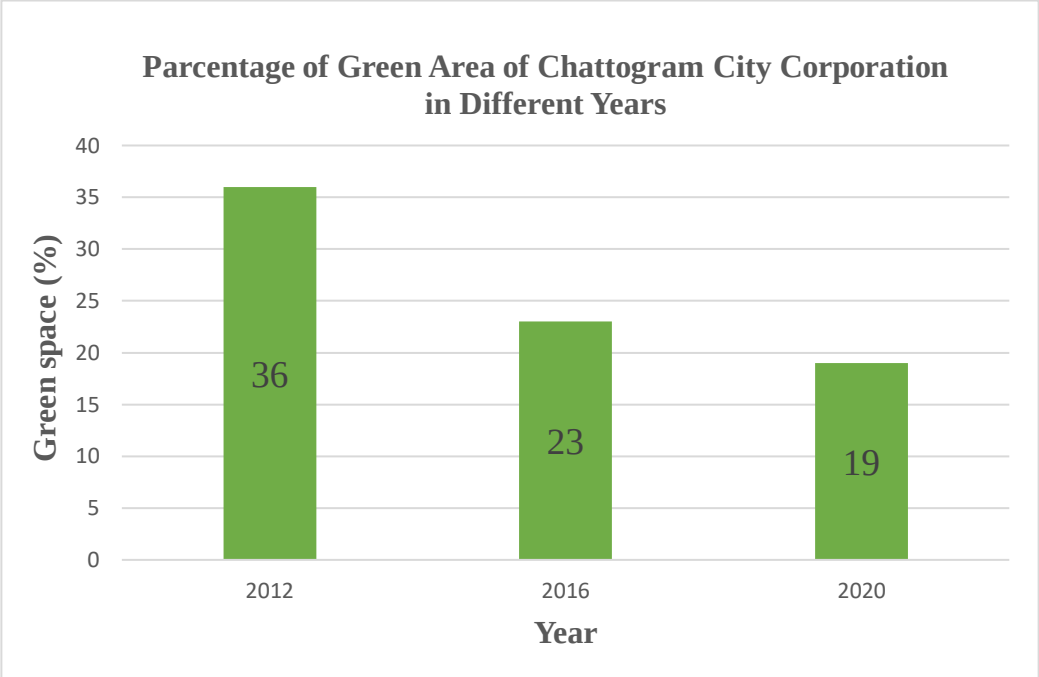

Fig. 4.14 Percentage of Green Area of Chattogram City Corporation in Different Years

4.4 Rangpur

For Rangpur classified images of 2012, 2016 and 2020 was analysed. From the analysis, it was found the in 2012, Rangpur had 28.58 sq. km bare land of 208.5 sq. km of total land area which is about 14% of the total land area. 160.4 sq. km land was covered by green areas which is about 77% of the total land area. 15.43 sq. km land was developed which is about 7% of the total land area and 4.09 sq. km of water bodies which is about 2% of the total land area.

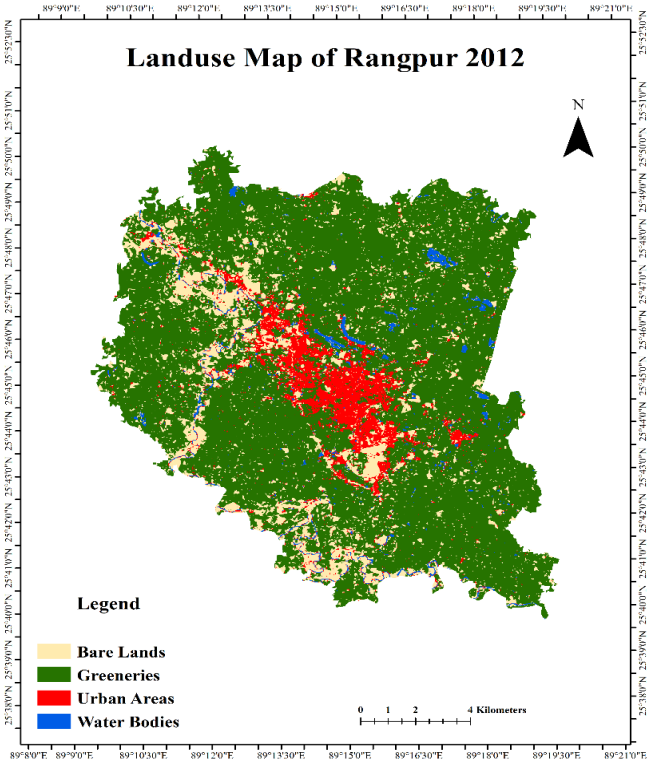

Fig. 4.15 Landuse Map of Rangpur 2012

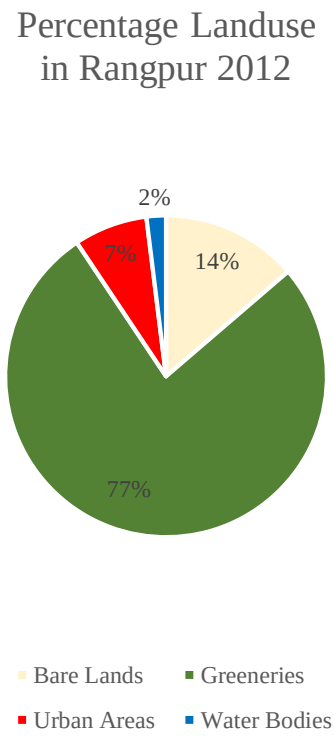

Fig. 4.16 Percentage Landuse in Rangpur 2012

Table 4.7 Landuse of Rangpur 2012

	2012		
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	28.58	14	
Green Areas	160.4	77	25
Urban Areas	15.43	7	
Water Bodies	4.09	2	

(Standard as per UN-HABITAT 2019)

From the analysis, it was found the in 2016, Rangpur had 48.74 sq. km bare land of 208.5 sq. km of total land area which is about 23% of the total land area. 120.68 sq. km land was covered by green areas which is about 58% of the total land area. 31.6 sq. km land was developed which is about 15% of the total land area and 7.47 sq. km of water bodies which is about 4% of the total land area.

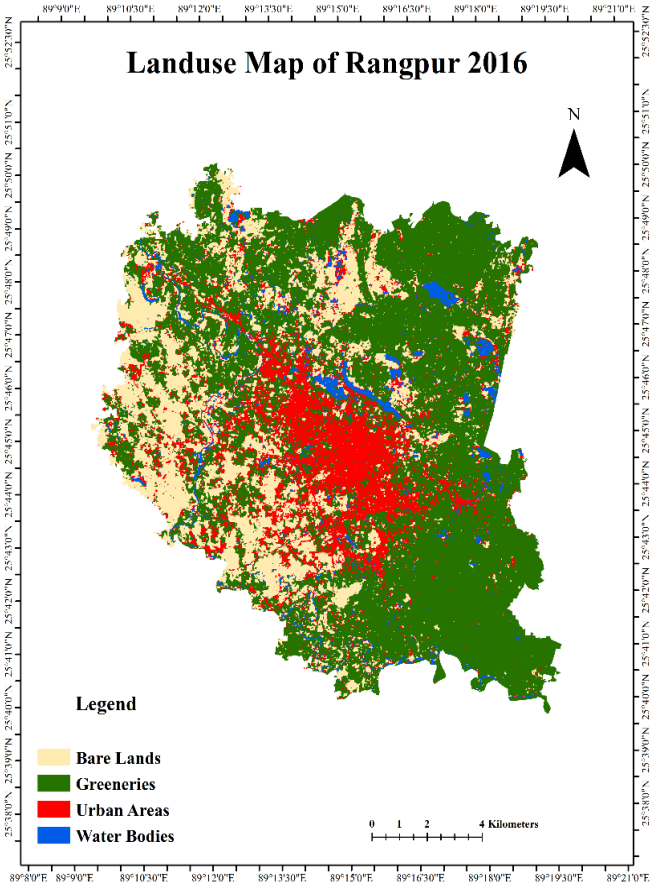

Fig. 4.17 Landuse Map of Rangpur 2016

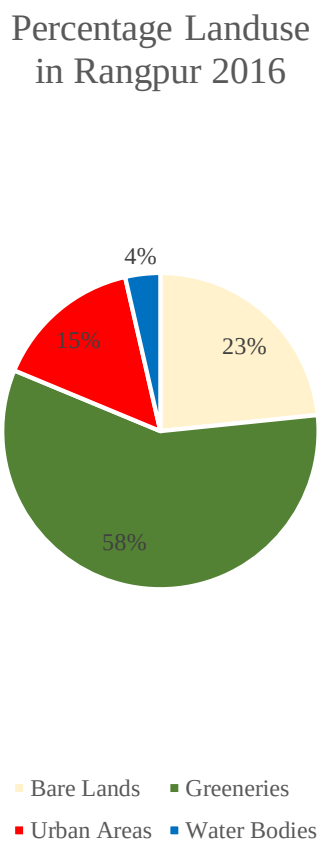

Fig. 4.18 Percentage Landuse in Rangpur 2016

Table 4.8 Landuse of Rangpur 2016

	2016		
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	48.74	23	
Green Areas	120.68	58	25
Urban Areas	31.6	15	
Water Bodies	7.47	4	

(Standard as per UN-HABITAT 2019)

From the analysis, it was found the in 2020, Rangpur had 73.94 sq. km bare land of 208.5 sq. km of total land area which is about 35% of the total land area. 86.25 sq. km land was covered by green areas which is about 41% of the total land area. 42.93 sq. km land was developed which is about 21% of the total land area and 5.34 sq. km of water bodies which is about 3% of the total land area.

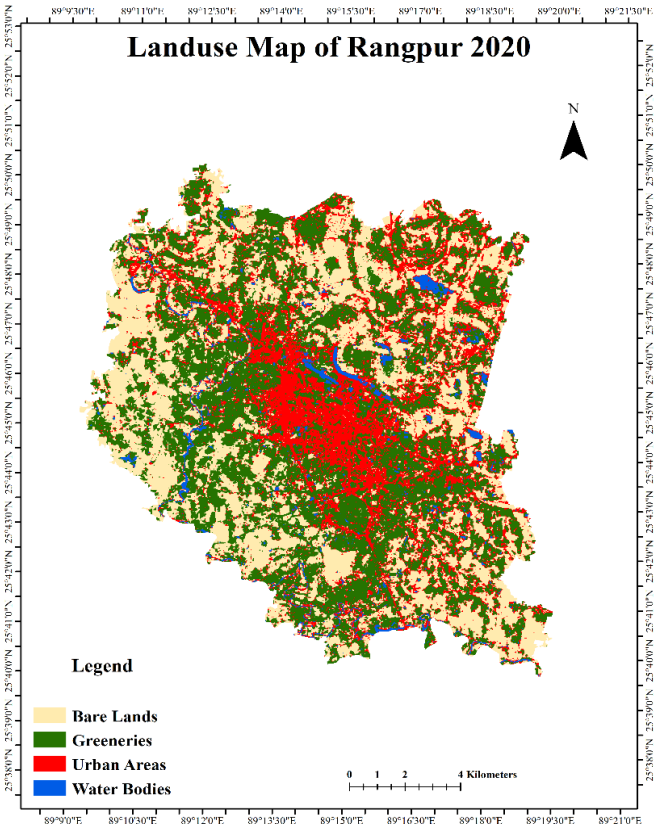

Fig. 4.19 Landuse Map of Rangpur 2020

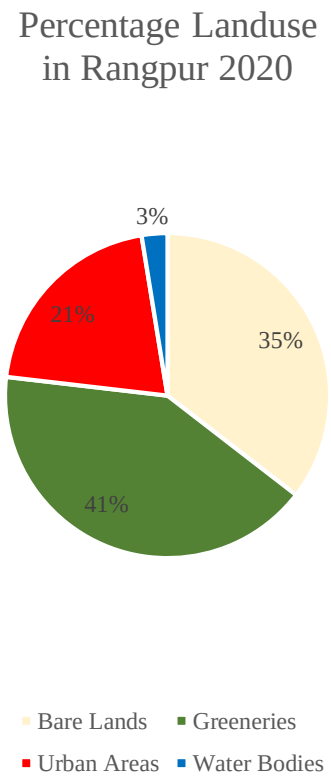

Fig. 4.20 Percentage Landuse in Rangpur 2020

Table 4.9 Landuse of Rangpur 2020

	2020		
Land Use Class	**Area (sq. km)**	**(%)**	**Standard (%)**
Bare Lands	73.94	35	
Green Areas	86.25	41	25
Urban Areas	42.93	21	
Water Bodies	5.34	3	

(Standard as per UN-HABITAT 2019)

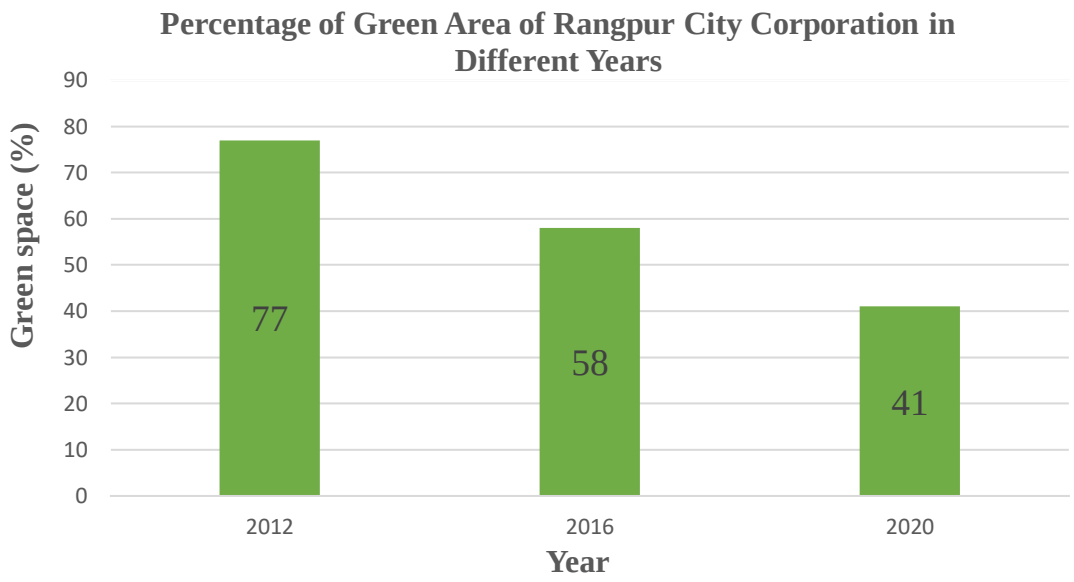

Fig 4.21 Percentage of Green Area of Rangpur City Corporation in Different Years

4.5 Summary

From the analysis, an appalling decrease in green areas over the years can be seen in all of the areas. Chattogram being the port city, has seen development since the colonial periods. But in recent times, major urbanisation has consumed the green areas of the city. Within only 8 years, the city has experienced 17% declination of green areas. It has gone under the standard from being comfortably in it in the gap of only 8 years.

Rajshahi on the other hand is the greenest city of the country. Yet, it has seen a major drop in the green areas as well. In 2012, 55% of the total land area was covered by vegetation but 8 years' time span has seen the green cover come down by 12% at 43% in 2020. Rajshahi has remained in the standard limit of green areas but the drop in green areas is concerning for the city.

Rangpur is one of the newest city corporations of Bangladesh. It has seen rapid urbanisation in recent times and hence, seen massive drop in green covers. A very healthy 77% of the total area was covered by green areas in 2012. But within 8 years it has come down to 41% which means a decrease by 36%. This decrease in green areas is very concerning and should be stopped before the city gets devoured by urban hardscape.

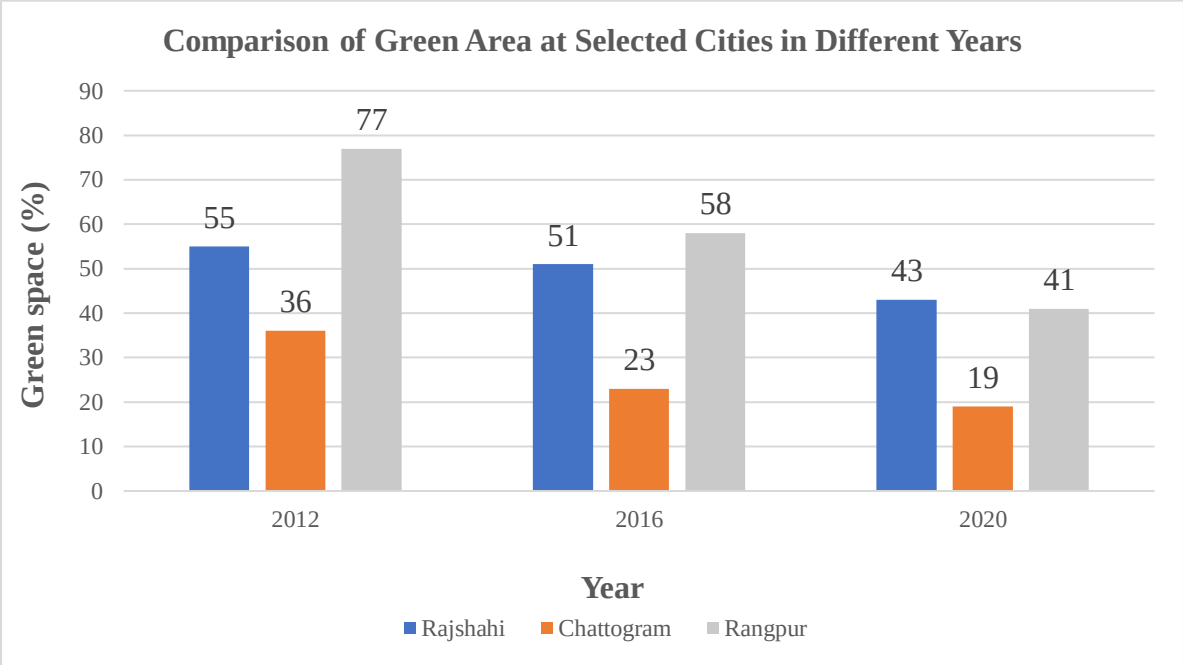

Fig. 4.22 Comparison of Green Area at Selected Cities in Different Years

CHAPTER V

CONCLUSHION & RECOMMENDATION

5.1 Conclusion

Rajshahi city corporation has a total land of 48.03 sq. km. In 2012 green area is found 26.36 sq. km which is about 55% of total land area. In 2016 green area is found 24.59 sq. km which is about 51% of total land area. In 2020 green area is found 20.82 sq. km which is 43% of total land area. As decreased 12% Green areas in 8 years' time span. As comparing with standard value, green area in Rajshahi was found satisfactory.

Chattogram city corporation has a total land of 184.27 sq. km. In 2012 green area is found 65.92 sq. km which is about 36% of total land area. In 2016 green area is found 42.59 sq. km which is about 23% of total land area. In 2020 green area is found 35.28 sq. km which is 19% of total land area. As decreased 17% Green areas in 8 years' time span. As comparing with standard value, green area in Chattogram was found below standard and not satisfactory.

Rangpur city corporation has a total land of 208.5 sq. km. In 2012 green area is found 160.4 sq. km which is about 77% of total land area. In 2016 green area is found 120.68 sq. km which is about 58% of total land area. In 2020 green area is found 86.25 sq. km which is 41% of total land area. As decreased 36% Green areas in 8 years' time span. As comparing with standard value, green area in Rangpur was found satisfactory.

It has been seen that Rajshahi has highest green area of 43% and Chattogram has the least green area of 19% which is under standard value of 25% green area.

5.1.1 Possible Ways to Increase and Maintain Green Area

1. The government should take strict steps to prevent deforestation.

2. Cutting of trees to make agricultural lands and cutting of agricultural areas to make construction should be monitored and restricted if needed.

3. Initiatives should be taken to plant more and more trees in the bare lands and also in the urban areas.

4. Rooftop gardening is another effective way to increase the beauty of the urban area and to contribute in improving the air quality.

5. Frequent seminars can be arranged for public awareness.

5.2 Recommendation

i. More cities can be taken to analysis green area for better understanding about the green space of Bangladesh.

ii. Green space analysis of Dhaka city could be more challenging, if it can be done it may show interesting result.

References

1. Pol. J. Environ. Stud. Vol. 31, No. 1, 2022
2. Annual report 2019 | UN-Habitat. (2022). Retrieved 20 February 2022, from https://unhabitat.org/annual-report-2019
3. Ahmed, B., & Ahmed, R. (2012). Modeling Urban Land Cover Growth Dynamics Using Multi-Temporal Satellite Images: A Case Study of Dhaka, Bangladesh. *ISPRS International Journal of Geo-Information*, *1*(1), 3-31. doi: 10.3390/ijgi1010003
4. Balogun, I., & Ishola, K. (2017). Projection of Future Changes in Landuse/Landcover Using Cellular Automata/Markov Model over Akure City, Nigeria. *Journal Of Remote Sensing Technology*, *5*(1), 22-31. doi: 10.18005/jrst0501003
5. Lilly Rose, A., & Devadas, M. D. (2009, June). Analysis of land surface temperature and land use/land cover types using remote sensing imagery-a case in Chennai city, India. In *The seventh international conference on urban clim held on* (Vol. 29).
6. Al-Hathloul, S., & Rahman, M. A. (2003). Dynamism of metropolitan areas: The case of metropolitan Dammam, Saudi Arabia. *J. Gulf Arab. Penins. Stud*, *29*, 11-43.
7. Celik, B., Kaya, S., Alganci, U., & Seker, D. Z. (2019). Assessment of the relationship between land use/cover changes and land surface temperatures: a case study of thermal remote sensing. *FEB Fresenius Environ. Bull*, *3*, 541.
8. Li, J., & Zhao, H. M. (2003). Detecting urban land-use and land-cover changes in Mississauga using Landsat TM images. *Journal of Environmental Informatics*, *2*(1), 38-47.
9. Streutker, D. R. (2003). Satellite-measured growth of the urban heat island of Houston, Texas. *Remote Sensing of Environment*, *85*(3), 282-289.
10. Hart, M. A., & Sailor, D. J. (2009). Quantifying the influence of land-use and surface characteristics on spatial variability in the urban heat island. *Theoretical and applied climatology*, *95*(3), 397-406.

11. Fu, P., & Weng, Q. (2018). Responses of urban heat island in Atlanta to different land-use scenarios. *Theoretical and applied climatology*, *133*(1), 123-135.
12. Niyogi, D. (2019). Land surface processes. In *Current trends in the representation of physical processes in weather and climate models* (pp. 349-370). Springer, Singapore.
13. Thapa, R. B., & Murayama, Y. (2009). Examining spatiotemporal urbanization patterns in Kathmandu Valley, Nepal: Remote sensing and spatial metrics approaches. *Remote Sensing*, *1*(3), 534-556.
14. Ahmed, B., Kamruzzaman, M. D., Zhu, X., Rahman, M., & Choi, K. (2013). Simulating land cover changes and their impacts on land surface temperature in Dhaka, Bangladesh. *Remote sensing*, *5*(11), 5969-5998.
15. Gaur, A., Eichenbaum, M. K., & Simonovic, S. P. (2018). Analysis and modelling of surface Urban Heat Island in 20 Canadian cities under climate and land-cover change. *Journal of environmental management*, *206*, 145-157.
16. Rahman, M. T. (2016). Detection of land use/land cover changes and urban sprawl in Al-Khobar, Saudi Arabia: An analysis of multi-temporal remote sensing data. *ISPRS International Journal of Geo-Information*, *5*(2), 15.
17. Tewolde, M. G., & Cabral, P. (2011). Urban sprawl analysis and modeling in Asmara, Eritrea. *Remote Sensing*, *3*(10), 2148-2165.
18. Kafy, A. A., Rahman, M. S., Islam, M., Al Rakib, A., Islam, M. A., Khan, M. H. H., ... & Sattar, G. S. (2021). Prediction of seasonal urban thermal field variance index using machine learning algorithms in Cumilla, Bangladesh. *Sustainable Cities and Society*, *64*, 102542.
19. Naim, M. N. H., & Kafy, A. A. (2021). Assessment of urban thermal field variance index and defining the relationship between land cover and surface temperature in Chattogram city: a remote sensing and statistical approach. *Environmental Challenges*, *4*, 100107.
20. ROTH, M., OKE, T. R., & EMERY, W. J. (1989). Satellite-derived urban heat islands from three coastal cities and the utilization of such data in urban climatology. *International Journal of Remote Sensing*, *10*(11), 1699-1720.

21. Ahmed, B. (2011). *Urban land cover change detection analysis and modelling spatio-temporal Growth dynamics using Remote Sensing and GIS Techniques: A case study of Dhaka, Bangladesh* (Doctoral dissertation).
22. Ahmed, S. (2018). Assessment of urban heat islands and impact of climate change on socioeconomic over Suez Governorate using remote sensing and GIS techniques. *The Egyptian Journal of Remote Sensing and Space Science*, *21*(1), 15-25.
23. Byomkesh, T., Nakagoshi, N., & Dewan, A. M. (2012). Urbanization and green space dynamics in Greater Dhaka, Bangladesh. *Landscape and Ecological Engineering*, *8*(1), 45-58.
24. Corner, R. J., Dewan, A. M., & Chakma, S. (2014). Monitoring and prediction of land-use and land-cover (LULC) change. In *Dhaka megacity* (pp. 75-97). Springer, Dordrecht.
25. Dewan, A. M., Kabir, M. H., Nahar, K., & Rahman, M. Z. (2012). Urbanisation and environmental degradation in Dhaka Metropolitan Area of Bangladesh. *International Journal of Environment and Sustainable Development*, *11*(2), 118-147.
26. Dewan, A. M., & Yamaguchi, Y. (2009). Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization. *Applied geography*, *29*(3), 390-401.
27. Shaunak, M. F., & Kafy, A. A. (2019). Remote sensing approach in wetland and land degradation assessment: a scenario of Modhumoti Model Town, Savar, Bangladesh.
28. Kafy, A. A., Raikwar, V., Al Rakib, A., Kona, M. A., & Ferdousi, J. (2021). Geospatial approach for developing an integrated water resource management plan in Rajshahi, Bangladesh. *Environmental Challenges*, *4*, 100139.
29. Nilufar, F. (2010, February). Urban morphology of Dhaka city: Spatial dynamics of growing city and the urban core. In *Proceedings of International Seminar Proceedings on the Celebration of* (Vol. 400).
30. Ummai, H., Fouzia, H., Asif, I., Mallik Sezan, M., & Arif, M. (2011). Remote sensing & GIS based spatio-temporal change analysis of Wetland in Dhaka City, Bangladesh. *Journal of Water Resource and Protection*, *2011*.

31. Al Rakib, A., Akter, K. S., Rahman, M. N., Arpi, S., & Kafy, A. A. (2020). Analyzing the pattern of land use land cover change and its impact on land surface temperature: a remote sensing approach in mymensingh, Bangladesh. In *1st International Student Research Conference-2020, Dhaka*.
32. Express, T. (2022). Dhaka: A city with inadequate green space. Retrieved 20 February 2022, from https://thefinancialexpress.com.bd/views/dhaka-a-city-with-inadequate-green-space-1511197116
33. Editor, R., Page, O., 2022, B., Quotes, S., Sports, O., gardens, H., & U.N. General Assembly graduates Bangladesh, N. (2022). U.N. General Assembly graduates Bangladesh, Nepal to developing countries bloc. Retrieved 20 February 2022, from https://www.thehindu.com/news/international/un-general-assembly-graduates-bangladesh-nepal-to-developing-countries-bloc/article37681442.ece#:~:text=Bangladesh%20is%20now%20scheduled%20to,Covid%2D19%20on%20its%20economy.
34. Environment and Planning B: Planning and Design, Volume: 39 issue: 2, page(s): 326-343.
35. J Epidemiol Community Health. 2006 Jul; 60(7): 587–592.