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GIS and Remote Sensing Application for Monitoring the Shrinking of Urban Green Space in Pabna Municipality

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Abstract

Urban green spaces are open spaces in urban areas that are primarily covered by vegetation which can be public or private. This study is an attempt to dynamically monitor green spaces in Pabna Municipality of Bangladesh in last 20 years. Both primary and secondary data were acquired to document the spatio–temporal dynamics of green spaces in the study area. Focus group discussion (FGD) has been done to collect primary data for this study. Secondary data has been collected from Landsat 5 TM images for 1997, 2007, 2017 and supervised classification is done for analysis. This study reveals that green spaces of Pabna Municipality area (3087. 27 ha) are rapidly decreasing over the years and in last twenty years, about 187 ha of urban green space has been lost with a rate of 9.36 ha per year. Population, urban growth rate and built up area are significant factors for the reduction of green spaces. To promote environment friendly planned and sustainable development of a municipality, appropriate measures should be taken to preserve green spaces in the municipal areas in Bangladesh.

Keywords: Urban green space, land use, urban growth rate, Built up area and Land cover classification

Introduction

Urban green space is the part of urban area covered by mainly vegetation and is generally considered as an important element in sustainable urban development (Atiqul, 2011). It is also the indicator to measure environmental quality and quality of residents' life (Hofmann et al., 2011 and Liu et Al., 2016). Urban green spaces as an important contributor can be a significant part of sustainable development. Developments of urban green spaces need to consider interdisciplinary and integrated approaches such as economic, political, social, cultural, management and planning aspects to improve existing urban green spaces (URGE, 2002).

Sustainable development of cities and development of urban green spaces are very important. It is an urgent need to improve the lifestyles of urban people and there should be a special focus on the consideration of environmental impact of human activities by raising awareness to the rational use of energy, water and food consumption and natural

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resources for environmental sustainability. Therefore the role played by green spaces in our urban environments can no longer be ignored by today's policy makers (Haq, 2011).

The rapid urbanization in developing countries is characterized by patterns and process of land use change (Schetke et al., 2016), which creates great challenges towards balanced and sustainable urban planning and expansion of city areas. The urban green space are recognized as important elements to sustain and generate ecosystem services for urban areas and overall wellbeing (Alberti et al., 2003).

Undoubtedly, urban green space have a significant positive influence on wellbeing (Gomez-Baggethun, and Barton, 2013). The extensive literature on urban green space already showcases the diverse and broad range of ecological and social benefits of urban green space and their role in achieving urban sustainability (Kabisch, Qureshi and Haase, 2015; Tzoulas et al., 2007)

In an urban transition scenario, land use change combined with lack of urban green space stewardship results in small, fragmented and degraded urban green space (Dallimer et al., 2015). One of the biggest challenges in this situation is the lack of capacity to plan and implement change (ICLEI, 2015), due to unavailability of data or records of the current situation of urban green space (TCPO, 2014). This lack of complete dataset coupled with rapid administrative boundary expansion and unauthorized land conversion in the urban transition process makes monitoring and management of urban green space more complex and challenging. Geographic information system (GIS) and Remote sensing are very effective and widely accepted tools and techniques to monitor these changes as an "automated systems for the capture, storage, retrieval, analysis, and display of spatial data" (Clarke, 1995, p. 13). GIS allows overlaying different information in an integrated manner that is understandable and communicable to different participants (Muyphy and King, 2013). Hence, GIS effectively integrates, represents and communicates data to guide the planning process of urban green space. These remotely-sensed data are widely used for Land Use Land Cover Change (LUCC) studies. In this context, this study is an attempt to dynamically monitor green spaces in Pabna Municipality of Bangladesh in last 20 years. Both primary and secondary data were acquired to document the spatial–temporal dynamics of green spaces in the study area.

Urban Green space

Green spaces refer to those land uses that are covered with natural or man-made vegetation in the built-up areas and planning areas (Wu, 1999). The green spaces usually include community parks, woodlands, nature reserves and agricultural lands (Maas et al., 2006). With the population increase and expansion of cities, more and more open space, woodland and cultivated land have been converted into construction land due to the increasing demands for transportation land, commercial land and residential land. At the same time, the demand for various types of agricultural products has also led to the conversion of some forest land and agricultural land into flower bases or agricultural bases (Wan et al., 2015). Urban greenery is also defined as the overall extent of outdoor

space with vegetation cover of trees, bushes, ornamental plants, or grass. Examples of such spaces are squares, parks, rows of trees on road sides, groves, and planted spaces in yards of public or private Builtings (Aravadinou and Evmorfoulou, 1999)

Urban Green Spaces are also considered as urban space covered by vegetation of any kind. This includes-

- smaller green space features (such as street trees and roadside vegetation);
- green spaces not available for public access or recreational use
- larger green spaces that provide various social and recreational functions (such as parks, playgrounds or greenways).

This study considers following categories of urban green spaces, such as – Parks and Playground, Garden, Urban Agriculture and Urban Forest.

Urban green space in Bangladesh

UNEP recommends a minimum of 25% open space (plantation and water body combined) within a city's total area. In Dhaka, open space area is only about 14.5% according to a 2012 study (Byomkesh et al., 2012: 46). Dhaka is a highly vibrant megacity with estimated population of roughly 2.1 million in 2020 with density of 23,234 people per square kilometer (UN, 2020). Vegetation create green barrier as visual boundary, natural screen and space buffer as a major element of landscape design (Tuli and Islam, 2014). Due to high density in an unplanned urban setup, the city is in real scarcity of open and green spaces for its' large number of dwellers. Urban vegetation minimizes direct solar radiation of the surface, optimizes wind velocity and its form and configuration influence temperature, air humidity and wind pattern of an urban setting. The scenario is even worse in the city core area. However this phenomena is also prevalent in the other types of urban areas, even in secondary cities and municipalities in Bangladesh.

Study Area

Pabna is one of the oldest zilla of Bangladesh, which was administratively created in 1828. Pabna Sadar subdivision of the greater Pabna zila was upgraded to a zila in 1984. The Geo position of the district is between 24˚03′ to 24˚12′ North latitudes and between 89˚10′ to 89˚25′ east longitude.

Pabna Sadar Upazila area is 443.90 sq km, located in between 23°53' and 24°05' north latitudes and in between 89°09' and 89°25' east longitudes. Maximum temperature is 33.9°C and minimum is 9.6°C; annual rainfall is about 1872 mm.

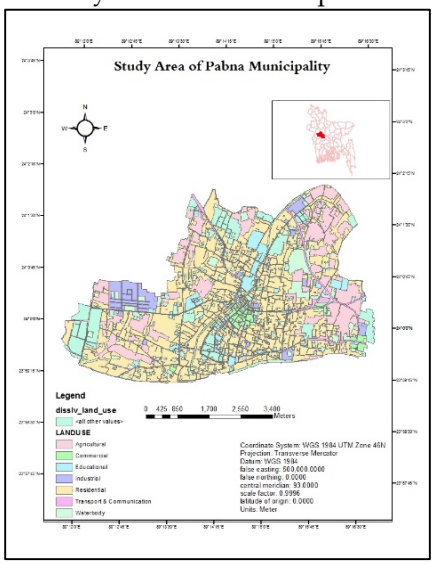


Fig 1: Pabna Municipality map

Characteristically the soil of the zila is divided into four types, viz flood plains of the Ganges, Karatoya, Jamuna and Barind Trac (BBS, 2001).

Table 1: Level of Urbanization and Urban growth rate (%) in Pabna Municipality

Year	Pabna Sadar Upazila Population	Pabna Municipality	Level of Urbanization	Urban Growth Rate %
1991	431513	103277	23.93	-
2001	476932	116305	24.39	1.2
2011	590914	144442	24.44	2.19
2021 (Proj)	739178	180134	24.37	2.23

(Source: City Population, n.d.; BBS 2001, Community Series: Pabna Zila and BBS 2011, Community Report: Pabna)

Methodology

Satellite Data Collection

Landsat 5 TM data have been used in this study to prepare LULC classes, extract the emissivity and considered indices values. Landsat images has been used for this study for time series analysis. This is due to the fact that data from multiple years are required and Landsat data are available in Bangladesh for this purpose. Landsat 5 TM data is free to download and Data used in this study was downloaded from the relevant website of United State geological Survey (USGS) (http://glovis.usgs.gov/).

Table 2: Details of Landsat data collection

Date of image	Satellite/sensor	Reference system Path/Row
06-03-1997	Landsat 5 TM	Path 138, Row 43
18-03-2007	Landsat 5 TM	Path 138, Row 43
13-03-2017	Landsat 5 TM	Path 138, Row 43

Source: http://glovis.usgs.gov/

Satellite Data Processing

Downloaded satellite data quality was acceptable because it has zero cloud coverage. So, it didn't require much more processing. In processing, at first study area was extracted with the help of Area of Interest (AOI). The data acquisition date has a highly clear atmospheric condition. All images bands 1-5 and 7 have a spatial resolution of 30m, and the thermal infrared band (band 6) has a spatial resolution of 120m for Landsat 5 TM images.

Supervised Classification process

a) While performing the unsupervised classification, there will be a few mixed classes and same categorized classifications.
b) These signatures are taken into account and subtracted from the dataset into one category in supervised classification.
c) Finally the field land use map were generated for the rest of the analysis.

Land Cover has been classified into 4 categories: (1) Green Space (2) Built-up area (3) Water bodies and (4) Others

Table 3: Description of Land Cover Classes

Land cover	Description
Green Space	Urban green spaces are open spaces in urban areas that are primarily covered by vegetation which can be public or private. Areas dominated by cropland such as paddy field.
Built Up Area	Areas with residential, industrial structure and/or constructed material including housing yard.
Water Body	A natural and continuous flow of water and also local pond.
Others	Miscellaneous use, Mixed used land cover.

Results and Discussion

Land Cover Classification for 1997, 2007 and 2017

Land cover map' 1997 shows that most of Pabna Municipality areas are covered by Green space (480.15 hectares) which was 15.55% of the total area. The amount of water bodies was 1111.95 hectares which was 36.01% of the total area. The remaining land cover was Built-up area (14.44%) and Other Land (33.99%).

Land cover map' 2007 shows that, total Green space Land cover was 386.1 hectare which was 12.52% of the total area. The amount of water bodies was 1010.25 hectares which was 32.72% of the total area. The remaining land cover was Built-up area 17.71% and Other Land 37.06%.

Land cover map 2017 shows that Green space is 292.95 hectare, Built up area is 1181.61 hectare and Water body is 381.06 hectare (12.34%). Built up is the dominant land cover type that is almost 38.27%, whereas the Green space is only 9.49%. Settlement is found mostly in the middle part of Pabna Municipality.

Table 4: LULC in March, 1997, 2007 and 2017

Land Use/Land Cover Class	1997		2007		2017	
	Land Use Amount (In Hectare)	Percentage (%)	Land Use Amount (In Hectare)	Percentage (%)	Land Use Amount (In Hectare)	Percentage (%)
Green Space	480.15	15.55	386.1	12.52	292.95	9.49
Built-up area	445.59	14.44	546.76	17.71	1181.61	38.27
Water Body	1111.95	36.01	1010.25	32.72	381.06	12.34
Others	1049.58	33.99	1144.16	37.06	1231.65	39.89
Total	3087.27	100	3087.27	100	3087.27	100

(Source: USGS, 2018)

The land and its agricultural products form very important resources for the people of the study area. Generally due to high density of settlements, any incremental loss of land which affects food production, living space, forest resources, and wildlife habitats have significant impact. In the study area, total cultivable land is 184905 ha; fallow land 699.68 acres; single crop land 9.30%, double crop land 39.14% and three times crop land 51.0%. Land under irrigation is 166415 ha. (Department of Agriculture Extension, 2017).

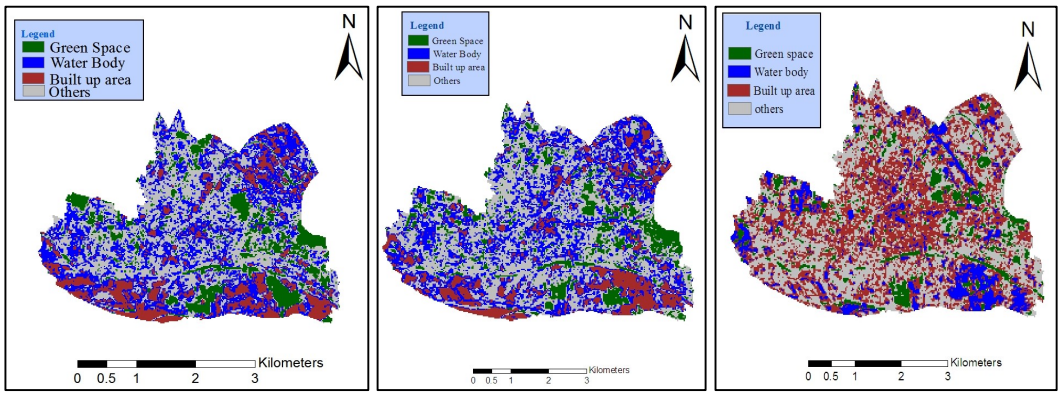


Fig 2: Land Use-Land Cover Map during 1997, 2007 and 2017 in Regional Scale for Pabna Municipality (March)

(Source: USGS, modified by Authors, 2018)

Green Space, Built up Area and Water body Change Comparison

The Figure 3 shows green space, Built up area and water body change comparison during 1997, 2007 and 2017. It reveals that the natural land cover such as Green space has been decreased over the years due to increase in Built up area. According to the table 4 in 1997, major land cover categories were water bodies and Green space, which were 1111.95 and 480.15 hectare.

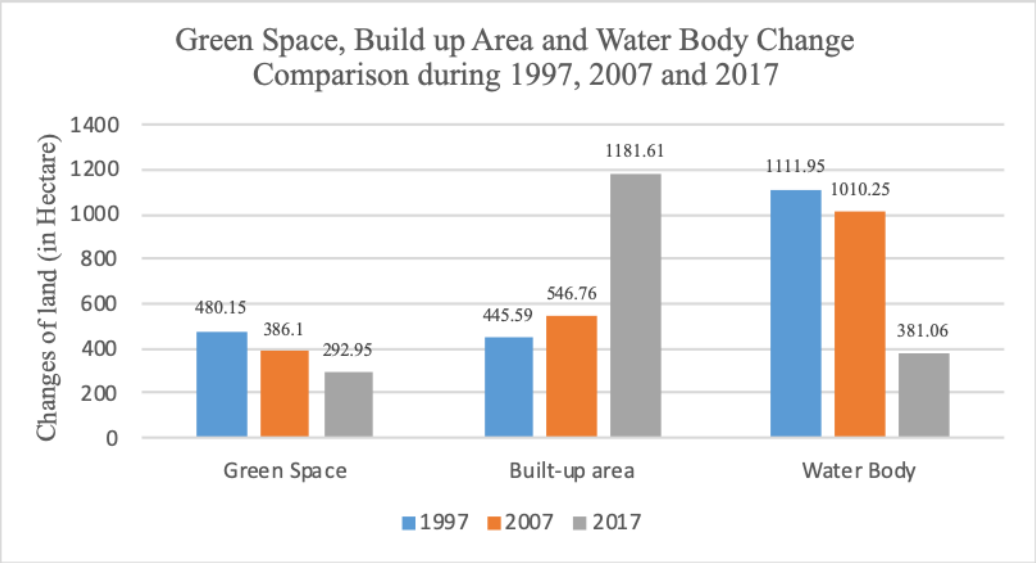


Fig 3: Green Space Change Comparison during 1997, 2007 and 2017

Other land cover were Built-up area (445.59 ha). During the 20 years between 1997 to 2017, the areas of Green space and Water body have been decreased significantly. At the same time, other land use category such as built up area have increased in terms of area. In 1997, there was very little built up area, but in 2007, built up area has been increased to 546.76 hectare. During the 10 years in between 2007 to 2017, the areas of green space have been decreased gradually. In 2017, the area of green space has become 292.95 hectare. On the other hand, built up area has been increased from 445.59 hectare in 1997 to 1181.61 hectare in 2017. At present the built up area occupied 38.37% area of Pabna Municipality due to urbanization. From here, it is easily understood that the share of green space area at Pabna Municipality is gradually decreasing in an alarming rate. On the other hand, the area of water body (river and ponds) was 1111.95 hectare in 1997. But in 2007 and 2017, it has been decreased to 1010.25 hectare and 381.06 hectare respectively. The settlement area has been increased due to expansion of human habitat. At present, built up land use is 38.37% area of Pabna Municipality, which was only 14.44% in 1997. So figure 3 shows that the water body has been decrease from 1111.95 hectare to 381.06 hectare between 1997-2017. In the same period, built up area has been increased from 445.59 hectare to 1181.61 hectare and green space has been reduced from 480.15 to 292.95 hectare.

Accuracy Assessment and validation of Land Use Classification

Accuracy assessment is an important feature of land-use mapping, not only as a guide to map quality and reliability, but also in understanding thematic uncertainty and its likely implications for the end user (Balcik and Göksel 2005). The accuracy of the thematic map is dependent on several factors such as classification, mapping unit or image quality and may contain errors which need quantification. The accuracy represents the correctness or degree to which the attributes of the map agree with the truth reference dataset (Congalton and Green, 2009). In this study, accuracy of the classification has been calculated through kappa statistic and error matrix. An error matrix shows the number of correctly classified image sampling units in the diagonal. The kappa statistic is a measure of agreement of the image data and the reference data (Jensen, 1986). If each measurement vector has N features, then select N+1 points per class and the practical minimum is 10*N per class (Akoso, 2013). Equations (1), (2), (3) and (4) is used to arrive at kappa statistics (Congalton and Green, 2009).

User's Accuracy in class i = $\frac{n_{ij}}{n_i}$ ..... (1)

Producer's Accuracy in class j = $\frac{n_{ij}}{n_j}$ ..... (2)

Overall Accuracy = $\frac{\sum_{i=1}^{k} n_{ij}}{n}$ ..... (3)

Kappa Coefficient = $\frac{n\sum_{i=1}^{k} n_{ij} - \sum_{i=1}^{k} n_{i.}\, n_{j.}}{n^2 - \sum_{i=1}^{k} n_{i.}\, n_{j.}}$ ..... (4)

Where, k represents the number and the map nomenclature to be 1, 2, . . . , k; n_{ij} = number of sample units that in the map belong to class i and in the reference belong to class j; $n_{i.}$ = sum of the elements in row i, i.e., the number of sample units classified into class i in the remotely sensed classification; $n_{.j}$ = sum of the elements in column j, i.e., the number of sample units classified into class j in the reference; n = total number of sample units (Congalton and Green, 2009).

Error matrix and total accuracy report for classified image of 1997, 2007 and 2017 is given in table 5 and 6.

Table 5: Error Matrix of Land Cover 1997, 2007 and 2017

	1997					2007					2017				
	GS	WB	BuA	O	RT	GS	WB	BuA	O	RT	GS	WB	BuA	O	RT
Green Space	26	2	1	2	31	16	0	0	4	20	16	0	0	1	17
Water body	7	42	2	4	55	0	31	1	5	37	0	17	1	0	18
Built up area	0	0	14	0	14	2	0	22	1	25	1	1	43	6	51
Others	4	4	2	50	60	9	7	2	60	78	1	3	7	63	74
Column Total	37	48	19	56	160	27	38	25	70	160	18	21	51	70	160

GS = Green space, WB = Water body, BuA = Built up area, O = Others and RT = Row Total

Table 6: Accuracy Assessment for Land Cover 1997, 2007 and 2017

	1997					2007					2017				
	RT	CT	NC	PA (in %)	UA (in %)	RT	CT	NC	PA (in %)	UA (in %)	RT	CT	NC	PA (in %)	UA (in %)
Green Space	37	31	26	70.27	83.87	27	20	16	64	80	18	17	16	88.89	94.12
Water body	48	55	42	87.50	76.36	38	37	28	77.78	75.68	21	18	17	80.95	94.44
Built up area	19	14	14	73.68	100	25	25	21	84	84	51	51	43	84.31	84.31
Others	56	60	50	89.29	83.33	70	78	62	83.78	79.49	70	74	63	90	85.14
Total	160	160	132			160	160	127			160	160	139		
Overall Classification Accuracy	82.50%					80.63%					86.88%				

Source: USGS and Author's calculation, 2018

The classified image for 1997 has 'Overall Classification Accuracy' of 82.50% and 'Overall Kappa Statistics' is 0.7537. The classified image 2007 has 'Overall Classification Accuracy' of 80.63% and Overall Kappa Statistics is 0.7177. For the classified image of 2007, the test sample for reference data was derived randomly from this land cover map and also was verified with Google earth map.

The accuracy assessment of the classification is based on the error confusion matrix. The classified image of 2017 has overall accuracy of 86.88% and Kappa statistic is 0.8039.

Kappa (K^) Statistics for Land Cover 1997, 2007 and 2017

Kappa statistics are commonly used to indicate the degree of agreement of nominal assessments made by multiple appraisers. They are typically used for visual inspection to identify defects. If the kappa value is poor, it probably means that some additional training is required. The Kappa statistic varies from 0 to 1.

Table 7: Conditional Kappa for each Category

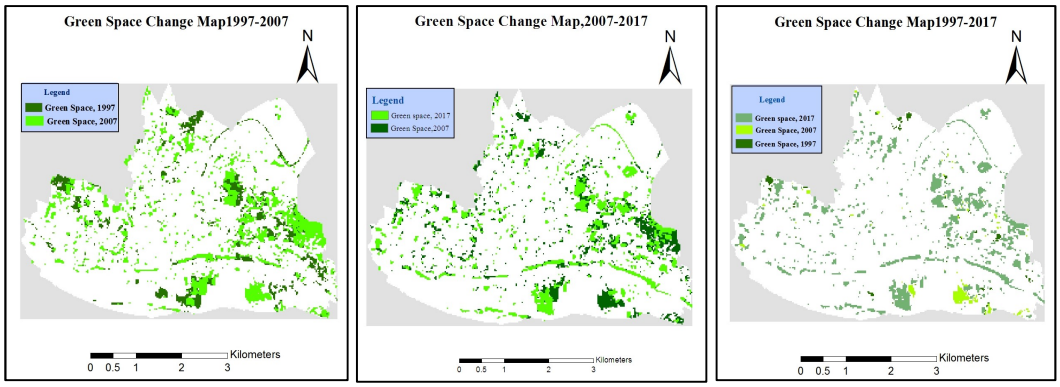
0 = agreement equivalent to chance
0.1 – 0.20 = slight agreement
0.21 – 0.40 = fair agreement
0.41 – 0.60 = moderate agreement
0.61 – 0.80 = substantial agreement
0.81 – 0.99 = near perfect agreement
1 = perfect agreement

Class Name	Kappa (1997)	Kappa (2007)	Kappa (2017)
Green space	0.7902	0.7594	0.9337
Water body	0.6623	0.7873	0.9361
Built up area	1.0000	0.8578	0.7697
others	0.7436	0.5897	0.7357
Overall Kappa Statistics	0.7537	0.7177	0.8039

For Land Cover 1997 Overall Kappa Statistics = 0.7537, for Land Cover 2007 Overall Kappa Statistics = 0.7177 and for Land cover 2017, Overall Kappa Statistics = 0.8039, which is substantial agreement.

Green Space Change Monitoring During 1997 to 2007

The change detection from 1997 to 2017 shows the decreasing rate of urban green space. The present study finds that, green space has been reduced 94.05 hectare from the year 1997 to 2007. At the same time, built up area has been increased 101.17 hectare which was almost 3.27%.

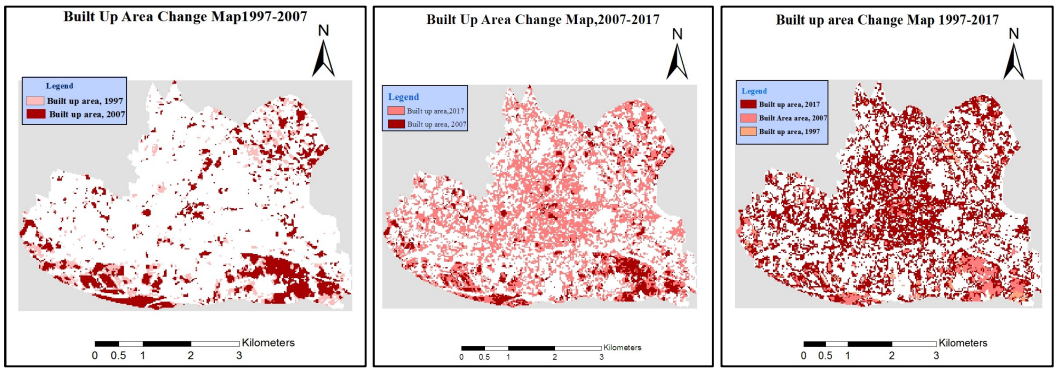


(Source: USGS modified by Authors, 2018)

Fig 4: Green Space Change Map 1997-2017

In land cover change 2007-2017, 93.15 hectares of green space has been reduced. So it can be said that the rate of green space has been decreased during those 10 years (2007 to 2017). During the same period, the built up area has been increased to 634.85 hectare.

In land cover changes during 1997-2017, 187.2 hectare area of green space has been decreased. At the same time, 736.02 hectare area of built up area has been increased.



(Source: USGS and modified by Authors, 2018)

Fig 5: Built up Area Change Map 1997-2017

From the correlation matrix, as revealed in table 8, there is a significant negative correlation between population and urban green space. So the increase of population has contributed as the main factor to reduce urban green space. Urban growth rate as like as population increase have negative relationship with urban green space.

Table 8: Correlation Matrix of Land use change and Urbanization Growth Rate

	Pop	Urban Growth Rate Percentage	Green Space	Built Up Area	Water body
Population	1	0.849* $R^2 = 0.720^*$	-0.997* $R^2 = 0.995^*$	0.947* $R^2 = 0.896^*$	-0.947* $R^2 = 0.897^*$
Urban Growth Rate Percentage	0.849* $R^2 = 0.720$	1	-0.884* $R^2 = 0.781^*$	-0.633 $R^2 = 0.400$	-0.634 $R^2 = 0.402$
Green Space	-0.997* $R^2 = 0.995^*$	-0.844* $R^2 = 0.781$	1	-0.921* $R^2 = 0.849^*$	0.922* $R^2 = 0.852^*$
Built Up Area	0.947* $R^2 = 0.896^*$	0.633 $R^2 = 0.400$	-0.921* $R^2 = 0.849^*$	1	-1.00 $R^2 = 1$
Water body	-0.947* $R^2 = 0.897^*$	-0.0634 $R^2 = 0.402$	0.922* $R^2 = 0.850$	-1.00 $R^2 = 1$	1

The built up area has relationship with urban green space because urban green space is converted as built up area to meet up the demand for urbanization and associated infrastructures like settlement, roads, etc. The water body is positively correlated with urban green space because both have been reduced with the increase of urbanization in the study area.

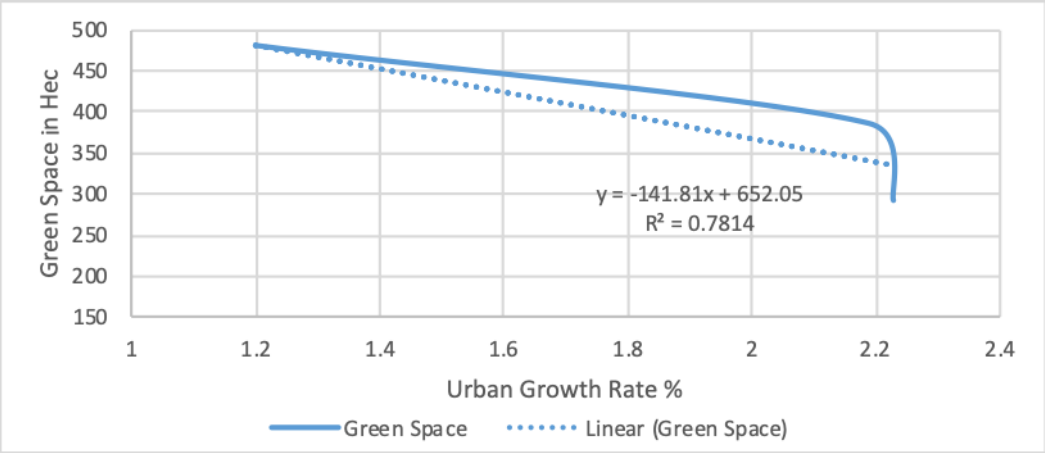


Fig 6: Change of urban green space to urban growth rate percentage

The Linear regression of the urban green space to urban growth rate percentage is:

y = -141.81x + 652.05 (here x = urban growth rate percentage). Now the present urban growth rate in Bangladesh is 3.1856% (World Bank, 2018) and if the Bangladesh urban growth rate percentage is considered in Pabna municipality, then the urban green space will be approximately 200 hectares in Pabna Municipality.

Nature of Temperature changes with Land Use from 1997 to 2017

As it has proved that land use dynamics is changing and the temperature is fluctuating simultaneously so it is important to identify the relationship between land use change and temperature fluctuations (Rahman and Hosen, 2018). Following Table 9 shows the changes in land surface temperature for various land use/land cover from 1997 to 2017 in two intervals.

Table 9: Changes in LST over LULC Changes in 1997 to 2007

Change in Land use/Land Cover	Average Change in Land Surface Temperature (in °C).	
	Changes 1997 to 2007 (in °C)	Changes 2007 to 2017 (in °C)
Agriculture to Built-up	5.03	0.84
Water to Built-up	4.51	1.7
Vegetation to Built-up	4.02	0.46

Source: Rahman and Hosen, 2018

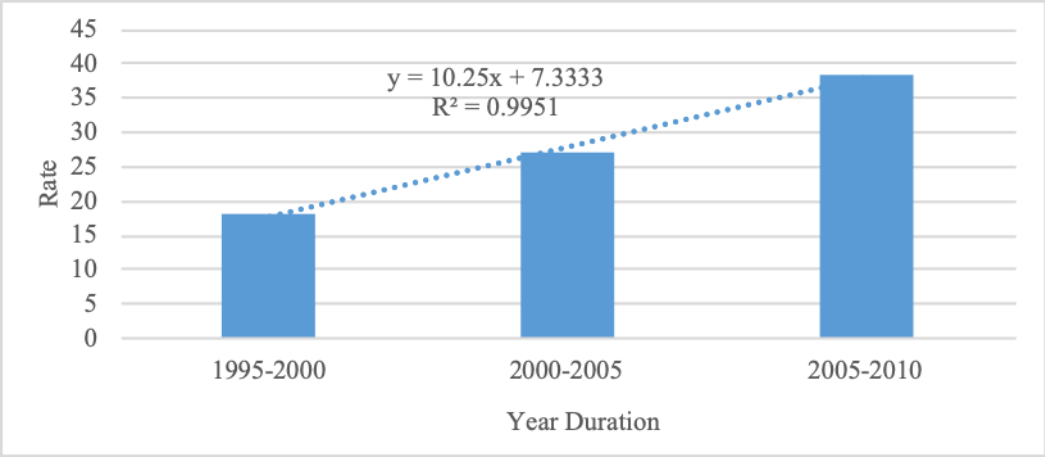
It reveals a significant increase in LST with the conversion of LULC. As for example, land use change from Agriculture to Built up Area has been contributed in temperature rise of 5.30°C from 1997 to 2007.

Socio-Economic and Demographic Factors in Urban Green Space Change

High urbanization and the high pace of social and economic development resulting from the increase of population in Pabna Municipality, lack of infrastructure, congested traffic, environmental degradation and housing shortage are major issues faced by urban areas in Pabna towards sustainable development. The most important challenge facing Pabna Municipality due to rapid urbanization is the conversion of agricultural land and forest to urban uses and infrastructures in urban areas.

Migration as the causes of Urban Green space change

Rate of migration has relations with green space reduction in urban areas. The term "migration" encompasses diversified forms of territorial mobility. These forms involve a large spectrum of movement ranging from commuting, temporary absence from home place for a couple of days to several years and seasonal to permanent migration.



(Source: BBS, 2011)

Fig 10: Migration in different years in the study area

Above Figure 10 portrays that migration trend was very low during 1995-2000 in Panna Municipality. In those years the urbanization growth was very low, ranging about 1.2%. However migration trend has been increased since 2015 and people from different places migrated to Pabna municipality for better work opportunity. Also good transportation facilities and ease of business have positively contributed behind this migration. From regression analysis of this study, Green Space Change can be measured as: ***Green Space Change = 639.263 – 9.085 x Migration Rate.***

Recommendations

The quality of cities significantly depends on how the urban green spaces are designed, managed and protected. The management, planning, design, policy implementation of urban green spaces as the key discussion issues of sustainable environment are highly integrated and incorporated into the sustainable development ideas at local and global level. Urban green spaces not only play important role to environmental sustainability but also it contributes to social, economic, recreation, cultural, aesthetics and economic developments in cities**.**

The purposes of green space development strategy are, therefore:

- To safeguard the future of green spaces;
- To improve the quality of urban areas and the neighborhoods;
- To make urban areas more attractive and thereby attract more resources;
- To enhance the well-being of local people and tourists.

Focus Group Discussions of this study revealed following recommendations for sustainable urban growth of Pabna Municipality.

- 'Bas Bazar Pond Area' of Pabna Municipality has great opportunity of developing green space.
- 'Jor Bangla Temple' is the historical place where lots of people visit everyday. Proper urban design with plantation and landscaping can make this space more green and hereby enhancing the beauty of the area.
- 'Tarash Bhabon' is located at the main town where temperature is relatively high and pollution are at high level. Appropriate planning for plantation can be very helpful to develop a green environment in this area to make it sustainable.

In order to conserve as well as to improve the quality of urban green spaces or natural green spaces- appropriate planning, monitoring and management based on participatory and integrated approach is very essential in Pabna Municipality.

Conclusion

Application of GIS and remote sensing technology is an important tool to identify changes of urban green space which can provide effective result to undertake important policy decisions. Urban green spaces, especially public parks and gardens provide resources for relaxation and recreation. Green spaces need to be uniformly distributed throughout the city and total area occupied by green spaces in urban area should be large enough to accommodate the requirements of the urban people. Bringing green space to the urban landscape can promote and inspire a better relationship with the environment while supporting important ecosystem services. Findings of this this study relating to the changes of urban green spaces in Pabna Municipality could be helpful for policy makers to undertake important policy decisions in various secondary cities in Bangladesh.

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