Jahangirnagar University Planning Review ISSN 1728-4198
Vol. 19, June 2021 (Printed in June, 2022), pp. 31-50, © Jahangirnagar University

Urban Green Space and Wetland Dynamics by Urbanization Impact: Protective Perspective by Present Monitoring Laws on Municipality

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Abstract

Water body and green space is very important elements of ecosystem to keep functioning of urban environment and to make relaxed of urban life. This study is an effort to detect the wetland and green space changes by the urbanization impact in savar municipality, Bangladesh. The changes of the important environmental issues are addressed here by the existing rules and regulations. In the methodology both the primary and secondary data is used to identify the urbanization impact and land use dynamics on urban agricultural land and wetland. From the USGS satellite (landsat 5 thematic mapper-TM) for the year of 1996, 2007 and 2018 data is used. Using a supervised classification algorithm, from a set of satellite images the land use change data were extracted. Producer's accuracy, user's accuracy, overall accuracy and kappa coefficient model is used to check the accuracy of the classified images and deriving all of the model the accuracy is about 80% and it means it is substantial agreement of the accuracy. The result exposed that agricultural land and green spaces and water body of savar municipality has gradually decreased and last twenty years (1996 to 2018) about 385 ha agricultural and urban green space is lost and about 171 ha water body is lost. Urbanization rate and build up area is significant factor to lose the green spaces. The reduction of water body and agricultural or green space is attributed due to the implementation of existing rules and regulations. In order to ensure sustainable water body and green spaces in the municipality the laws should be executed for appropriate working of the municipality's environment.

Key words: Urban green space, Water body, Urbanization, land use change, build up area and Controlling rules and laws.

Introduction

To meet the growing demand of urbanization, the land use change have significantly changed the natural resources in a large percentage of the earth's environment system (Rahman et al., 2012; Foley et al., 2005; Song et al., 2018; Vitousek, 1997). Urbanization and population growth is mainly the responsible factor for land use change in any municipality (Briassoulis, 2009; Mahmud, Rahman and Sharmin, 2020). Land use change is frequently connected with environmental loss, if managed with present environmental rules and regulation, it may progress environmental quality (Rahman and Hosen, 2018; Koellner and Scholz, 2008). Urbanization and fast population progress have negative impacts on environment settings (Rahman, Hossain and Miti, 2019; Ahmed and Rahman, 2020) and unplanned land use development also have harmful possessions on natural arrangements (Akther and Rahman, 2015; Rahman, 2012; Mahmud, Rahman and Sharmin, 2020). On the other hand, decreases in agricultural land or vegetation, water body may have negative impacts on environments (Rahman et al., 2020; Biswas, Rahman

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and Akther, 2016). The ecological system is consists of social, economic and environment and the green space and water bodies are main concerning issues in environment system (Huang and Chen, 2002; Rahman and Cornia, 2020). Urbanization growth trend creates impact on urban agricultural land or green land and water bodies (Nakagoshi, Watanabe and Kim, 2006; Mabuhay et al. 2005; Kong and Nakagoshi 2006; Phan and Nakagoshi, 2007, Gan et al., 2014).

Several previous studies have identified the green space and water body conversion by buildup areas in greater Dhaka or other areas in Bangladesh (Byomkesh, Nakagoshi, and Dewan, 2012; Hassan and Nazem, 2015; Rahman, Hossain and Miti, 2019; Mahmud, Rahman and Sharmin, 2020; Chowdhury and Faruqui, 1989; Islam, 1996, 2005). Other studies have used satellite data and remote sensing GIS tool to identify land use change (Rahman and Hosen, 2018; Rahman, Hossain and Miti, 2019; Sarker and Rahman, 2018; Moniruzzaman et al., 2020). But none of these studies considered the special type of area or municipality in which urbanization growth trend is very high and changing patterns of agricultural land or urban green space and wetlands and to find out the reasons behind change of urban green space and water body are the focus of this study.

Savar Municipality has been experiencing the continuous development of Buildup area by destruction of its agricultural land and water bodies in response to rapid urban expansion (Hasan and Southwort, 2017; Rahman, Hossain and Miti, 2019; Rahman and Akther, 2015). The population density is 20,313 which is huge (BBS, 2011). An investigation of the land cover map of the Savar area shows that approximately 211% buildup area had developed between the year 1972 to 1980 (Hasan and Southwort, 2017).

Unplanned development by destroying natural system shows that it makes the urban area defenseless to natural hazards such as flood and water logging (Dewan et al., 2007; Dewan and Yamaguchi, 2008; Rahman, Hossain and Miti, 2019) and quality of life is also reducing (Amin, Dewan and Kabir, 2008). For example in Bangladesh the availability and quality of water in the urban centers and the water supply systems is hampered by rapid and unplanned urbanization (Hasan et al., 2020). With the growing population housing demand the open spaces/playgrounds and wetland are converting to buildup areas (Rahman et al., 2020) and loss of open spaces and water body increasing the risk vulnerability as like as earthquake (Chakrabarty, Rahman and Ubaura, 2020; Rahman, Tariq and Sharmin, 2020, 2021; Shawon et al., 2021). All these destroy the city’s environmental, social life and the degradation of green and water body creates harmful impact on environments and humans (Byomkesh, Nakagoshi and Dewan, 2012).

Urbanization is a major event in human history. The term "urbanization" refers to the concentration of people in small areas, resulting in land transformation for agricultural, commercial, residential, and transportation purposes (Franco, et all, 2015). Despite Bangladesh's rapid urbanization in recent years, just a little more than a quarter of the population lives in cities. Bangladesh's demographic, economic, and social fabric are all factors in the country's rapid urbanization. Bangladesh's urban population grew rapidly after independence, from 6.27 million in 1974 to 28.61 million in 2001 (Shafi, 2010). By 2020 the urban population is expected to reach nearly 80 million, almost half of the total population (Rahman, 2002).

The term land use refers to the changes that have arisen on the land as a result of residential, commercial, institutional, and other uses, while the term land cover refers to the various types of features that exist on the earth's surface (Lillesand and Kiefer, 1996). As an important contributor, urban green spaces may play an important role in long-term growth (Herzele and Wiedeman, 2003). Multidisciplinary and integrative approaches such as economic, political, social, cultural, management, and planning must be considered to improve present urban green space facilities and services (Haq, 2011). Despite their importance, the total global wetland area is shrinking faster than any other form of ecosystem (Mahmud, 2018). As a result, today's policymakers can no longer overlook the importance of green spaces in our urban environments (Haq, 2011).

This research will help to find out urbanization and land use change impact on urban green space and wetland. Furthermore, it will also give the emphasis to protect the urban green space and wetland in urbanized area.

Considering the realities, the objectives of this study were: (1) to evaluate the urbanization and land use change pattern in the study area within different time period; (2) to determine the changing patterns of urban green space and wetlands in the study area; (3) to find out the reasons behind change of urban green space in Savar Municipality and (4) to identify essential measures to put in the study area to conserve urban green space and wetlands.

Material and Methods

Data Used

The aim of the study is to determine the impact of urbanization on LULC change and land use dynamics in Savar municipality, especially for water bodies and green space. The land use land classification is based on supervised classification in this study from the satellite image of landsat 5 thematic mapper (TM) (Li et al., 2013) for the year of 1996, 2007 and 2018. The free images on remote sensing from the landsat database from the United States Geological Survey Earth Explorer are used in this research paper (http://glovis.usgs.gov/). In this analysis, Landsat 5 TM data were used to create LULC groups, extract reflectivity, and calculate indices values. Landsat data are useful since a long-term digital archive with a medium spatial resolution and fairly stable spectral and radiometric resolutions is available (Patraa et al., 2018). Multiple years of data are needed for this study, and Landsat 5 TM data is available for free in Bangladesh. The data for this analysis was obtained from the United States Geological Survey's website (USGS) (http://glovis.usgs.gov/).

Table 1: Details of Landsat data collection

Date of image	Satellite/sensor	Reference system Path/Row
15-05-1996	Landsat 5 TM	Path 137, Row 44
30-05-2007	Landsat 5 TM	Path 137, Row 44
28-05-2018	Landsat 8 TM	Path 137, Row 44

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

Landsat 5 TM data has seven bands including thermal band which is used as six visible and infra-red bands are used for preparing LULC and emissivity and indices extraction.

Based on the USGS-LULC classification scheme, four major LULC classification forms were described in this research review. These were grouped into 5 categories: (1) Agriculture (2) Built-up area (3) Water bodies (4) Vacant Land and Others. When integrated with GIS, remote sensing improves the accuracy land use classification and change over time (Richards, 1993). ERDAS Imagine 14 with Maximum Likelihood Algorithm has been used for supervised classification, and Google Earth was used to almost double land cover styles.

Land Use /Land Cover Change (LULC) Analysis

Using photographs from 1996, 2007, and 2018, a time-series study is performed to assess the rate of change in urban green space. ERDAS Imagine 14 and Arc GIS 10.5 were used for this study. Satellite imagery and spatial analysis were used in this study, with image processing, image classification, accuracy evaluation, and change detection being the four main measures.

The water body and annual rate of green space changes were estimated using the formula below, and vegetation and cultivated lands were considered green spaces in this analysis (Byomkesh, Nakagoshi and Dewan, 2012):

Change rate of green spaces and water body = $(UA_{i+n} - UA_i)/n$ ……………………….(1)

where n is the length in years of the interval being assessed, UA_{i+n} is the green space area at time i+1, and UA_i is the green space area at time i.

In ERDAS imagine 14, a spatial analysis was performed to analyze change detection in order to determine the change area from the various land covers created.

To begin, land use maps from three separate years 1996, 2007 and 2018 were created, and all image class attributes were collected.

Trends of Urban Growth

According to UN estimates, a small decrease in Bangladesh's rural population begins after 2015, accelerates after 2020, and results in a 15.5 million reduction in the rural population between 2020 and 2050. (Figure 1). Although there is a large margin of error in these estimates and forecasts, the main point is that, from now on, the entire rise in Bangladesh's population (which could total 52 million over the 40-year period between 2016 and 2046) would almost certainly have to be accommodated in urban areas. And if the rural population declines as projected, the increase in the urban population will be even larger than the increase in Bangladesh’s total population.

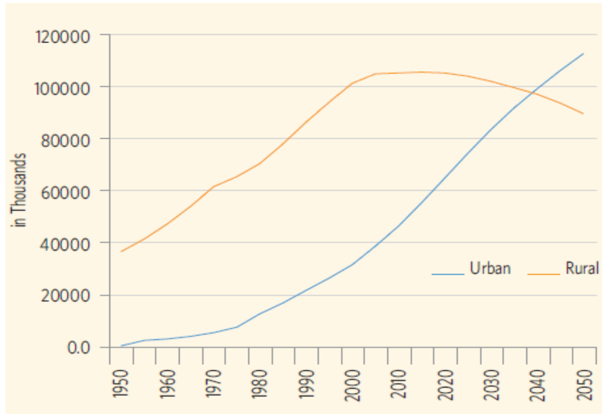

Figure 1: Urban and Rural Population Growth

Source: United Nations, Population Division, 2014

Urban areas, on the other hand, cause serious changes in conservation and efficiency patterns, particularly in land usage, water, energy, and other natural resources.

Urban Growth in Savar

Savar's first urban construction took place on the Dhaleswari River's northeast side, and the small township was situated between Namabazar and Savar Thana (Figure 2). To the north, east, and south, the land was mostly rural or marshy. According to the 1972 thematic map, approximately 14,580 hectares (58%) of the total land area in Savar was agricultural, and 6954 hectares (27%) was lowland (Table 2). All of this growth has boosted the price of land in Savar. (Sharif and Esa, 2014; Amin, 2009). According to a Savar land cover map, the built-up area increased by 211 %between 1972 and 1980, while population increased by 92 % (estimated from the 1974 to 1981 census) (Hasan and Southwort, 2017).

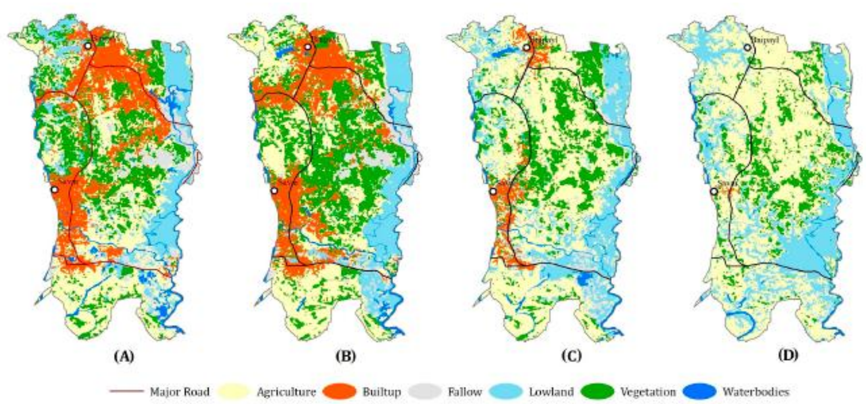

Figure 2: Land use/land cover map of Savar from 1980 to 2015. Map: (A) 2015; (B) 2000; (C) 1990; and (D) 1980

Source: Developed by the Author, 2018

Table 2: Statistics for each land cover class, as well as overall and annual increase/ decrease rates in Savar (Unit Hectare and %)

Savar	1972	1980	1990	2000
Agriculture	14,580	14,764	14,265	13,043
Build-up	40	93	628	628
Water Body	7543	7245	7057	6147
Vegetation	3186	3186	4267	4572

Source: Hasan and Southwort, 2017

The pattern of Savar's urbanization persisted in the following years, but at a much faster pace than before. For example, Savar's overall urban growth between 1990 and 1995 was approximately 325 percent, with an annual increase of 325 percent.

Savar had 131,429 residents in 1974 (BBS, 1974), on the other hand, the proposed development of a number of large-scale industrial zones, such as the Dhaka Export Processing Zone in Dhamsona in the early 1990s and heavy industrial units in Nayarhat in the mid-1970s, placing Savar into urban growth pressure. The population increased as a result, owing primarily to a massive influx of rural migrants finding jobs in Savar's increasing land price (Amin, 1991 and Islam, 1996).

Population

According to the Census Report 2001, total population of Savar Municipality was 143301. But according to the 'Bangladesh Pourashava National Data Base, Savar Pourashava, 2005, General information section', the total population of Savar Municipality is 1,59,012 where 89,686 are male and 76,325 are female. According to the BBS Census Report 2011, total population of Savar Municipality was 2,86,008.

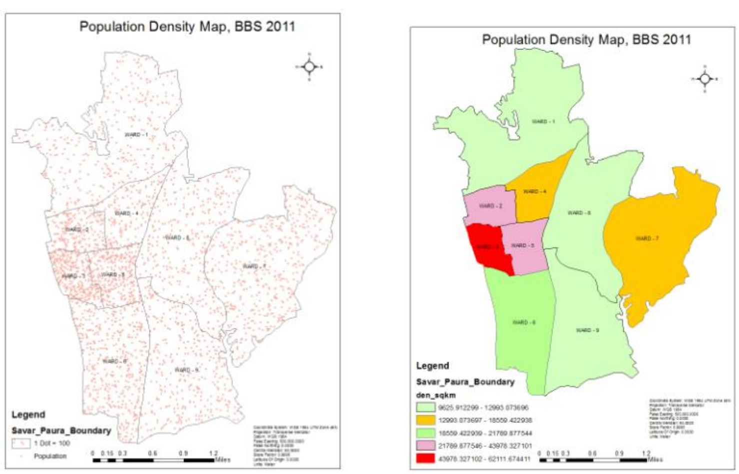

Figure 3: Population Density Map of Savar Municipality

Source: BBS 2011

Land Use Change

Dhaka-Aricha road is passing through the pourashava which divided the pourashava in two parts. The western part comprising of Ward-1, 2, 3, 4, 5 & 6 and eastern part is composed of 7, 8 & 9. Lad use pattern is guided by the major roads and consequently by major infrastructure.

Table 3: Land Use Changing Pattern in Savar Pourashava, 1974- 2001

Land Use Pattern	Land Area in Acre				Land Use Change in (Percent)		
	1974	1981	1991	2001	1974-1981	1981-1991	1991-2001
Housing and Settlement Area	173	264	439	742	52.60	66.29	69.02
Cropped Land	2264	2202	1923	1662	-2.74	-12.67	-13.57
Orchards	416	344	264	148	-17.31	-23.26	-43.94
Commercial Area	7	8	14	46	14.29	75	69.57
Industrial Area	43	51	66	114	18.60	29.41	72.73
Fallow Land	420	404	551	501	-3.81	36.39	-9.07
Water Bodies	87	84	79	55	-3.45	-5.95	-30.38
Roads	44	87	147	237	97.73	68.97	61.22
Others	240	250	211	189	4.17	-15.6	-10.42

Source: Masud, 2008

From 1974 to 2001, there appeared a significant change in the landscape features in Savar Pourashava in relation to the types and pattern of land use. The agricultural land decreased from 72.56 percent (together with orchards) to 59.21 percent between 1974 and 2001; while housing and settlement land use increased in a visible manner. The share of housing and settlement area has accommodated for 20.09 percent of the total land area in 2001 over the area of 4.68 percent in 1974 (Masud, 2008).

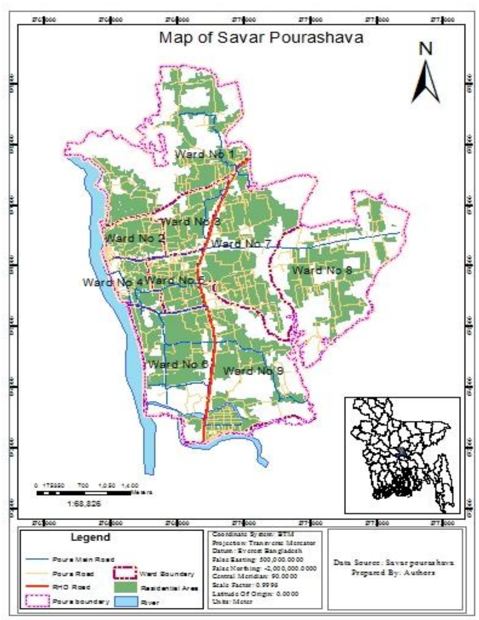

Figure 4: Map of Study Area

Study Area

According to the Census Report 2001, the population growth rate of the Municipality was 2.1%. But according to the 'Bangladesh Pourashava National Data Base, Savar Pourashava, 2005, General information section', total population growth rate of Savar Municipality is 2.3%. But now it is almost 4 %

and it is medium growth rate. According to the Census Report 2001, with only 14.08sq.km area the population density of the Municipality was 8000/sq.km. But at 2005, according to the 'Bangladesh Pourashava National Data Base, Savar Pourashava, 2005, General information section', the population density of

Savar Municipality is 11243/sq.km which is comparatively very high to the national density of 972 per sq. km. According to BBS 2011 census the total population of savar pourashava is 286007 and the number of household is 74515. The population density is 20,313.

Results and Discussion

Accuracy Assessment and Validation of Land Use Classification

Accuracy assessment is an important part of land-use mapping, not just for determining map quality and reliability, but also for determining thematic ambiguity and its possible consequences for the end user (Balcik and Göksel 2005). Thematic map accuracy is determined by a number of variables, including classification, mapping unit, and image quality, and can contain errors that must be quantified. The degree to which the attributes of the map agree with the truth reference dataset is represented by the accuracy (Congalton and Green, 2009). The precision of the classification was determined using the kappa statistic and the error matrix in this analysis. The number of correctly classified image sampling units is shown in the diagonal of an error matrix (Jensen, 1986). Select N+1 points per class if each measurement vector has N attributes, and the realistic minimum is 10*N per class (Akoso, 2013). Equations (2), (3), (4) and (5) is used to arrive at kappa statistics (Congalton and Green, 2009).

User's Accuracy in class i = $\frac{n_{ij}}{n_i}$ …………………… (2)

Producer's Accuracy in class j = $\frac{n_{ij}}{n_j}$ …………………………. (3)

Overall Accuracy = $\frac{\sum_{i=1}^{k} n_{ij}}{n}$ …………………………. (4)

Kappa Coefficient = $\frac{n\sum_{i=1}^{k} n_{ij} - \sum_{i=1}^{k} n_{i.}\, n_{j.}}{n^2 - \sum_{i=1}^{k} n_{i.}\, n_{j.}}$ …………………………. (5)

Where k denotes the number, and nomenclature denotes the map nomenclature to be used 1, 2, . . . , k; n_{ij} = number of sample units belonging to class i in the map and class i in the reference 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).

Table 4 shows the error matrix and overall accuracy study for classified images from 1996, 2007, and 2018.

Table 4: Accuracy Assessment for Land Cover 1996, 2007 and 2018

Year	1996		2007		2018	
Class Name	PA %	UA %	PA %	UA %	PA %	UA %
Agri/Green space	70.27%	83.87%	64.00%	80.00%	88.89%	94.12%
Water body	87.50%	76.36%	77.78%	75.68%	80.95%	94.44%
Built up area	73.68%	100.00%	84.00%	84.00%	84.31%	84.31%
Vacant Land	89.29%	83.33%	83.78%	79.49%	90.00%	85.14%
OCL	82.50%		80.63%		86.88%	
OKS	0.7537		0.7177		0.8039	

Source: USGS and Author's calculation, 2018

PA = Producer Accuracy; UA = User Accuracy; OCA = Overall Classification Accuracy; OKS = Overall Kappa Statistics

The reference data research sample was drawn at random from this land cover chart and double-checked with a Google Earth map. Overall Classification Accuracy is 82.50 percent, and Overall Kappa Statistics is 0.7537, which indicates substantial agreement. The highest producer accuracy is 89.29 % for vacant land, followed by 70.27 % for green space, 87.50 % for water body, and 73.68 % for built up area. However, the class "Built up area" has the highest user accuracy, at 100 %. The class Water body has the lowest accuracy of 76.36 % in this scenario.

Overall Classification Accuracy for the classified picture 2007 is 80.63 %, and Overall Kappa Statistics is 0.7177, indicating substantial agreement. The producer accuracy for the class "Built up area" is 84.00 %, followed by Green space 64.00%, Water body 77.78%, and vacant 83.78%.

The overall accuracy of the 2018 classified image is 86.88 %, with a Kappa statistic of 0.8039. The highest producer accuracy is 90 % for the class "vacant," followed by 88.89 percent for green space, 80.95 % for water body, and 84.31 % for built up area. It means that others have the best chance of correctly classifying a reference location. However, in the user accuracy, class "water body" has the highest which is 94.44%.

Investigation of Land Use Dynamics

Spatial Variation of Land Use Change during 1996, 2007 and 2018

Land use change during 1996 to 2018 in agriculture, build- up area, vacant land and especially in water body varies significantly in different time.

Table 5: Land use change during 1996, 2007 and 2018

	Land use in February, 1996		Land use in March, 2007		Land use in March, 2018	
Land Use/Land Cover Class	**Land Use (In Hectare)**	**(%)**	**Land Use (In Hectare)**	**(%)**	**Land Use (In Hectare)**	**(%)**
Agriculture	589.14	34.75	412.44	24.55	204.66	12.23
Built-up area	628.2	37.05	610.92	36.36	933.59	55.81
Water Body	183.96	10.85	102	6.07	12.74	0.76
Vacant land	294.3	17.36	184	10.95	17.19	1.03
others	--	--	370.64	22.06	504.63	30.17

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

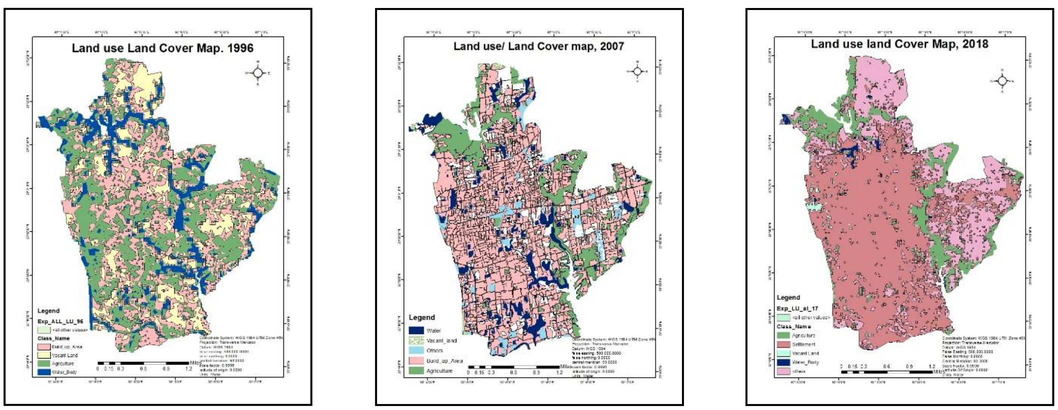

Figure 5: Land Use Map during 1996, 2007 and 2018 in Regional Scale (March)

Source: Developed by the Author, 2018

Land Use Change Comparison

In the study area land use has changed drastically from 1996 to 2018 especially from 2007 to 2018. Below figure shows the changes in land use 1996 to 2018 in a comparative perspective. In the last 20 years the areas of the built-up spaces has increased drastically and massive decrease has been evident in the vegetated, water and agricultural areas. The largest area change appeared in built-up cover with an increase of 305.39 hectare from 628.2 hectare in 1997 to 933.59 hectare in 2018. This wider variation in urbanized area illustrates that the municipality experienced rapid urbanization during those two decades. Meanwhile, the area of agricultural land was found to obvious decreases of 384.48 hectare from 589.14 hectare in 1996 to 204.66 hectare in 2018.

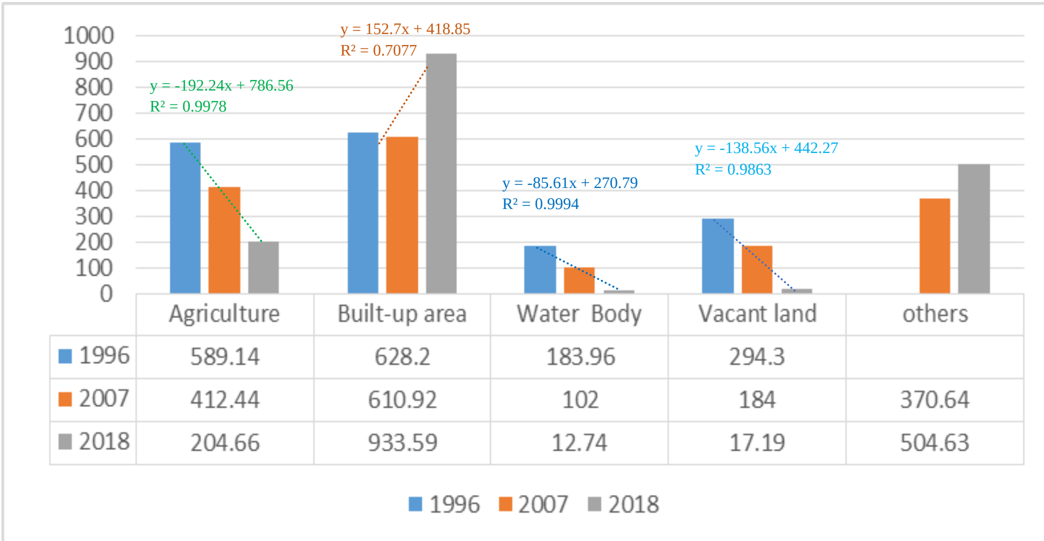

Figure 6: Land Use Change Comparison during 1996, 2007 and 2018

Source: Developed by the Author, 2018

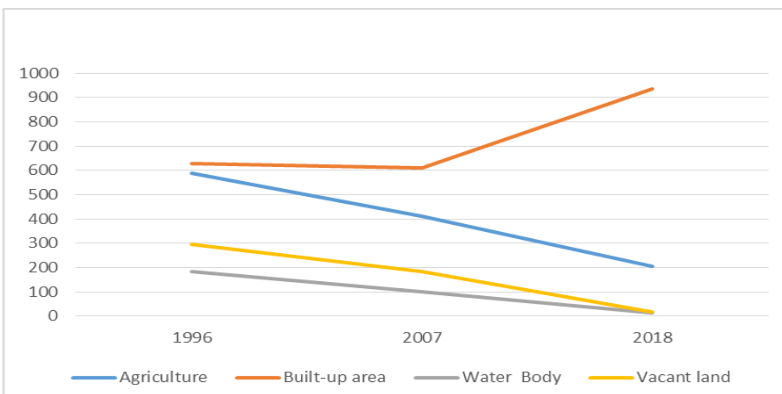

Figure 7: Land Use Change during 1996, 2007 and 2018

Source: Developed by the Author, 2018

The largest area change appeared in water body with a decrease of 171.22 hectare from 183.96 hectare in 1996 to 12.74 hectare in 2018. The area changes in agriculture and water body in this 20 years period were partly due to conversion of agriculture to built-up and water body to build up area. In addition other like bare soil and vacant land has been significantly replaced with built-up area and some replaced in agricultural land.

So it proves that a clear indicator of change in land use and it has undoubtedly potential impact on the change of urban climate and natural flow routes.

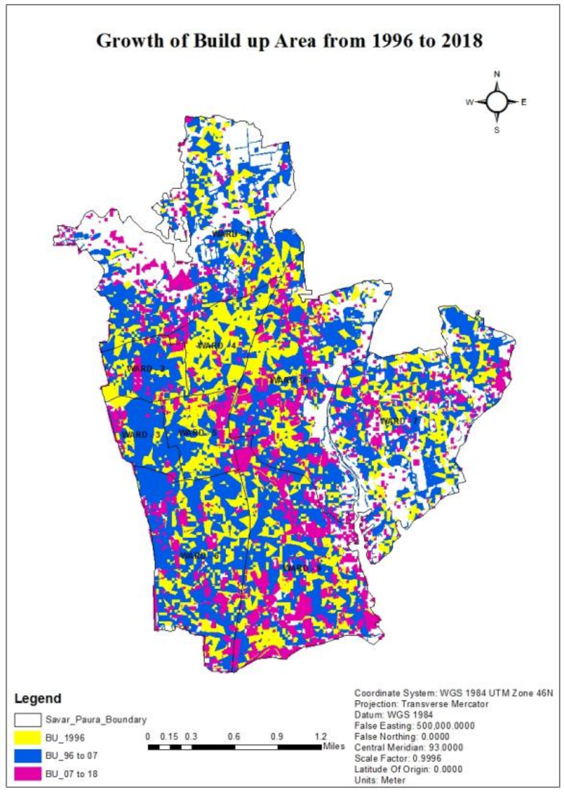

Figure 8: Growth of Buildup area during 1996, 2007 and 2018

Source: Developed by the Author, 2018

The above figure 8 shows the build up area in Savar pourashava and in ward 1, ward 2, ward 3, ward 6, ward 7 and ward 9 have occurred in greater scale in terms of settlement during the 1996 to 2007. According to area statistics derived from land use maps, urban development in those wards increased significantly from 628 hectares in 1996 to 933 hectares in 2018, with a cumulative growth rate of about 300 hectares (Table 5). This rate of built-up growth is significantly higher than in any other metropolitan area. This expansion can be due to the region's economic development and expansion, as well as human population increase.

Later the Buildup area in ward 1, ward 8 and ward 9 have occurred the greater change of settlement during the 2007 to 2018.

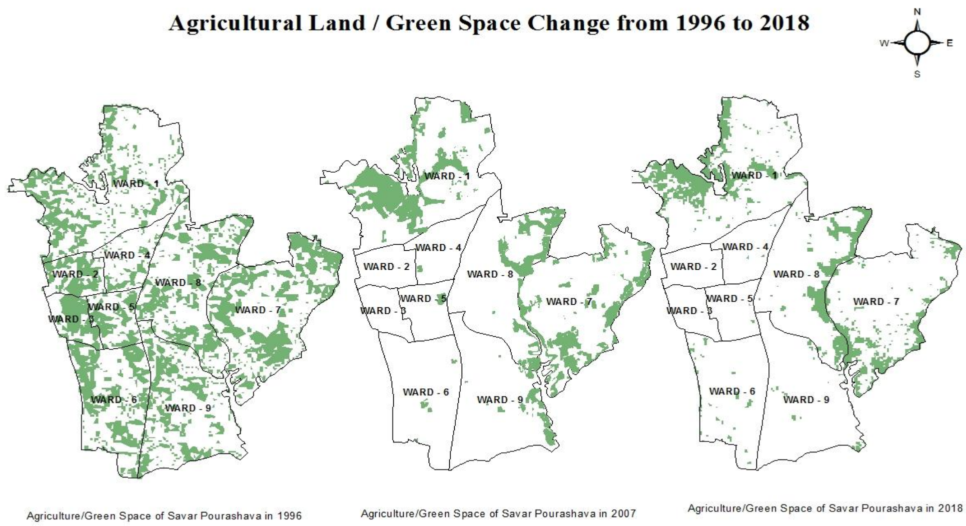

Figure 9: Agricultural Land/Green Space Change during 1996 to 2018

Source: Developed by the Author, 2018

According to the region statistics obtained from the land use maps, agricultural land loss in wards 2, 3, 4, 6, and 5 decreased significantly from 589 hectares in 1996 to 412 hectares in 2007, a total decrease of around 167 hectares (Table 5). The decrease can be attributed to the region's industrial development and expansion, as well as human population increase.

Later the water bodies in ward 7 and ward 9 have changed during the 2007 to 2018 due to the conversion of agriculture to settlements.

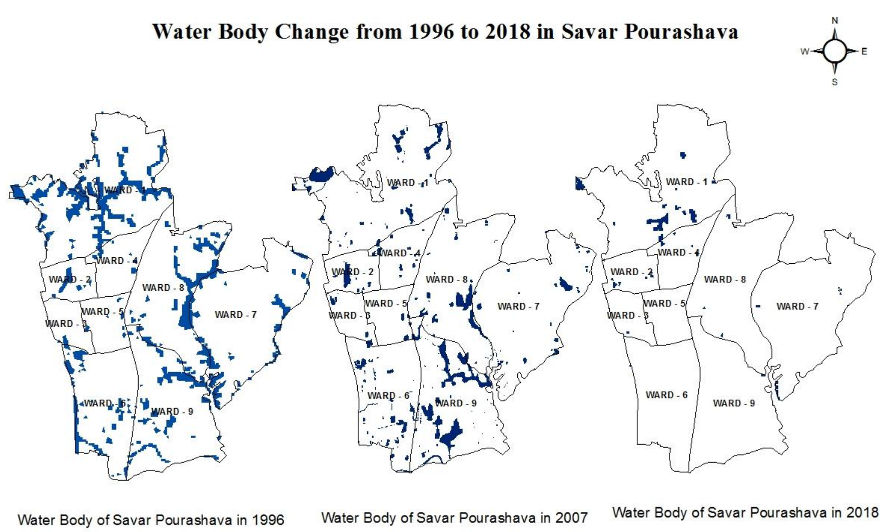

Figure 10: Water Body Change during 1996 to 2018

Source: Developed by the Author, 2018

According to figure 6.8 of the land use charts, water body loss in wards 1, 3, 4, and 5 decreased significantly between 1996 and 2007, from 183 hectares in 1996 to 102 hectares in 2007, a cumulative loss of around 80 hectares (Table 5). The decrease can be due to the region's expansion and human population increase.

The water body in ward 9 was decreased during the 2007 to 2018 due to the conversion of water body to settlements.

Relation of Land Use Change with Indices during 1996 to 2018

Correlation with NDBI was found 0.36 which was a positive relation that means higher the NDBI values, average higher the buildup area in May, 1996.

Table 6: Correlation between LU and Indices from 1996 to 2018

	1996	2018
Land use change (Build Up Area)	Correlation with Indices	Correlation with Indices
	NDBI	NDBI
	0.36	0.6

Source: Developed by the Author, 2018

Above the table showing that higher the NDVI, higher the buildup area. Built-up areas and relevant classes with high NDBI Values in May, 2018 had higher build up area.

Causes behind the Land Use Change in Savar Pourashava

The reciprocal relationship between man and the environment influences land use patterns.

Land use patterns are influenced by a variety of factors. Human alteration of the Earth's land surface such as land cover and land use changes are among the most important (Lambin, 2001). Land value also influences the use of individual land parcels. For a specific usage, a specific region may have a greater benefit (Hafiz, 2002). Individual land managers' decisions have repercussions for land use reform. Environmental and socio-economic impacts of land use transition are narrowly classified, with the former receiving more recognition and coverage than the latter. One reason for this disparity in attention may be that the latter are more suitable, have a longer time horizon, and are subject to the effect of far more complexes, as well as being less visible and verifiable than the former.

The following are the main reasons for Savar Municipality's land use changes (source: FGD, 2018):

- Migration
- Occupational variation
- Income distribution pattern
- Improved Education
- Changes Land value
- Available basic services

- House rent system
- Rental situation of different areas
- Reduced agricultural production etc.

Recommendations and Conclusion

To protect the water body and urban greenery or agricultural land this research is focused on some selected rules regulation which should be effective to control the natural water body and urban green space in urban area in Bangladesh. These are:

Mega city, Divisional Town and District Town's municipal areas including country's all the municipal areas' playground, open space, park and natural water reservoir Conservation Act, 2000,

Section 5 of this Act: *Obligation to change classes of playground, open space, park and natural water body*

section 6 and section 8: *The person will be penalized as either not more than 5 years in jail or not more than 50 thousand tk or the both.*

Savar Paurashava should follow this act strictly.

Water Act 2013

The passed Water Act 2013 is focused on Bangladesh's National Water Policy and is intended to promote the integrated production, management, extraction, distribution, use, preservation, and conservation of water resources. This act should be followed by the Paurashavara government.

The Paurashava Master Plan

Savar Paurashava has prepared a Master Plan which was approved by the government. Total 69 ponds, 4 khals and 1 river area is identified by the Pourashava and these should be reserved as natural area. No action or effort is taken by the Paurashava to protect and conserve of these water bodies in the study area.

The *Urban and Regional Planning Act 2013*

This act will ensure the urban land use management with balancing the economic growth according to section 12 (1) of the act. But if any violation of any activities of it the punishment will be as imprisonment of minimum one year and maximum five year and the monetary fine of minimum five lac taka to maximum fifty lac taka under the section 20 (1).

Private Residential land Development Rules, PRLD 2004

In Section 6 there is clear statement that all the water bodies should be kept under natural flow and should not be converted it to as residential land. In Sub-Section 9(3), there is also the clear evidence to protect the water bodies in private residential land development rules.

The above stated rules regulation is quite enough to protect the water body and urban green space in any urban area but there should ensure the regular practice by the rules and law enforcing authority and lastly should be ensure the law and rules administration in the urban local authority.

Conclusion

In the urban sense, water bodies and urban green spaces serve a variety of purposes that improve people's quality of life. The ecological benefits provided by water bodies and green spaces, which range from biodiversity protection to climate change mitigation, must not be ignored in today's sustainable planning. Water bodies and green spaces also aid in the successful reduction of energy costs associated with cooling buildings. Furthermore, water bodies and green spaces raise property value due to their aesthetic and amenity. However, the social and psychological advantages of water bodies and green spaces in cities are the most sought after. Water bodies and green spaces must be evenly dispersed in the city, and the total area covered by water bodies and green spaces must be sufficient to meet the needs of the city's population. Cities absorb the vast majority of the world's wealth and house the vast majority of the world's population. Including a body of water and green space in the urban landscape can promote and facilitate a healthy relationship with the environment while also supporting essential services. Water bodies and green space reflect habitats and ecosystems.

References

Ahmed, M. and Rahman, M. M. (2020). "Local Climate Change Governance and Making Climate Resilient Town: The Role of Local Authorities." *Research and Reviews: Journal of Architectural Designing,* 2(1), 1–13. http://doi.org/10.5281/zenodo.3901378.

Akther, F. and Rahman, M. M. (2015). "Expansion of Real Estate Development and Its Consequences on Land Use and land Price in Secondary Cities: A Case Study on Comilla City Corporation," *Jahangirnagar University Planning Review*, ISSN 1728-4198, Vol. 13, June 2015, pp. 101 - 112.

Akoso, T. (2013). Remotely Sensed Image Classification: Supervised Classification Algorithm Using Envi 5.0 Software, University Of Lagos.

Amin, A. (1991). Dhaka's Informal Sector and its Role in the Transformation of Bangladesh Economy; Ahmed, S.U., Ed.; Dhaka Past Present Future; The Asiatic Society: Dhaka, Bangladesh, 1991; pp. 446–470.

Amin, S. M. N., Dewan, A. M. and Kabir, M. H. (2008). Urban Development and Environmental Degradation: the Case of Dhaka Metropolitan, Bangladesh. In: Annual Meeting of the Association of American Geographers, Boston, MA, USA, 15–19 April, 2008.

Amin, S. R. (2009). "A Study on Land Value of Savar Municipality."Master's thesis, Bangladesh University of Engineering & Technology, 2009.

Bangladesh Bureau of Statistics (BBS), (1974). Bangladesh Population Census; Dacca District; Government of Bangladesh: Dhaka, Bangladesh, 1974.

Bangladesh Bureau of Statistics (BBS), (1983). Bangladesh Population Census 1981; Government of Bangladesh: Dhaka, Bangladesh, 1983.

BBS. (2011). Population Census-2011, Community Series 2011, Zila: Dhaka. Bangladesh Bureau of Statistic, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. Bangladesh. Retrieved from www.bbs.gob.bd/webtestapplication/userfiles/image/census 2011.

Balcik, F. B. and Göksel, C. (2005). Remote sensing and GIS integration for land cover analysis, a case study: Bozcaada Island. Water science and technology: a journal of the International Association on Water Pollution Research. DOI: 10.2166/wst.2005.0411 Retrieved From https://www.researchgate.net/publication/7645404_Remote_sensing_and_GIS_integration_for_land_cover_analysis_a_case_study_Bozcaada_Island

Biswas, M. R. U. I., Rahman, M. M. and Akther, F. (2016). "An Aproch to Implement Master Plan in the Urban Local Government of Bangladesh: A Case Study on Phulpur Municipality," *Jahangirnagar University Planning Review*, ISSN 1728-4198, Vol. 14, June 2016, pp. 97 - 112.

Briassoulis, H. (2009). Factors influencing land-use and land-cover change. UNESCO Encyclopaedia Life Support Syst. 1, 126–146.

Byomkesh, T., Nakagoshi, N. and Dewan, A. M. (2012). Urbanization and green space dynamics in Greater Dhaka, Bangladesh. *Landscape Ecological Engineering (2012).* 8:45–58. DOI: 10.1007/s11355-010-0147-7

Chowdhury, A. M., Faruqui, S. (1989). Physical growth of Dhaka City. In: Ahmed SU (ed) Dhaka: past, present and future. The Asiatic Society of Bangladesh, Dhaka, pp 43–61

Chakrabarty, A., Rahman, M. M. and Ubaura, M. (2020). "Assessment of Emergency Evacuation Preparedness for Seismic Hazard in an Urban Area" in the 17th World Conference on Earthquake Engineering, 17WCEE, Sendai, Japan - September 13th to 18th 2020, pp. 6h-0004, 1-9. Sendai, Japan. Available at https://www.researchgate.net/publication/344407256_Assessment_of_Emergency_Evacuation_Preparedness_for_Seismic_Hazard_in_an_Urban_Area.

Congalton, R.G.; Green, K. (2009). Assessing the Accuracy of Remotely Sensed Data: Principles and Practices, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2009.

Dewan, A. M. and Yamaguchi, Y. (2008). Effect of land cover change on flooding: example from Greater Dhaka, Bangladesh. *Int J Geoinform* 4(1):11–20.

Dewan, A. M., Islam, M. M., Kumamoto, T. and Nishigaki, M. (2007). Evaluating flood hazard for land-use planning in Greater Dhaka of Bangladesh using remote sensing and GIS techniques. *Water Resour Management.* 21(9):1601–1612.

Franco, S., Mandla, V.R., Rao, K. R. M., Kumar, M. P. And Anand, P.C. (2015). Study of Temperature Profile on Various Land use and Land cover for Imerging Heat Island. *Journal of Urban and Environmental Engineering*, v.9, n.1, p.32-37. doi: 10.4090/juee.2015.v9n1.032037.

Foley, J. A., De Fries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., et al. (2005). Global consequences of land use. *Science 309*, 570–574. doi: 10.1126/ science.1111772

Gan, M., Deng, J., Zheng, X., Hong, Y., and Wang, K. (2014). Monitoring Urban Greenness Dynamics Using Multiple End member Spectral Mixture Analysis. PLoS ONE 9(11): e112202. doi:10.1371/journal.pone.0112202

Hafiz, S.E. (2002) Role of Rice on Land Use Change. Khulna, Khulna University, Bangladesh.

Hasan, M. R., Uddin, M. K., Rahman, M. M. and Kauser, M. R. H. (2020). "Analysis of Access to Water: A Case Study on Some Selected Slum Areas of Chittagong City." *The Jahangirnagar Review, Part II: Social Sciences*, Vol. XLII, 2018, ISSN 1682-7422, pp. 295-310.

Hasan, M. M. and Southwort, J. (2017). Analyzing Land Cover Change and Urban Growth Trajectories of the Mega-Urban Region of Dhaka Using Remotely Sensed Data and an Ensemble Classifier. Sustainability. Retrieved on 02/05/2019 from https://pdfs.semanticscholar.org/33ee/b919602310b7997a74584da5bd207fe345ba.pdf

Hassan, M. M. and Nazem, M. N. I. (2015). Examination of land use/land cover changes, urban growth dynamics, and environmental sustainability in Chittagong city, Bangladesh. *Environ Dev. Sustain. (2016).* 18:697–716. DOI 10.1007/s10668-015-9672-8.

Haq, S. M. A. (2011). *Urban Green Spaces and an Integrative Approach to Sustainable Environment*. Journal of Environment Protection, Vol. 2 No. 5, July 15, 2011. Retrieved on July 11, 2018 from http://www.urge-project.org.

Herzele, V., and Wiedeman, T. (2003). A Monitoring Tool for the Provision for Accessible and Attractive Green Spaces, Elsevier Sciences: Landscape and Urban Planning, (Vol. 63, No. 2, pp. 109-126). doi:10.1016/S0169-2046(02)00192-5

Huang G, Chen Y (2002). Ecocity: theory and design approach. Science Press, Beijing (in Chinese)

Islam, N. (1996). Dhaka from City to Megacity: Perspectives on People, Places, Planning and Development Issues; Urban Studies Program, Department of Geography, University of Dhaka: Dhaka, Bangladesh, 1996.

Islam, N. (2005). Dhaka now: contemporary development. The Bangladesh Geographical Society, Dhaka.

Jensen, M.C. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. The American Economic Review, 76, 323-329.

Koellner, T., and Scholz, R. D. (2008). Assessment of land use impacts on the natural environment. *Int. J. Life Cycle Assess*. 13, 32–48. doi: 10.1007/s11367- 006-0292-292

Kong, F. and Nakagoshi, N. (2006). Spatial-temporal gradient analysis of urban green spaces in Jinan, China. Landsc Urban Plan 78:147–164

Lambin, E. F. (2001).Remote Sensing and GIS Analysis. In international Encyclopedia of the social and behavioral science, New York.

Li, W., Du, Z., Ling, F., Zhou, D., Wang, H., Gui, Y., et al. (2013). A comparison of land surface water mapping using the Normalized Difference Water Index from TM, ETM+ and ALI. Remote Sens. 5, 5530–5549. doi: 10.3390/rs511 5530

Lillesand, T.M. and Kiefer, R.W. (1996). *Remote Sensing and Image Interpretation.* John Wiley & Sons, Inc. 3rd Edition.

Mabuhay, J., Isagi, Y. and Nakagoshi, N. (2005). Ecological indicators of biodiversity in tropical urban green spaces. WSEAS Trans Environ Dev 1:85–91

Mahmud, H., Rahman, M. M. and Sharmin, S. (2020). "Urbanization Impact on Wetlands: A Case Study on Dhamrai Paurashava." *The Jahangirnagar Review, Part II: Social Sciences*, Vol. XLI, 2017, ISSN 1682-7422, pp. 277-291.

Mahmud, S. H. (2018). An unpublished BURP thesis on Urbanization Impact on Wetland: A Case Study on Dhamrai Paurashava. Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka – 1342.

Masud, M. B. 2008. Land Use Change in Savar Municipality: 1974-2001. An Unpublished BURP Thesis, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka.

Moniruzzaman, M., Thakur, P.K., Kumar, P., Ashraful Alam, M., Garg, V., Rousta, I., Olafsson, H. (2020). Decadal Urban Land Use/Land Cover Changes and Its Impact on Surface Runoff Potential for the Dhaka City and Surroundings Using Remote Sensing. Remote Sensing. 2021, 13, 83. https://doi.org/10.3390/ rs13010083.

Nakagoshi, N., Watanabe, S. and Kim, J. E. (2006). Recovery of green resources in Hiroshima City after World War II. Landsc Ecol Eng 2:111–118

Patraa, S., Sahoob, S., Mishra, P., Mahapatrac, S. C. (2018). Impacts of urbanization on land use /cover changes and its probable implications on local climate and groundwater level. *Journal of Urban Management.* 7 (2018), pp. 70-86. https://doi.org/10.1016/j.jum.2018.04.006.

Phan, D. U. and Nakagoshi, N. (2007). Analyzing urban green space pattern and eco-network in Hanoi, Vietnam. Landsc Ecol Eng 3:143–157

Rahman, M. H. (2002). *Urbanization and Urban Social Services in Bangladesh.* Dhaka, Bangladesh: Ananya Publishers.

Rahman, A., Kumar, S., Fazal, S., and Siddiqui, M. A. (2012). Assessment of land use/land cover change in the North-West district of Delhi using remote sensing and GIS techniques. *J. Indian Soc. Remote Sens*. 40, 689–697. doi: 10.1007/ s12524-011-0165-164

Rahman, M. M. (2012). “An Investigation into Urban Water Quality: A Focus on Savar Pourashava,” Ja*hangirnagar University Planning Review*, ISSN 1728-4198, Vol. 10, June 2012, pp. 127-138.

Rahman, M. M., Tariq, A. A. and Sharmin, S. (2021). “Earthquake Resilience at District Level Hospital in Bangladesh: Tactic of Non- Structural Elements and Social Awareness” in the 1st Croatian Conference on Earthquake Engineering, 1CroCEE, Zagreb, Croatia, 22 - 24 March 2021, pp. 187 - 198, Zagreb, Croatia. Available at https://crocee.grad.hr/event/1/overview.

Rahman, M. M., Tariq, A. A. and Sharmin. S. (2020). “Planning Intervention in Emergency Evacuation to Minimize Hazard Impact: A Case Study of Old Dhaka and Dhaka Export Processing Zone.” Journal of Earthquake Science and Soil Dynamics Engineering, 3(3), 1–16. http://doi.org/10.5281/zenodo.4305837.

Rahman, M. M., Rahman, A., Satu, S. A., and Sharmin. S. (2020). “Locational Attributes of Playgrounds in a City: Need Assessment Approach on Zone 2 in DNCC, Bangladesh.” *Journal of Research in Infrastructure Designing*, 3(1), 1–15. http://doi.org/10.5281/zenodo.3877989.

Rahman, M. M. and Akther, F. (2015). “Provisions and Violations of Setback Rules in Building Constructions: A Case Study of Savar Pourashava,” *The Jahangirnagar Review, Part II: Social Sciences*, Vol. XXXV, 2011, pp. 179 – 191.

Rahman, M. M. and Hosen, M. M. (2018). “Land use - Temporal Pattern Analysis of Urban Heat Island by Using Remote Sensing: A Case Study on Pabna Municipality,” *Pabna University of Science and Technology Studies*, Volume 03, 2018, pp. 1-7.

Rahman, M. M., Hossain, S. M. and Miti, S. S. (2019). “The Deterioration of Water Bodies in Savar Municipality & Impact upon the Natural Drainage and Flow Routes.” *International Journal of Advanced Research in Innovative Discoveries in Engineering and Applications* [IJARIDEA], Vol.4, Issue 3, 27 June 2019, pg. 7-13.

Rahman, M. M., Akther, F., Satu, S. A. and Sharmin, S. (2020). “Geographic Information System (GIS) based Approach in Delineation of Efficient Natural Flow Routes for Drainage Plan of a Municipality”. *International Journal of Research Publications*. Volume-50, Issue-1, April, 2020. DOI: 100501420201045. http://ijrp.org/paper-detail/1046

Rahman, M. M. and Cornia, M. H. (2020). “Urban Green Space Shrinking in Pabna Municipality, Bangladesh: Monitoring Approach by GIS and Remote Sensing.” *Jahangirnagar University Planning Review*, ISSN 1728-4198, Vol. 18, 2020.

Richards, J. A. (1993). Remote Sensing Digital Image Analysis. Berlin: Springer.

Sarker, S., and Rahman, M. M. (2018). “Trend Analysis of Bank Erossion of Jamuna River and Migration Impact: A Case Study on Teota Union of Shibalaya Upazila,” Journal of Bangladesh Institute of Planners, ISSN 2075-9363, Vol. 9, 2016, April 2018, pp. 81-93.

Sharif, M. S. and Esa, A. J. (2014). Dynamics of Land Price and Land use Change: A case Study of Savar Municipality, Bangladesh. Journal of South Asian Studies. J. S. Asian Stud. 02 (01) 2014. 83-89

Shafi, S. A. (2010). *National Building Code and Its Implementation.* Paper Presented at the Round Table Discussion on Implementation of National Building Code, National Press Club, Dhaka. Retrieved July 10, 2018, from http://www.blast.org.bd/content/key-note/national-building-code-29June.pdf.

Shawon, T. A., Mahmud, M. A., Rahman, M. M., Ubaura, M. and Rashied, M. (2021). “Evaluating Earthquake Vulnerability Using Analytical Hierarchy Process (AHP) and Social Appraisal of Retrofitting in Lalmatia, Dhaka” in the 1st Croatian Conference on Earthquake Engineering, 1CroCEE, Zagreb, Croatia, 22 - 24 March 2021, pp. 145 - 156, Zagreb, Croatia. Available at https://crocee.grad.hr/event/1/overview.

Song, X., Hansen, M. C., Stehman, S. V., Potapov, P. V., Tyunkvina, A., Vermote, E. F., et al. (2018). Global land change from 1982 to 2016. *Nature* 560, 639–643. doi: 10.1038/s41586-018-0411-9

Vitousek, P. M. (1997). Human domination of earth's ecosystems. Science 277, 494–499. doi: 10.1126/science.277.5325.494