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Trend in Changes of Land-use Pattern and Exploring the Driving Forces of Such Changes of Rangamati Paurashava between 1975 and 2016 years

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Abstract: Bangladesh now ranks fourth among Asian countries in terms of urban growth, with a pace of 4.8 percent from 2000 to 2011.RangamatiPaurashava's land use has changed as a result of rapid urbanization and population increase.Understanding and measuring the spatiotemporal dynamics of urban land-use changes and their driving causes is therefore critical for developing appropriate policies and monitoring tools for decision-making on urban growth.The major goal of this research is to look into the Rangamati Paurashava's urban expansion pattern. Thus, the objective of this study was to identify the changes that occurred in the land-use pattern of the study area between 1975 and 2016 and explore the driving forces of such changes involved. A GIS and remote sensing technique are used to classify and analyze land use, and a GIS technique is utilized to model land-use change.The collected maps and photos were sorted and categorised for analysis and interpretation based on the past trend of land-use changes (from 1975 to 2016).This study used a Landsat MSS/TM/ETM image and a Google image to create land-use classification.This research was carried out using a combination of GIS and remote sensing.These strategies were built in order to detect and assess changes in land-use classes.The first segment used satellite data and remote sensing techniques to create land-use maps using maximum likelihood supervised image classification for the research periods of 1975, 1988, 2005, and 2016.The study found that the proportions of settlement areas were increasing while vegetation continued to decline based on the results of remote sensing image categorization.The conversion of vegetative land to habitation areas in the Rangamati area could be linked to an increase in population and faster economic development.It is expected that this type of research will help to shape the city's urban form in a planned manner.So that, in the near future, Rangamati can be a lot more habitable and planned city.Change analysis of diverse land-use patterns within the city is critical for optimal management, allowing decision-makers and planners to take appropriate action.The land-use maps created as part of this project will aid in the creation of sustainable urban land-use planning decisions as well as the forecasting of future growth trends.

Keyword: GIS, Remote sensing, Satellite, Supervised image, Landsat, Sustainable

1. Introduction

In emerging countries, rapid urbanization has been a major issue in urban studies.Many countries in both the developing and developed worlds are facing issues as a result of rapid urbanization.At various stages, urban expansion is a complex process including the spatiotemporal changes of all socioeconomic and physical components. (Das,2016).Rapid and unplanned urbanization is putting cities' long-term viability at jeopardy (Dandapath, 2016).The dispersal of new development on isolated tracts separated from neighboring areas by vacant land is known as urban sprawl (Ottensmann, 1977).Needs for space Development in cities is closely linked to population increase, whether natural or as a result of immigration, and is accomplished by invading formerly undeveloped land outside of already packed cities.As a result, land-use change occurs, which is an unavoidable byproduct of economic activity.Part of the vulnerability of places and individuals to climatic, economic, and socio-political perturbations is determined by such changes. (Silas O. Rakama 2017).

Land-use change (LUC) is the transformation of a piece of land in general.This transformation is motivated by a need, which necessitates not just a change in land cover but also a change in intensity and management.Changes in land use are a serious problem that damages biodiversity and has a negative influence on human life. (Md. Shahidul Islam, 2011).

Land-use and environmental management and planning in metropolitan settings are affected by the dynamics of human land-use changes.As a result, simulating human land-use change is critical for assessing the social and environmental consequences of human activities.A significant amount of research has been done on the use of remote sensing and GIS to simulate land use around the world.It is critical to determine the degree of land-use changes in metropolitan settings where demand for land for varied purposes persists.This is necessary in order to spot patterns and determine the extent to which land-use types trade-offs exist between different land-use applications. The use of remote sensing and GIS tools to map land-use changes has yielded some surprising results as well as policy recommendations for long-term land management. (Divine Odame Appiah, 2015).

Human activities ranging from land-uses have had significant impacts on the urban environment, according to his study on urban land-use.As a result, land-use change analysis is critical for determining the interconnections between the drivers and effects of land-use change.This is due to the fact that they have long-term consequences for environmental management (Divine Odame Appiah, 2015).In the Rangamati district, urban migration from the main city centers to areas closer to the district has resulted in a rise in the infrastructure of developed and bare land, as well as concrete land-use surfaces in the district's south-eastern section.

A multi-sectoral analysis of the key driving forces of land-use change is also included in this study.An analysis of spatial processes and policies affecting land-use was developed as part of the design phase for a new land-use model for the Rangamati town. For each of the biggest land-occupying industries, the summary was based on certain sector-specific research efforts into the driving drivers of land-use change (Economic, Social, and Industrial, Cultural, Environmental and Land-use policy).Each study project had a similar setup, with a top expert in charge of writing a note on driving forces for a specific industry, as well as input from leading experts via workshops to gather perspectives and insights from the field. The primary drivers for the various industries were discussed using underlying research in this study.

The primary difficulties to be solved in the development of a new land-use model were identified based on insights into the main and impending driving forces. (Zondag, 2009).

For analyzing the geographical and temporal dynamics of LULC, Geographic Information Systems (GIS) and remote sensing (RS) are strong and cost-effective technologies.Remote sensing data give rich multi-temporal information on LULC change processes and patterns, and GIS may be used to map and analyze these trends (Zhang, 2002).Furthermore, satellites provide retrospective and consistent synoptic coverage, which is particularly beneficial in places where change has been rapid.Furthermore, because digital archives of remotely sensed data allow for past LULC changes to be studied, the spatial pattern of such changes in relation to other environmental and human causes may be assessed. (Ashraf M. Dewan 2009).

To examine variations in LULC using satellite data, a number of change detection algorithms have been developed, with pre- and post-classification comparisons being widely employed.Procedures such as picture differencing, band rationing, change vector analysis, direct multi-date classification, vegetation index differencing, and principal component analysis have been developed as part of the pre-classification method. (Ashraf M. Dewan 2009).

The spatial and chronological features of the LULC alterations that have shaped Rangamati's urban growth are poorly understood.Although most wealthy countries have both recent and broad LULC data, developing countries, like Bangladesh, have a relative dearth of geospatial data or access to it (Ashraf M. Dewan 2009).This empirical study will use geospatial data to try to discover the Spatio-temporal pattern of LULC changes in Rangamati town, so that both scientists and decision-makers may examine the numerous dynamics affecting LULC changes in this urban setting.

The goal of this project is to confirm earlier findings from a socio-economic study about residents' perceptions of land-use change patterns in the district.As a result, the justification for using Landsat TM imagery to explain the real trends of land-use changes in the district was warranted.By offering data and analytical tools for the study of urban environments, GIS and remote sensing have the ability to help decisions. (Divine Odame Appiah, 2015).

Using remotely sensed data and socio-economic information, the study's goals were to investigate the characteristics of LULC changes and identify the underlying driving forces in the Rangamati area. The purpose of this research is to detect changes in the land-use pattern of the study area between 1975 and 2016, as well as to investigate the driving causes behind such changes in land.

2. Literature Review

In general, urban areas are defined by the concentration of people, and rapid urban growth is frequently related with and driven by population concentration.Changes in land-use/cover patterns are a result of urbanization or growth, which can have negative consequences for the ecology of the area, particularly hydro-geomorphology and vegetation. (Jat, 2008).

With the assumption that activities on the earth's surface influence climate, land-use and land-cover changes became a popular research topic on global environmental change some decades ago.

In the early 1980s, it was recognized that land-use and land-cover change had a considerable impact on global climate via the carbon cycle, with terrestrial ecosystems acting as both sources and sinks as a result of the changes. (Sahalu, 2014).

Changes in land use and land cover resulting from the direct and indirect effects of human actions on the environment in order to improve one's quality of life.One of the direct effects of people is population growth, which has an impact on land use, particularly in developing countries, across longer time frames.

According to Lambin et al (2003), As land-use and land-cover change is a complex process, it can also be caused by mutual interactions between environmental and social factors at multiple geographical and temporal dimensions. (E. F. Lambin, Geist, H. J and Lepers, E, 2003).

Climate change, hydrology, air pollution, and biodiversity are all impacted by changes in land use and land cover.Meyer and Turner (1992) reported that it resulted in a variety of microclimatic alterations in their investigation.Deforestation is linked to rising global surface temperatures due to changes in land use.This resulted in a significant amount of warmth in the urban area, which is referred to as an urban heat island.Water pollution was also discovered as a result of land cover changes from cultivation to settlement, according to their findings (urban areas).It has also been stated that the extinction of forest species has a variety of consequences on biodiversity. (Meyer, 1992).

Understanding both how people make land-use decisions and how specific environmental and social elements interact to influence these decisions is necessary for identifying the causes and implications of land-use and land-cover change.Land-use change models are useful for understanding the effects of dynamic land-use and land-cover changes because they provide information on land-use trajectories by projecting into the future.However, models' ability to predict outcomes is critical for better environmental management and land-use planning. (E. F. Lambin, Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W.,Folke, & C, 2001).

Furthermore, RS and GIS have been acknowledged as potent and effective instruments for detecting the spatio-temporal dynamics of land use and land cover, and have been frequently used in this regard (LULC).Researchers can gather valuable multi-temporal data for monitoring land-use patterns and processes using RS, and GIS tools enable analysis and mapping of these trends using GIS techniques.RS may usually be used to provide a spatially explicit time series of land-use change.Change detection and statistical analysis are commonly used tools that allow us to uncover structural variation among distinct land-cover patterns and diagnose land-use change based on time series socio-economic data.These time-series assessments of land-use change, as well as the identification of the driving forces behind it, can provide crucial information to decision-makers for the long-term management of land resources and regional development. (Hualou Long 2008; Md. Shahidul Islam, 2011).

RS has been shown to be useful in producing source information and supporting decision-making activities in a variety of urban applications in several research.Important RS research has been undertaken in the area of urban planning to date, particularly in urban change analysis and modeling of growth, LULC evaluation, and urban heat-island study.RS-based multi-temporal land-use change data, in particular, give information that can be used to examine the structural variation of LULC patterns, which can be used to minimize the irreversible andcumulative consequences of urban growth and are crucial for optimizing the allocation of urban services.Furthermore, precise and comprehensive land-use change statistics are essential for developing long-term urban and environmental planning .It is therefore very important to estimate the rate, pattern, and type of LULC changes to predict future changes in urban development(Ashraf M. Dewan 2009).

Agricultural land, urban and built-up areas, forest and vegetation, aquatic bodies, and wetlands are the main land-use classes in Bangladesh.The majority of the country is covered by agricultural land, followed by urban areas, which have been quickly increasing in the area surrounding Dhaka, particularly in the southern capital area.High population increase, fast urbanization, and infrastructural development have all been linked to shifting land-use patterns across the United States.Urban areas and aquatic bodies have grown in recent decades, at the expense of forests and agricultural land.The majority of the research evaluated here describe a broad trend involving the conversion of agricultural and forested land into urban areas. (Raju Rai 2017).

The driving factors are critical processes that must be taken into account in the new land-use model.Agriculture, housing, water, nature, and employment were among the key land-occupying sectors targeted by the driving forces.A similar strategy was employed for each area, which consisted of a renowned expert producing a note on the main reasons behind land usage for that sector.Such a note reflected the leading expert's expertise, which was reinforced – in one or two expert workshops – by the knowledge of an expert panel on important driving forces and their impact on the spatial distribution of activities and land-use.These seminars were open to participants from a variety of backgrounds, including academic institutions, government organizations, and consulting firms, in order to capture the variations in knowledge and attitudes. The sector-specific reports on the driving forces behind land-use resulted from this activity(Zondag, 2009).

3. Objectives and Methodology of the Study

The main aim of this study is to explore the pattern of urban expansion of the Rangamati Paurashava. The specific objectives of this study were to identify the changes that occurred in the land-use pattern of the study area between 1975 and 2016and exploring the driving forces of such changes involved.This research employed a satellite image recorded by the Landsat satellite between 1975 and 2016 with minimum cloud cover across the whole surface being studied.Such images have a spatial resolution of 30 m, which is deemed sufficient for analyzing land cover and land use across vast areas.The multispectral data was acquired by the Landsat satellite, which was provided by the USGS.The Earth Explorer Database was employed as a satellite data provider, and it distributes remotely sensed data for free.At the L1T level, the image was downloaded (orthorectified).Data was analyzed once it was collected.The data is analyzed using GIS software.The image analysis that was utilized to classify the images and the overall accuracy of the classification results.

4. Study Area Profile

Rangamati is a district in Bangladesh's south-eastern region.It's part of the Chittagong Division. Rangamati is Bangladesh's largest district by area.The Chittagong Hill Tracts include Rangamati. Rangamati town covers 546.48 square kilometers, including 386.18 square kilometers of forest. Rangamati town is situated between the latitudes of 22°30' and 22°49' north and the longitudes of 92°04' and 92°22' east.In 1972, Rangamati Paurashava was founded. Rangamati Paurashova has a population of 78587 people, according to census data.The town has a total size of 64.75 square kilometers. Rangamati town is divided into 9 wards and 55 mahallas by Rangamati Paurashava. The district's total area is 6116 km2, with 1292 km2 of riverine land and 4825 km2 of forestland. (BBS, 2011).

Map 1: Study area map of Rangamati Paurashava Boundary Source: Prepared by Author, 2018

5. Data Analysis Result and Discussion

5.1 Area of land-use category in the 1975 year

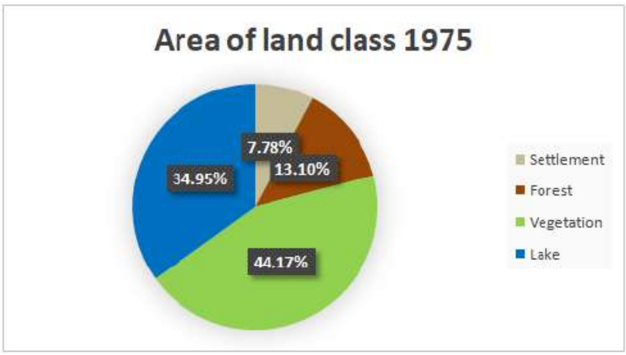

Figure1: Area of land class Rangamati Paurashava in the 1975 year Source: Prepared by Author, 2018

It is apparent from the figure show that most of the land-use category in vegetation area (44.17%) which covers the area 2860.01 hectares in the study area. The immediate next higher fractions of land class area in lake area (34.95%) which cover the area 2263.09 hectares.it is also shown that less percentage of settlement area (7.78%) which covers the area 503.94 hectares because of population growth rate is limited in 1975.

5.2 Area of land-use category in the 1988 year

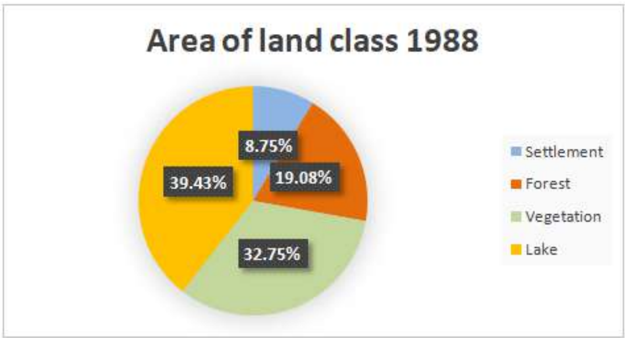

Figure 2: Area of land class Rangamati Paurashava in the 1988 year.Source: Prepared by Author, 2018

It is evident from figures in which it can be seen that most of the land class area in lake approximately 39.43 % which is a large amount cover the area 2552.98 hectares. The immediate next higher fractions of land class area in vegetation area (32.75%) which is cover the area 2120.46 hectares. It is also noticed that less percentage of forest(19.08%) and settlement area(8.75%) which is little cover area 1235.25 hectares and 566.31 hectares in urban area.it is also found that area of land class in 1988 are increasing lake area 4.48%, forest 5.98%, and 0.97% settlement area but large amount decreasing vegetation area 11.42% than 1975.

5.3 Area of land-use category in the 2005 year

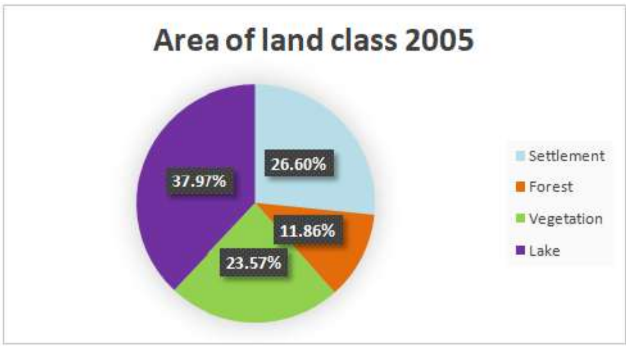

Figure 3: Area of land class Rangamati Paurashava in the 2005 yearSource: Prepared by Author, 2018

It is apparent from figures in which it can be appreciated that large fraction area of land-use category in the lake (37.97%) and settlement area (26.60%) which cover the area 2458.81 hectares and 1722.27 hectares. As the Bangladesh population increasing day by day,it needsa huge amount of housing and infrastructure development. So Rangamati Paurashava increasing the settlement area day by day but decreasing forest (11.86%) and vegetation area(23.57%) in 2005 years.

5.4 Area of land-use category in the 2016 year

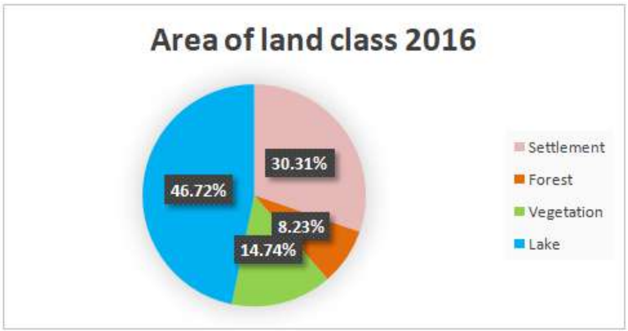

Figure 4: Area of land class Rangamati Paurashava in the 2016 year. Source: Prepared by Author, 2018

It is noticed from figures in which it can be seen that maximum of the land-use category in the lake (46.72%) which covers most of the area 3024.96 hectares. The huge amount of lake area increasing than before years. The immediate next higher fractions of land class area in settlement area (30.31%) which covers the area 1962.29 hectares. In this year vast amountsof infrastructure and housing development having provided in Rangamati Paurashava due to the increasing population growth rate in Bangladesh. As a result ofthe huge amount of forest (8.23%) and vegetation area (14.74%) decreasing in recent years in the study area.

5.5 Changes in areal extent between 1975 to 2016 at Rangamati Paurashava

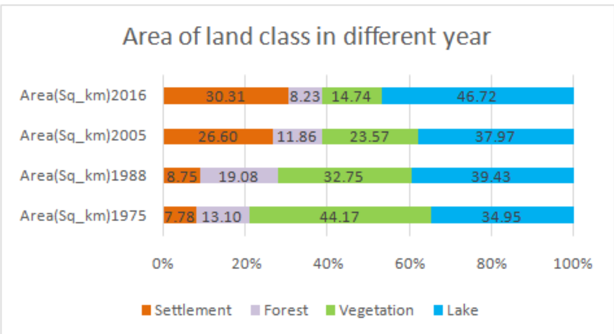

Figure 5: Area of land class Rangamati Paurashava in a different year Source: Prepared by Author, 2018

It is evident from figures in which it can be seen that there has been an increase of settlement areas with respective values 7.78 % of the study area in 1975 to 8.75 % in 1988 to 26.60 % in 2005 and 30.31% in 2016. Lake areas have also shown a consistent increase between the study periods with values of 34.95% in 1975, 39.43% in 1988, and 46.72% in 2016.But there has a decreasing 37.97% in 2005 than before years. However, there have been a decrease in Forest and vegetation areas as clearly shown in figures In 1975 Forest and vegetation areas covered 13.10% and 44.17% of the study area. From the figure, vegetation was the most dominant land-use class in the study area but showed a continuous decrease from 23.57 % by 2005 to 14.74 % in 2016. Because of the successive decrease of vegetation areas, settlement areas have dynamically increased in the study periods.

5.6 Classification and Validation results of Land-use Maps

The land-use maps generated after running a maximum likelihood supervised classification are presented in figure 6 below. As shown from the figures, there has been an increase of settlement areas with respective values 7.78 % of the study area in 1975 to 8.75 % in 1988 to 26.60 % in 2005 and 30.31% in 2016 indicated in table 1. Lake areas have also shown a consistent increase between the study periods with values presented in table 1 below. However, there have been a decrease in Forest and vegetation areas as clearly shown in figures 6 In 1975 Forest and vegetation areas covered 13.10% and 44.17% of the study area. From figure 6 below and table 1, vegetation was the most dominant land-use class in the study area but showed a continuous decrease from 23.57 % by 2005 to 14.74 % in 2016. Because of the successive decrease of vegetation areas, settlement areas have dynamically increased in the study periods. This could be due to an increase in population growth associated with high demand for land and urban supplies. It is also visible from figure 6 and table 1 that Lake has shown a decrease from 34.95 % of the study area in 1975 to 37.97 % in 2005 and again showed a little increase of about 46.72 % of the study area in 2016. The small decreased in the lake and changed to settlement areas in 2005 was related to a retreat of the lake due to siltation and the subsequent use of this land for settlement areas.

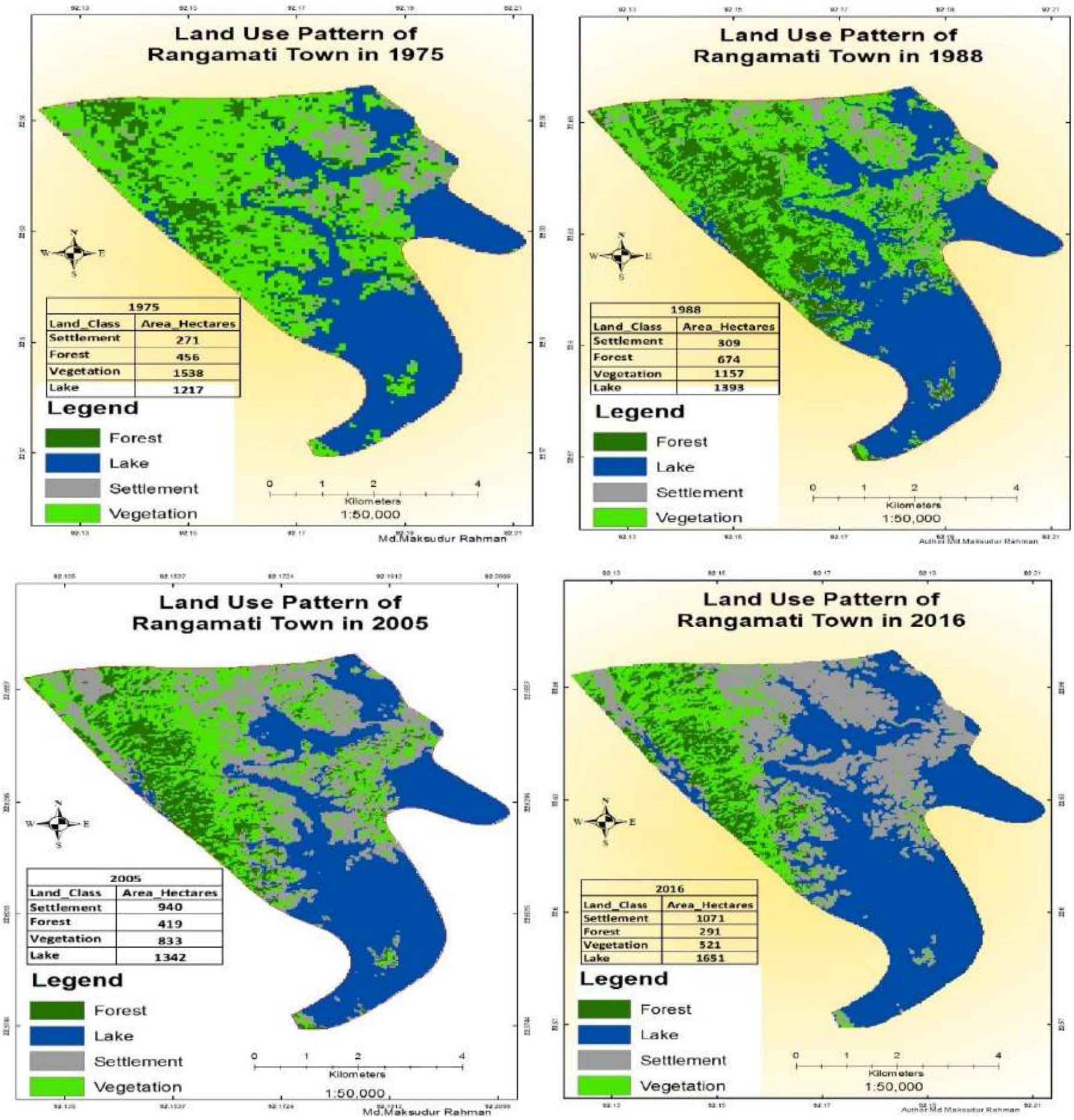

Figure 6: Changes in the land-use pattern of Rangamati Paurashava in a different year. Source: Prepared by Author, 2018

Table 1: Area of Land class in Different year

Land-use	1975		1988		2005		2016	
	Area (Hectares)	Area (%)	Area (Hectares)	Area (%)	Area (Hectares)	Area (%)	Area (Hectares)	Area (%)
Settlement	503.94	7.78	566.31	8.75	1722.27	26.60	1962.29	30.31
Forest	847.96	13.10	1235.25	19.08	767.69	11.86	533.17	8.23
Vegetation	2860.01	44.17	2120.46	32.75	1526.22	23.57	954.58	14.74
Lake	2263.09	34.95	2552.98	39.43	2458.81	37.97	3024.96	46.72
Total	6475.00	100.00	6475.00	100.00	6475.00	100.00	6475.00	100.00

Source: Prepared by Author, 2018

5.7 Factor for changing the pattern of land-use utilization

5.7.1 Demographic factor

The population's size, composition, and behavior are all affected by demographic and societal changes.Birth rate, life expectancy, household formation and dissolution, and foreign migration are all factors that have influenced demographic trends in the past.Because of reasons such as individualization and a more multi-ethnic population, the range of infrastructure types is growing.In some areas, demographic contraction rather than expansion has recently emerged as a driver of potential land-use change.

5.7.2 Economic growth

Economic and financial forces, such as income (including a growth in dual-income households) and capital development, are becoming increasingly relevant.Many of the government's housing policy options are also financial instruments, such as housing transfer taxes, fiscal support (tax deductions) for homeowners, rent liberalization, and a shift in housing subsidies for low-income persons from rental housing solely to all housing.The financial situation of people, housing prices, and government financial meddling must all be explicitly entered into the component to construct a model simulation of these forces.

5.7.3 Land-use policies and regulations/ Policy factor

Land-use changes are mostly influenced by socio-economic forces, notwithstanding physical constraints.They are primarily defined by changes in agricultural and construction land, both of which are intimately linked to human production activities.Increasing demand for non-agricultural land as a result of urban and manufacturing expansion is usually the source of large land-use changes.

5.7.4 Industrialization

The strong negative relationship between the increase in industrial output value and the decrease in farmland, as well as the strong positive relationship between industrial output value and construction land, shows that urban-related industrialization is one of the most important driving forces of land-use changes and plays an important role in reducing the quantity of farmland. Urbanization and industrialisation are two of the most major drivers of land-use change, according to most experts.The policies established/implemented by central/local governments, as well as the individual conduct of land-users, are at the root of the urbanization and industrialization phenomenon.

5.7.5 Housing

Other key policy drivers have an impact on the housing market.Because changes are delayed and heavily influenced by existing patterns, dwellings, jobs, and land-use (e.g. ecological areas) are significant givens for the present infrastructure pattern.Changes in the existing housing stock, such as urban regeneration or gentrification, as well as urban utilities and features, are becoming increasingly essential.Furthermore, as a result of rising ownership of second homes, an ambiguous difference between houses with a purely temporary, recreational role and regular dwellings, and a more short-term occupation of houses, the connection between supply and demand is shifting and becoming more complex.

5.7.6 Employment

Locational variables, company organization, and the mentioned economic structure per sector are all key driving forces determining land use in economic sectors.In addition to classic locational considerations such as transportation costs, labor supply, and cost and agglomeration factors like consumer market size, so-called soft locational factors are becoming increasingly significant.Employee skills (and training possibilities), knowledge access, quality of residential facilities, environmental regulations, and a location's image are all aspects to consider.

6. Conclusion and Recommendation

6.1. Conclusions

Land-use changes have a wide range of consequences at all geographical and temporal scales.It has become one of the most important challenges in terms of environmental change and natural resource management as a result of these repercussions and influences.It is vital to understand the complex interaction between changes and their drivers over geography and time in order to predict future developments, build decision-making systems, and construct alternative scenarios.

This research was carried out using a combination of GIS and remote sensing.These strategies were built in order to detect and assess changes in land-use classes.The first segment used satellite data and remote sensing techniques to create land-use maps using maximum likelihood supervised image classification for the research periods of 1975, 1988, 2005, and 2016.The study found that the proportions of settlement areas have increased as a result of the remote sensing image categorization results.Settlement areas changed rapidly, from 7.78 percent of the study area in 1975 to 8.75 percent in 1988 to 26.60 percent in 2005 and 30.31 percent in 2016.The conversion of so many vegetation areas to residential areas was aided greatly by vegetation areas.It has been steadily decreasing since 2005, from 23.57 percent to 14.74 percent in 2016.

The conversion of vegetative land to habitation areas in the Rangamati area could be linked to an increase in population and faster economic development.

Settlement areas rose by 503.94 hectares, 566.31 hectares, 8.75 hectares, 1722.27 hectares, and 1962.29 hectares, respectively, according to land-use change analysis results for 1975, 1988, 2005, and 2016.The transition from all categories to build-up areas was used to examine the spatial trend of changes in settlement areas between 2005 and 2016.With the rapid expansion of infrastructure, the tourism economy, and an expanding population, the trend and magnitude of changes in settlement areas are anticipated to continue. Spatio-temporal information on land-use changes, particularly in metropolitan areas, was provided by land-use change.It also allows you to comprehend the impact of urban dynamics influenced by a collection of drivers.The findings of the investigation revealed significant changes in settlement areas between the study periods.Regardless of the driving reasons that have negative impacts on the simulation process, the 2016 simulation findings quantified that much of the vegetation and woodland had been converted into built-up areas.During the study period, the settlement's finding has grown significantly (1975 to 2005).In a steep area, it is hard to declare Level-2 and Level-3 land-use features using Landsat images.

6.2. Recommendations

Remote sensing and geographic information systems (GIS) are crucial tools in land use change studies, according to the findings of this study.As a result of the findings of this study, the following next research directions are suggested:

- Expansion of settlement should be regulated.
- Deforestation must be stopped and afforestation program should be under taken.
- High-resolution imageries, such as IKONOS and QuickBird, are critical for producing high-quality land use maps.Because urban areas have diverse and heterogeneous features, mapping these areas with high resolution photography gives superior information.
- For each year, consistent multi-temporal Landsat satellite data allows for detailed image comparison, change analysis, and modeling. Even though there has been uneven temporal availability of data, it is a prerequisite of equal interval of image acquisition for the Markov chain model.
- Incorporating socioeconomic data, land policy, biophysical, and human elements (people density, technology, and politics) into land use analysis for future forecasts could increase its performance. As a result, efficient land utilization is critical to planners, decision-makers, and stakeholders.

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