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Assessment of Land Use Pattern using Remote Sensing and GIS: A Case Study of Itahari Sub-Metropolitan

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Abstract

Itahari is one of the fastest-growing cities in the Koshi province of the southeastern part of Nepal. Over the last two decades, cropland coverage has plummeted in the Itahari Sub-metropolitan region depicting the shift in land use. This research provides a comprehensive assessment of the changes in urbanization in Itahari through Geographic Information Systems (GIS) and remote sensing data. The Cropland area was 77.46 square kilometers, whereas the Built-up area was only 1.44 square kilometers in 2005. The built-up area gradually increased from 2005 to 2013, reaching 2.32 square kilometers, drastically increasing to 5.71 square kilometers in 2019 following the declaration of Itahari as a sub-metropolitan city in 2014. The loss of cropland may hurt Farmers' standard of life due to a reduction in the area's agricultural production. It will also impede the natural drainage system and groundwater recharge zones. We advise urban planners to include ecosystem-based adaptation and mitigation in City planning.

Keywords

Itahari, land use and land cover, Built up area, remote sensing, Cropland

1. Introduction

According to studies, just a small fraction of the earth's surface is preserved in its original state [1]. Man's existence on Earth and his use of land have had a substantial impact on the natural environment, causing the Earth's surface to be altered significantly as a result of anthropogenic activity. This has led to an obvious pattern in how land use and land cover (LULC) vary through time [2]. Land use refers to the purpose for which land is used, meanwhile land cover is the bio-physical state of the land [3]. In most parts of the world, changes in land use and cover have immediate impacts on the continued existence of livelihoods [4].Urban ecosystems are heavily impacted by human activity and have intimate linkages to the lives of nearly half of the world's population, hence attention to changes in urban land use and land cover has increased significantly over the last ten years. This means that we must employ cutting-edge change detection methods like remote sensing and GIS. Several temporal satellite imageries took on in present-day change detection approaches can indispensably supply information on numerous characteristics of landforms and streams, vegetation, and soil analysis [5].

By making use of GIS and remote sensing tools, various levels of investigation have been done to investigate land use and land cover changes in the land ecosystem of Nepal, including research studies by Shalaby and Tateishi [6], Lamichhane and Shakya [7]. The land use and land cover use pattern is also the input of different study area likewise ground water potential zoning, determination of ground water and surface water interaction [8] [9]. Land cover and land use research in Nepal's eastern region is extremely sparse. In recent years, rapidly expanding cities have been responsible for converting agricultural areas into built-up areas with little planning, resulting in biodiversity loss and increased slum settlements, particularly on marginal lands such as flood plains, which are not only vulnerable to seasonal flooding but also threaten ecosystem [10].

The Itahari Sub Metropolitan Area's outcomes are very similar to those of the other cities in Nepal's eastern Terai. The statistical information accumulated through this study will assist in understanding changes in land use and land cover as well as help to create policies and long-term approaches to facilitate successful land management in Itahari Sub-Metropolitan City. As a result, the project will contribute to the generation of general information on changes in Land Use and Land Cover throughout the preceding fifteen years.

To make use of Remote Sensing and Geographic Information System (GIS) approaches to detect and assess overall land use land cover change, the study's area was chosen. Figuring out the existing pattern of land-use change over various periods between 2005 and 2019 is the most important goal. Policymakers and land-use planners ought to recognize the outcome and result value for the city's charming landscape planning.

2. Methodology

2.1 Study Area

Itahari is located in the Terai region of our country. It is located in Nepal's Koshi Province's Sunsari district. The settlement is located 92 kilometers west of Kakarbhitta, 16 kilometers south of Dharan, and 25 kilometers north of Biratnagar. The distance from the Kathmandu Valley is roughly 358 kilometers. The area lies in between 26 degree 37 minute to 26 degree 43 minute longitude and 87 degree 12 minute to 87 degree 20 minute latitude with an area of 93.57 sq km. Additionally, it serves as Nepal's principal commercial and industrial hub.

The city is not very old in terms of years. It was only founded in

1997 AD. Following the consolidation of the rural development zones of Khanar, Ekamba, Pakali, and Hansposa, the town was designated a sub-metropolitan city in 2014. Like many other cities in Nepal, it lacks both the attraction of ancient history and the attractiveness of a unique culture.

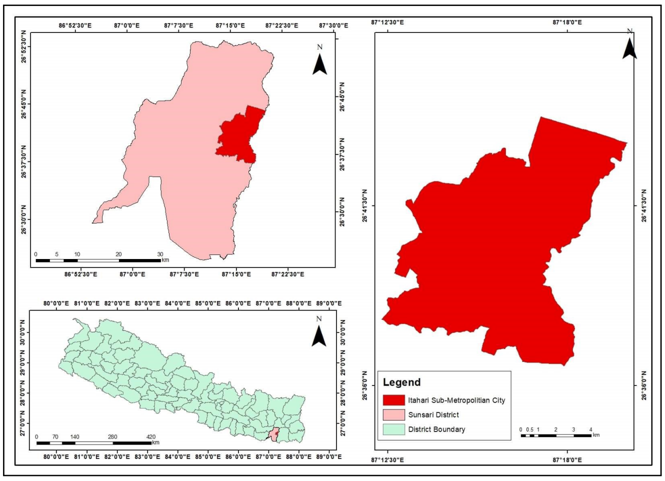

Figure 1: Location of study area

2.2 Research Frame

The secondary data employed in this study are crucial. Land sat images from satellites have been acquired for creating the base maps for statistical analysis and applying various approaches in order to accomplish the study objectives.

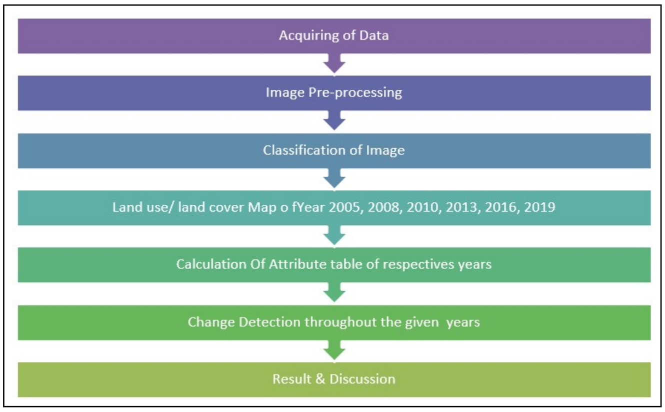

Figure 2: Flow diagram illustrating LULC mapping process

2.3 Data Preparation

Radiometric or geometric adjustments are applied to the obtained images [11]. Data correction for sensor anomalies and unwanted noise, as well as data transformation to accurately represent the reflected or emitted radiation detected by the sensor. Image enhancement's sole objective is to improve the appearance of imagery in order to aid in visual interpretation and analysis. Contrast stretching was used to improve the tone separation of different components of a scene, while spatial filtering was used to highlight specific spatial patterns in an image. The original bands were combined and converted using arithmetic processes into "new" images that better display or highlight specific elements in the environment. Image pre-processing, enhancement, and modification are carried out.

2.4 Land Use/Cover Classification

In this study area land use and land cover patterns were detected using supervised classification. For this process several FCC images were created with the fundamental colors red, green, and blue (RGB). These FCC pictures were utilized to differentiate between different land use land cover. For this study, we used the FCC of RGB= bands 4, 3, and 2. This combination generally causes built-up areas to appear blue, vegetation to appear red, water bodies to appear dark blue to black, and soils with no vegetation to appear white to brown. Image categorization is the process of organizing image pixels into groups or classes in order to create a thematic representation. Image classification encompasses a variety of processes that could be performed on photographic or image data. Such class was prepared for different year likewise of 2005, 2008, 2010, 2013, 2016 and 2019.

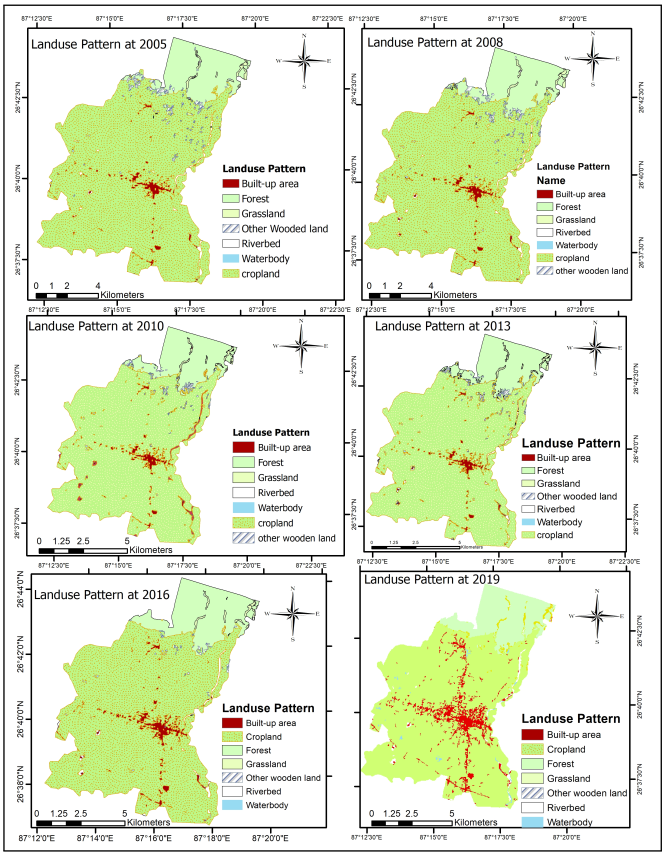

Figure 3: Land use covers pattern

Figure 3 show that farmland covered the most area, accounting for more than two-thirds of the total occupied area. Similarly, forest and built-up areas contribute less to overall area. Land use/cover is estimated using Arc maps 10.5 for all years from 2005 to 2019, and the area of several categories of land cover, i.e. cropland, water body, riverbed, grassland, forest, built-up area, and other wooden area, is obtained.

3. Result and Discussion

The area derived from the research area's land cover is divided into seven classes: cropland, forested areas, riverbeds, grasslands, forests, and other wooded places. Different area vocations are revealed by the processing of input image, as illustrated in table 1.

Table 1: An overview of land cover classification data from 2005-2019

Land Use Types/Year	2005 (sq.km)	2008 (sq.km)	2010 (sq.km)	2013 (sq.km)	2016 (sq.km)	2019 (sq.km
Water body	0.11	0.14	0.12	0.20	0.18	0.39
Forest	12.20	13.07	13.39	13.66	13.66	13.57
River bed	0.76	0.77	0.79	0.84	0.89	0.82
Built up area	1.44	1.56	1.67	1.81	2.32	5.71
Cropland	77.46	76.58	76.44	76.02	75.72	72.14
Grassland	0.54	0.56	0.52	0.52	0.53	0.55
Wooded land	1.08	0.90	0.64	0.53	0.28	0.40
Total	93.57	93.57	93.57	93.57	93.57	93.57

The area of various classes of land cover in respective years is illustrated in table 1.

From the Table 1, Cropland occupies the majority of the land use in study area, while water bodies occupy the least coverage area. it is interesting to note that cropland covers 77.46 sq km. out of total area i.e. 93.57 sq. km in the year 2005 which is greater than 2/3rd of overall area. Increasing population and developing pattern creates a decreasing trends in cropland day by day which results in reached to 72.14 sq km area by decreasing 5 sq. km within one and half decades. Similar findings show that the built-up area, which measured in 2005 was 1.44 square kilometers, is reached to 5.17 square kilometers by the end of the period. Other land use class has no significant changes in their coverage area. The status of different class area in their respective year is also shown in figure 4. This study shows that increasing of built-up area is results of conversion of cropland area. This conversion directly impact on the production of agriculture goods. Similarly it's force to import the agricultural product and results in decrease the farmer incomes. That same time the built up area will also altered the surface of land which increase surface runoff and decrease the infiltration area which results in flooding as well as decrease in ground water recharging.

Figure 5 depicts the shifting distribution of cropland in various categories, including water bodies, forest, riverbeds, and built up area. There is no discernible difference between cropland and grassland. A water body, a forest, and crops all undergo very minor changes over the course of a year. However, there has been a significant shift in the built-up area percentages from 2016 to 2019, which is 4.54Similarly, there are no significant conversions from water bodies, forests, riverbeds, or other wood land to built-up areas over the research period. As a result, our study demonstrates that solely cropland has been turned into built-up area.

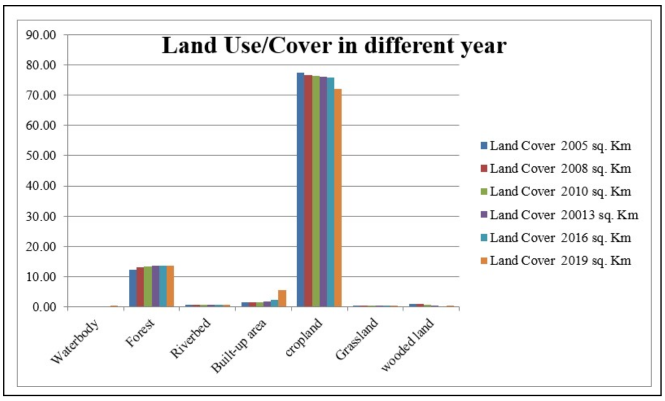

Figure 4: Land use / covers between 2005 and 2019

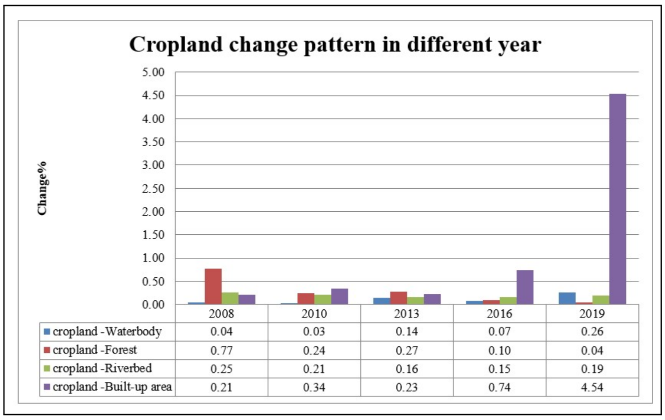

Figure 5: Land use covers changing pattern from cropland between 2005 to 2019

4. Conclusion

GIS and remote sensing techniques is used to identify and forecast changes in land use and land cover in the Itahari Sub metropolitan area over a decade and a half. For this study remote sensing data revealed that the Itahari land use cover had changed dramatically during the previous one and half decade. Itahari land sat images from the years 2005, 2008, 2010, 2013, 2016, and 2019 are analyzed using the fairly accurate Interactive Supervised Classification feature of the Geographic Information System (GIS) Arc 10.5 software. The generated land cover classifying images and land cover areas of seven categories show that the land cover of Itahari city changed dramatically between 2005 and 2019. (which comprise the built-up area, grassland, forest, riverbed, water body, Cropland, and other wood lands).

Since the northern half of the metropolitan area is dominated by forests, the central-eastern region is densely populated. The same is true for a region of open agricultural fields surrounding the core city. There have been significant changes in land use and cover, with agricultural land and open space vanishing due to urban development. A direct result of unplanned growth in urbanization and built-up areas is the reduction in the size of agricultural fields. Most of the area loss in farming has been directly attributed to inhabited areas. The conversion of developed regions results in a fall in agricultural productivity and economic loss. In order to address these current patterns of shifting land use and land cover, we recommend Itahari Sub Metropolitan to create appropriate plans and strategies. Based on its production, agricultural land needs to be properly categorized. For the purpose of implementing a program of a forestation on barren and infertile land, a user's committee should be established.

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