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Urban Growth Dynamics of Ghaziabad District using Remote Sensing

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Abstract

Human activities are the primary cause of environmental changes, particularly in rapidly developing places. These changes in land use or land cover (LULC) can be evaluated by mapping the different land cover classes. This study aimed to assess the LULC dynamics of the Ghaziabad district of Uttar Pradesh using Landsat satellite imageries. Two time periods,i.e. 1992 and 2022,were taken into consideration to find the land variation. According to the findings, there has been a significant surge in the built-up category from 140 sq km to 223 sq km, whereas the surface covered by vegetation land decreased from 136 sq km to 101 sqkm showing a decline of 15.5% to 11.5% in 30 years.The study's findings demonstrate the use of satellite digital image processing for locating and mapping LULC alterations.

Keywords: Land use/ Land Cover, Environmental changes, Landsat, Satellite image processing

Introduction

The world is gradually changing into an urbanarea, with 3.5 billion people living in cities now, which is expected to rise to 60% by 2030. (Sustainable Development Goal 2021). In the coming decades, 95% of urban expansion will take place in developing countries, according to World Urbanization Prospects (2018). Cities are the hubs of positive forces for technological innovation, human development, poverty reduction, and the development of economic growth, which account for around 60% of the world's gross domestic product (Sustainable Development Goal 2021; UN 2019). However, these urbanized areas also represent 60% of resource use, 70% of energy consumption, and 70% of global carbon emissions (UN-Habitat 2019).

Urban expansion is a dynamic and intricate socio-economic process that alters cities' size and demographic makeup (Kafi et al. 2014; UN 2019). Urbanization is fueled by modernization, industrialization, and globalization, all of which are directly tied to economic growth (Mallupattu and Reddy, 2013). Due to the availability of more possibilities and

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amenities, including work, education, health care, and other recreational activities, people move from rural to urban locations (Li et al., 2012). Consequently, this causes the land use and land cover features, which are mostly caused by human activity rather than natural phenomena, to rapidly change and shift (Hamad et al. 2018; Mahmoud and Alazba 2016).

With more than 1210 million citizens, India ranks second in the world in terms of population, making up 17.5% of the world's population (Census of India 2011). India is rapidly urbanizing, which is causing significant changes to the country's land use and cover. Punia and Singh (2011) noted the dualistic nature of Indian cities, whereby, on the one hand, urbanization in the country as a whole is slowing down while, on the other, it is accelerating in class-I cities. According to Kundu (2006), India's urbanization trend is mostly focused on the metropolis.

Regional mapping of LULC is crucial to consider both good and negative changes, assess the effects of "from-to", identify driving forces behind those changes, and comprehend the relationship between people and the environment (Kafi et al. 2014; Alipbeki et al. 2020; Mengistu and Salami 2007). Geographic information systems (GIS) and remote sensing are effective tools and cutting-edge methods for obtaining LULC data because they provide vast spatial coverage, are real-time, highly accurate, and reliable (Maina et al. 2020; Lu et al. 2019). Due to their ease of access and relatively superior spatial resolution, remote sensing data from the Landsat series of satellites have been widely employed in LULC investigations (Lu et al. 2019).

Objectives:

The main objectives of this research work are as follows:
(i). To analyze the urban growth of Ghaziabad district
(ii). To geo-visualized the spatio-temporal changes in land use and landcover

Study Area

The study was conducted in the Ghaziabad region, a suburban district of Uttar Pradesh. It comes from the Meerut division and islocated in the National Capital Region. Ghaziabad has the third-highest population density in Uttar Pradesh (Census of India, 2011). The Ganga-Yamuna Doab passes through the district of Ghaziabad.It is roughly rectangular. It measures 37 kilometers in width and 72 kilometers in length. It is situated between 77°26' and 78°10' East longitude and latitude of 28°30' to 28°59' North (Figure 1). Before November 14, 1976, Ghaziabad was a part of the district of Meerut (Shazli& Munir, 2017). The district of Ghaziabad was established on November 14, 1976.The size of the city is roughly 133.30 square kilometers.

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Ghaziabad is the largest and most evolving city in Uttar Pradesh. The Ghaziabad region is situated to the east of the state of Uttar Pradesh and to the west of the national capital territory of Delhi. The city is in the National Capital Region's northeast (NCR). It is known as the "Gateway of Uttar Pradesh" due to its proximity to Delhi (Sharma &Joshi, 2016). Districts Meerut in the north, Gautam Budh Nagar and Bulandshahar in the south, Hapur in the east, and the national capital Delhi in the west surround Ghaziabad. It is located in the upper Ganga plain in the north. The city is well connected by the metallic road and is located about 19 km east of New Delhi. Uttar Pradesh's major cities, including Lucknow, Saharanpur, Moradabad, Aligarh, and many others, are easily accessible from the city.

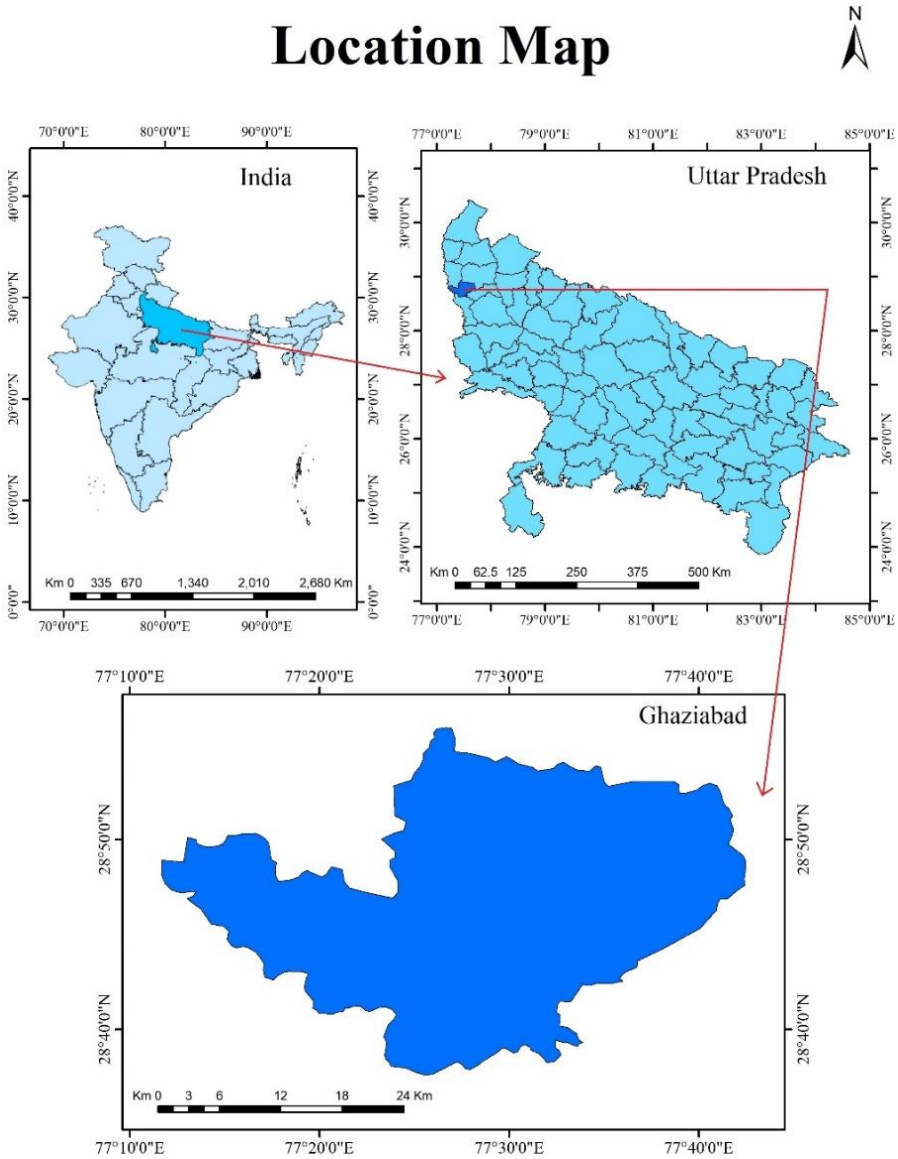

Figure 1: Study area location

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Data used

The complete dataset of all land use and land cover classifications was generated by integrating multi-temporal satellite images from the LANDSAT series satellites Landsat 5 and Landsat 8 (Table 1). Five LULC classes were identified in the area, which are: Built up, cropland, fallow land, vegetation cover and water body.

Table1: Details of satellite data used in this research work

S.No	Satellite	Description of satellite	Data of acquisition
01	Landsat 5	LT05_L2SP_146040_19921127_20200914_02_T1_SR	27-11-1992
02	Landsat 8	LC09_L2SP_146040_20221122_20221124_02_T1_SR	22-11-2022

LANDSAT 5 and Landsat 8 images were utilized to acquire the LULC for 1992 and 2022. The USGS online portal (https://earthexplorer.usgs.gov/) was used to obtain all of the satellite images. High Resolution imagery (Google earth) and toposheet of the AOI were included in the process to create the shape file of the study area. This toposheet was georeferenced in Qgisgeospatial software by using the re sampling method of nearest neighborhood. The digital image based Visual interpretation method was included to generate the tanning samples of the study area for training of the classification algorithm.

Methodology

Thefollowing chart (Figure 2) represents a framework for evaluating the role of earth observation techniques in identifying shift and change in the LULC of the Ghaziabad district region of UttarPardesh state, India, utilizing semi-automatic classification approaches.The following methodology was employed in this study to map the changes in the study area's Land Use Land Cover across three decades, from 1992 to 2022.

To get atmospheric error-free data, all images were first radiometrically corrected by calculating To A (top of atmosphere) reflectance. Following the radiometric corrections, the geometric correction was used to remove the geometric error, and the images was re sampled correctly using the nearest-neighbor resample method. The study area was then subset with the help of corrected images. For LULC classification, the supervised image classification method (maximum likelihood) was used.

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The supervised classification method was used, with the algorithm of maximum likelihood and a band composition of Green, Red, and NIR, to select training samples for the feature classes of water bodies, while the true composite of blue, green, and red bands was used to collect training samples for the feature classes of settlement, cropland, fellow land, and vegetation, with a band composition of NIR, red, and green.

To simplify the process of assessment and analysis of change detection, the numerous LULC classes in the research field were split into five categories. The categorization output includes Built up, cropland, fellow land, Vegetation over and water body.

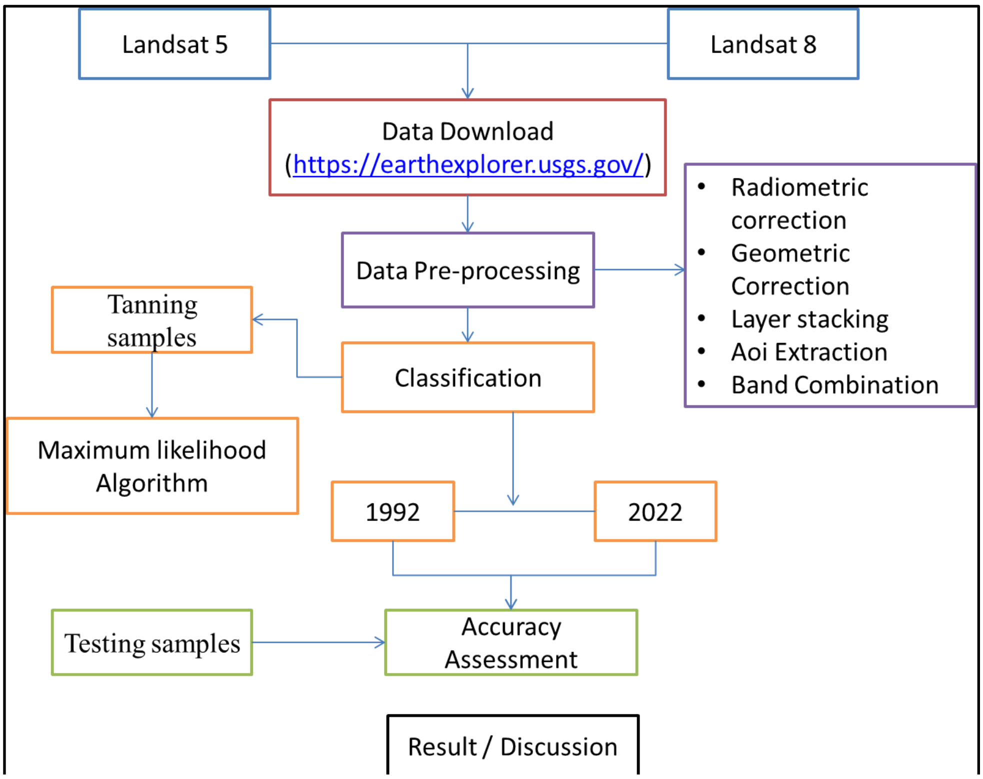

Figure 2: Methodology framework of the study work

Post classification, the two independently classified images were compared to create a change detection analysis. The classification was beneficial since it identified the type and degree of shift and change that had happened through pixel level comparison.

The accuracy evaluation compares the classified imagery to testing samples to determine how accurate the classified map is with regard to the ground. This produces a matrix table displaying three different types of accuracies (user, producer and overall). The accuracy evaluation is one of the first steps in any image analysis process. The main goal of this section is to validate the classified images against the available testing sets.

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Results

The changes in the LULC are described in terms of number of pixels for each classification category. Figure 3presented a LULC of Ghaziabad district in 1992 and 2022 prepared through supervised classification method. Table 2 presents the LULC statistics obtained from the LULC map. The LULC statistics show that in 1992, cropland and fallow land constituted the largest LULC categories in Ghaziabad, followed by the built-up area. The cropland and fallow land collectively occupy an area of 592sq km, representing 67.73% of the total land cover of the Ghaziabad district. The water bodies are the least land cover type. They occupied an area of 6 sq km, which represents 0.68% of the total land cover of the study area.

The overall correctness of the classified land use/land cover map was also examined as part of the accuracy assessment of the classified map. For the years 1992 and 2022, the observed total accuracy is 88% and 91.43% respectively.

LULC observations from 2022 show a significant increase in the built-up settlement from 140sq km in 1992 to 223 sq km in 2022, which implies an increase from 16% to 25.5%. Whereas the surface covered by vegetation land decreases from 136 sq km to 101 sq km showing a decline of 15.5% to 11.5%.

Table 2: Area Distribution of LULC classes in Ghaziabad District

LULC classes	Area in sqkm 1992	Area in %	Area in sqkm 2022	Area in %	Change in %
Built up	140	16.018	223	25.514	59.285
Cropland	392	44.851	324	37.070	-17.346
Fallow land	200	22.883	221	25.286	10.5
Vegetation	136	15.560	101	11.556	-25.73
Water body	6	0.6864	5	0.572	-16.66
Total Area	874	100	874	100	

From the change analysis, it was observed that there is a 59.28 % increment in built-up, 17.34% negative change has occurred in Ghaziabad over 30 years. From the Figure 3, it was observed that the Ghaziabad region, which is connected to NCT-Delhi had experienced the increment in the built-up, it has been noted that the area has grown into numerous small, densely built-up enclaves.In 1992, crops encircled the Hindon river floodplain; however, by 2022, built-up areas had begun to appear in this area.

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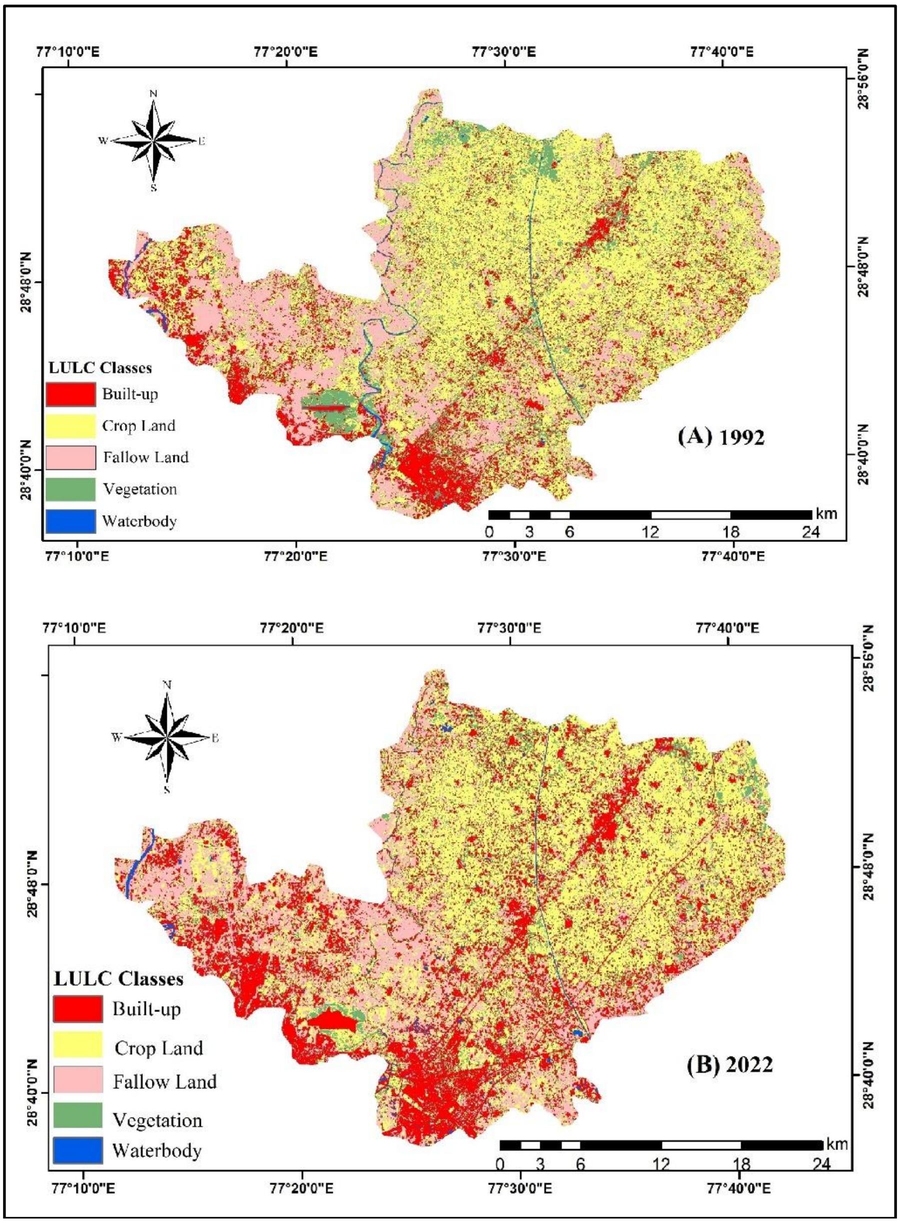

Figure 3: Showing LULC variation in 30 years in Ghaziabad district of Uttar Pradesh

Conclusion

In this research work, the application of employing Geographic Information System and remote sensing data, which drive towards urban sustainable development. This study has provided insights on the LULC dynamics of Ghaziabad district utilizing Landsat series datasets. The results reflect the significant expansion of the built-up areas in Ghaziabad district on the expense of vegetation and agriculture land. Through this research, we were able to determine effective urban planning strategies to combat environmental degradation.

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