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Impact of Urban Growth on Landuse and Land cover change. A case study of Pudusserri Gramapanchayat in Palakkad Gap using Geospatial Techniques

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Abstract

Urban regions are currently developing and growing more quickly throughout the planet. Urban expansion has a major impact on the dynamics of land cover (LULC), which frequently leads to important changes in the environment and the socioeconomic system. This study examines how urban growth affects LULC in Pudusserri Grama Panchayat, which is situated in the Palakkad Gap. Through the study of satellite imagery and GIS data from various periods, the research finds patterns and trends in land conversion, highlighting the encroachment on agricultural land, deforestation, and the rise of built-up places. The study stresses how important sustainable urban planning is to lessen adverse effects on the community and local ecosystem. This study provides a thorough chronological and spatial analysis, which helps policymakers combine development with environmental conservation.

Supervised categorization was used to create growth in the built-up area. Between 2001 and 2021, the study area's built-up area grew from 430.65 hectares to 1002.01 hectares. The entire geographical area in 2001 was 6784.3 hectares, of which 430.65 hectares were built-up land and the remaining 6353.65 hectares were noted as non-built-up area. The built-up area shares 1002.01 hectares in 2021, while the non-built-up area contributes 5782.9 hectares, as the geographical area did not change during the study period. The outcome of the study was that agriculture had shown a tremendous decrease from the period 2001 to 2021. Most of the agricultural area was converted to build-up land. The built-up land had been increased. In the period 2001, it was only 430.65 hectares but there was a tremendous increase in the period 2021. Vegetation has been increased in the period 2001- 2021. Wasteland and water bodies had a tremendous decrease in the period 2001-2021.

Keywords: Urbanization; Land Cover (LULC); Builtup; Urban growth

1 Introduction

Urbanisation has been a significant social and economic phenomenon occurring on an unprecedented scale and rate around the world (Sun et al., 2013). The urban areas cover a very small fraction of the world's land surface, their rapid expansion has significantly altered the natural landscape and created enormous environmental, ecosystem, and social impacts (Berling-Wolff and Wu, 2004, Grimm et al., 2000, Mundia and Murayama, 2010, Pickett et al., 2001, Weber and Puissant, 2003). The unplanned and uncontrolled rapid growth has resulted in serious negative effects on urban dwellers and their environment (Chadchan and Shankar, 2012). From 1960 to 2019 the Landuse Landcover LULC has been changed and it has impacted one-third of the world (Winkler et al. 2021). Urbanization is a gift to human society if it is controlled, coordinated and planned.

Urbanisation is a phrase derived from the Latin word *Urb*, which means city. An urban area is a territory with a high population density and concentrated settlements. Urbanisation is the socioeconomic process of transforming rural areas into urban centers. Urban expansion is the process by which economic agglomerations expand and contract. The pattern of concentration and evolution of economic activity has been shown to have a substantial impact on urbanisation, city layout, economic activity organisation, and national economy expansion.

LULC is a being a critical issue (Verburg et al. 2000; Lambin et al. 2003; Gao et al. 2015). The built-up is generally considered the parameter for quantifying urban sprawl (Torrens and Alberti, 2000; Barnes et al., 2001, Epstein et al., 2002). The uncontrolled change created environmental and socio-economic challenges (Fitawork et al. 2020). Rapid urbanization is accountable for the complicated pattern of urban physical enlargement and growth (Mohamed et al., 2020).

Change patterns are the result of complex interactions between humans and the physical environment (Verburg et al., 2004; Rahimi 2016). spatial design is an important determinant of many ecological and socio-economic processes (Lambin and Meyfroidt, 2011; Shen et al. 2011). Urban growth model and geographic understanding provide the data needed to analyze the impact of population growth on changes (Asranjani et al., 2013; Patra, et al., 2018).

The determinants of urban change are driven by population growth and land consumption constraints and possibilities, economic and social factors, spatial interactions, and urban policy and their effectiveness (Shixu et al. 2014; Mohamed et al., 2020). The main factor in the city that influenced change was the large-scale human activity such as affordable housing, transportation and industry, service, and market (Angélil & Hebel, 2016).

Intense anthropogenic activities, such as urbanization and industry, have a major impact on demographic characteristics

and physical landscape changes. Rapid change brings unsustainable urban development and environmental problems (Cetin, 2016). Analysing urban growth through time would be a tool that supports the analysis of the causes and consequences of change (Verburg et al., 2004; Arsiso et al., 2018).

Land cover (LULC) change has become a critical issue for decision planners and conservationists due to inappropriate growth and its effect on natural ecosystems. Such activities are important issues and challenges for urban and state planners and environmentalists to shape environmentally friendly and sustainable urban economic growth (Singh, 2003; Verburg et al., 2017). Moreover, rapid urbanization has a significant impact on change by changing open space, and agriculture to built-up urban impervious surfaces (Devendran & Banon, 2022). Urban land expansion is the root cause of many environmental and societal modifications (Gao and O'Neill 2020).

Satellite-based remote sensing (RS) data with GIS techniques are found to be most effective in characterising the LULC changes in the spatiotemporal framework and integrating the associated driving factors (Aneesha Satya et al. 2020; Fichera et al. 2017; Singh et al. 2015). Changes in land cover are an important manifestation of human interactions with the environment, with manifold consequences for ecosystems and human livelihoods (DeFries et al., 2007, Foley et al., 2005). Measuring land-use/cover change (LUCC) is complicated by the dynamic nature of human-managed landscapes, which experience changes at multiple scales, and not necessarily at the same time (Altieri, 2009, Wrigley, 1971). Urbanization associated with modified LU/LC patterns is responsible for various issues related to the environment (Malik et al., 2020; Mohammad & Goswami, 2019).

1.1 Study Area

The Palakkad District's Pudukseri Panchayat is a place that is rapidly developing. Covering a surface area of 122.84 sq. km. The panchayat is limited by reserve forest to the north, Elappally and Vadakarapathi panchayats to the south, Tamil Nadu's eastern border, and Elappally panchayats to the west of Marutha Road. Earlier, the area's primary industry was agriculture. Nonetheless, the industrial sector has been rapidly expanding in this area over time, with both large and small-scale businesses located here. Kanjikode, the second-largest industrial sector in Kerala, is located in the Pudukseri panchayat.

1.2 Location

Pudukseri is a gram panchayat in Kerala, India's Palakkad district. Pudukseri grama panchayat is situated between 76°37'41'' E longitude and 76°41'5'' E longitude, and between 10°44' 25'' N latitude and 10°48'46'' N latitude. The Malampuzha Community Development Block is where

it belongs. It is a local government agency that looks after the towns of Walayar, Pudukkottai Central, Kanjikode, and Pudukkottai West. This panchayat is home to Kerala's first IIT and the second-largest industrial area.

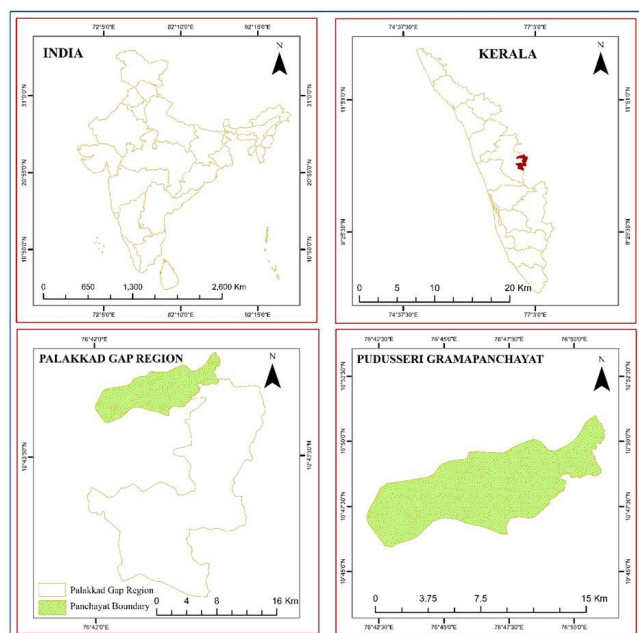


Fig. 1. Study area location

Two types of soil make up the majority of the Pudukkottai grama panchayat: laterite soil and black cotton soil. The eastern side of the panchayat is where the majority of the laterite soil is found. Laterites on high grounds are more compact when compared to low-lying areas. The Western portion of the panchayat is where the black cotton soil is primarily found. They exhibit mud cracks and have high water retaining power. The panchayat's Northeastern corner is where the hydromorphic soil is found. The region has a humid climate with a particularly hot season lasting from March to June in the western half of the region, whereas the eastern section of the region has a less humid environment. The most significant rainy season is between and the second week of June marks the beginning of the South West Monsoon, which lasts until September. The southwest monsoon season brings about 75% of the annual precipitation. There is essentially no rainfall from December to May. The district's temperature ranges from 200°C to 450°C. The district has two types of climates. From 1960 and 2020, the temperature drastically changed. Around 25.5°C was recorded in 1960, whereas 27.1°C will be recorded in 2020. The temperature is up to 25.9°C on average. There was a significant change in the amount of rainfall between 1960 and 2020.

Around 250mm was recorded in the year 1960, and about 247mm was recorded in the year 2020. It receives 240.1mm of rain on average. According to Census India's 2011 report,

Pudukkottai Town has a population of 20,140, of which 9,948 are men and 10,192 are women. Additionally, Pudukkottai West has a child sex ratio of about 1005, which is higher than the state average for Kerala, which is 964. Pudukkottai West has a literacy rate of 88.51%; male literacy is almost 92.44% higher than female literacy, at 84.67%. In the Palakkad district of Kerala, India, there is a census town by the name of Pudukkottai Central. It has a population of 45642, out of which 22903 are males and 22739 are females. Scheduled Caste and Scheduled Tribe constitute 11% and 1.8% of the total population respectively. According to Census India's 2011 report, Pudukkottai Town has a population of 20,140, of which 9,948 are men and 10,192 are women. Moreover, Pudukkottai West has a child sex ratio of about 1005, which is higher than the state average for Kerala, which is 964.

Pudukkottai West has a literacy rate of 88.51%; male literacy is almost 92.44% higher than female literacy, at 84.67%. Pudukkottai West Census Town oversees 5,016 homes in total and provides them with necessities like water and sewage. According to data from the 2011 Census, the Pudukkottai Central town has a total population of 16629, with 8469 men and 8160 women. Male children under the age of six make up 872 of the population of children under the age of six, while female children under the age of six make up 830. Pudukkottai Central City has an overall literacy rate of 86.49%, with a male literacy rate of 92.15% and a female literacy rate of 80.63%. In Pudukkottai Central, there are 964 females for every 1000 males. The child sex ratio is 952 male children under the age of six per 1000. The primary crop grown in the fields is paddy. Also grown are ground nuts. Many ponds and streams are used for agricultural irrigation. Coconut, tamarind, ground nuts, and fruits like mangoes, bananas, etc., were reported to be the other products cultivated. Agriculture engages more than 65% of the workers.

1.3 Data and Methodology

Table 1. Data

Data	Format	Year	Data Sources	Data collection
Satellite Images	Raster	2001 and 2021	USGS	download
Administrative Boundary	Vector	2011	Panchayat	Institutional Survey
Land Use/Land Cover	Raster/Vector	2001 and 2021	Image Classification	Level 1 Classification (NRSC)

2 Methodology

A methodology is developed to know about the changes. Two Multi-spectral Landsat satellite images were collected from the United States Geological Survey (USGS) for the year 2001, and 2021 to extract the LULC. Landsat satellites have the best land resolution and spectral bands to monitor effectively and record LULC changes as a result of urbanization. These two satellite images were taken in the same month (April) to avoid the seasonal effects during data analysis. After the pre-processing of satellite images, the land cover identification has to be done using a supervised classification method with a maximum likelihood algorithm. It is necessary to do the change detection analysis. The identified and land cover classes for each year, the method suggested by the National Remote Sensing Agency in level-I classification has to follow. Ground truth data and field checks need to be carried out to finalize the maps.

3 Result and Discussion

LULC refers to the use of land for activities such as agriculture, conservation, development, parks, wildlife habitats, urban areas, or any other activity, as well as the results of human-environment interactions in a specific location, as influenced by socioeconomic dynamics and climate change processes. Identification of LULC has become a key component of sustainability research and is essential for assessing regional, local, and global environmental change. On land, human influence and population have grown significantly over the past century, and change is a dynamic and ongoing process over time. For effective planning, sustainable development, environmental monitoring, global change, and the calculation of forest degradation, accurate and up-to-date LULC maps are crucial.

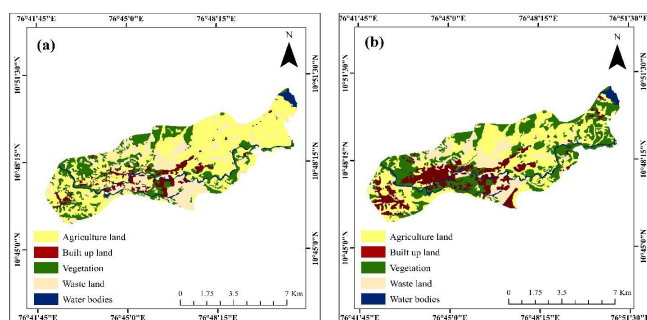
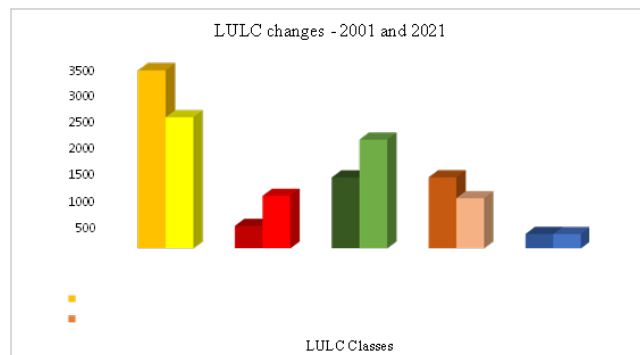


Fig. 2. LULC Detection in Pudusseri Gramapanchayat of Palakkad Gap region



LULC adjustments in the Palakkad Gap region's Pudusseri Grama panchayat. Agriculture occupied the majority of Pudusseri grama panchayat's land in 2001, making up around 3373.52 hectares of the grama panchayat's overall area. However, in 2021, there were only 2487.38 hectares of arable land. About 430.65 hectares of land were considered to be built in 2001. But as of 2021, there are now roughly 1002.01 hectares of built-up land. In 2001, there was less vegetation; it covered roughly 1349.85 hectares. However, it was amended to 2064.66 hectares in 2021. In the year 2001, there were roughly 1352.39 hectares of wasteland. It has dropped by roughly 955.13 hectares in 2021. The waterbodies were approximately 277.89 hectares in size in 2001, but by 2021 they had shrunk to 275.12 hectares. The total area of land in 2001 was roughly 6784.3 hectares. About 6784.3 hectares of land were present overall in 2021.

Table 2.

Sl No	LULC	2001(Hect)	2021(Hect)
1	Agricultural land	3373.52	2487.38
2	Built up land	430.65	1002.01
3	Vegetation	1349.85	2064.66
4	Wastelands	1352.39	955.13
5	Water bodies	277.89	275.12
		6784.3	6784.3

3.1 Urban Growth in terms of Built-up

The built-up area of the study area has increased from 430.65 hectares to 1002.01 hectares during the period of 2001 – 2021. The total geographical area during the year 2001 was 6784.3 hectares, out of which the built-up area shares an area of 430.65 hectares and the rest 6353.65 hectares noticed as non-built-up area. Since the geographical area was not varied during the study period, the built-up area shares 1002.01 hectares and contributed 5782.9 hectares during the year 2021.

The increase in built-up area has taken place between the years 2001 -2021, in which it was extended from 430.65

Table 3.

Year	Total area (Hect)	Builtup area (Hect)	Builtup area (%)	Changes in Builtup area (Hect)	Changes in Builtup area (%)
2001	6784.3	430.65	6.34	-	-
2021	6784.3	1002.01	14.76	571.36	132.80

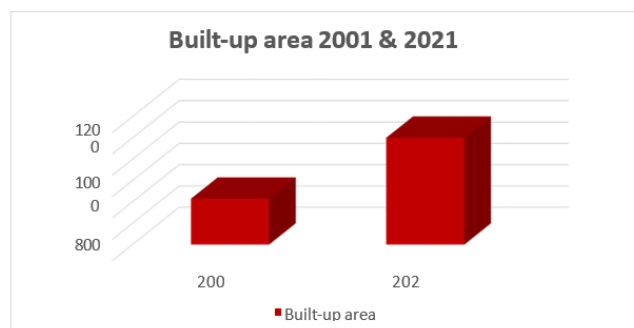


Fig. 3.

hectares to 1002.01 hectares. The built-up was extracted from Landsat imageries of 2001 and 2021 for measuring urban expansion of the study area.

3.2 Findings, Suggestion and Recommendations

The work is carried out on the impacts of urban growth on land use landcover changes in the Puduserri Gram panchayat using geospatial techniques. The main focus of the study was the impacts of urban growth on land use landcover change in the Puduserri gram panchayat in Palakkad gap region. The major two strong objectives in the previous chapter have made an attempt to find the reasons and solutions for the changes in land use landcover due to impacts of urban growth in Puduserri gram panchayat in the Palakkad gap region. The changes in the urban growth have affected the LULC greatly in this region. The findings and suggestions are given below.

3.2.1 Findings

- Land use land cover changes of Puduserri Gram panchayat in Palakkad Gap Region.
 - The agricultural had showed a tremendous decrease from the period 2001 to 2021. Most of the agricultural area was converted to build-up land.
 - The built-up land had been increased. In the period 2001, it was only 430.65 hectares but there was a tremendous increase in the period 2021.

- Vegetation has been increased in the period 2001-2021.
- Wasteland had a tremendous decrease in the period 2001-2021
- Water bodies had a tremendous decrease from 2001 to 2021.

2. The urban growth in terms of built-up area.

- The built-up area of the study area has increased from 430.65 hectares to 1002.01 hectares during the period of 2001 – 2021.
- The total geographical area during the year 2001 was 6784.3 hectares, out of which the built-up area shares an area of 430.65 hectares and the rest 6353.65 hectares noticed as non-built-up area.
- Since the geographical area was not varied during the study period, the built-up area shares 1002.01 hectares and the non-built-up area contributed 5782.9 hectares during the year 2021.

4 Conclusion

The idea of the study reveals that the Puduserri Grama panchayat is urbanized day by day. The changes themselves debit that and the urbanization also increases. From the analysis done it is clear that the urbanization increases and the land use also has been increases both go hand in hand and are directly proportional. When urbanization increases land use also increases. Even though the development is taking place there are a lot of things that need to be taken care of.

Palakkad Gap or Palghat Gap is a low mountain pass in the Western Ghats between Coimbatore in Tamil Nadu and Palakkad in Kerala. It has an average elevation of 140 meters with a width of 24–30 kilometers. The pass is located between the Nilgiri Hills to the north and Anaimalai Hills to the south.

Urban expansion is the process of economic agglomerations expanding and contracting. Urbanization, the layout of cities, the organisation of economic activity, and the expansion of the national economy have all been proven to be significantly influenced by the pattern of concentration of economic activity and its evolution. Palakkad Gap or Palghat Gap is a low mountain pass in the Western Ghats between Coimbatore in Tamil Nadu and Palakkad in Kerala. It is between 24 and 30 km wide, with an average elevation of 140 meters. The Palakkad gap will offer a variety of opportunities for people in the future, hence Palakkad's growth as an urban core is crucial. The difference significantly affects the summertime temperature in Kerala's Palakkad Plain. The study's primary goals were to assess the changes in land cover in the Puduserri grama panchayat in the Palakkad gap area and to calculate the rate of urban growth in terms of built-up area.

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