

# Dynamics of Land Use Land Cover of Southern India: A Review

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## ABSTRACT

Land use land cover (LULC) change detection is pivotal for the understanding and analysis of the interactions and associations of humans and environment. LULC can show the pattern of human usage of land which plays an important role in urbanisation. The study on the change of land use pattern is of great significance as it aligns with the temperature of the area, urban microclimate and sustainable development. This paper reviews the LULC dynamics in the city of Bengaluru, lying to the South of India. The study also focusses on the importance of remote sensing technology for the LULC dynamics analysis. There is no standard for land use classification, which provides a hindrance to the collection and analysis of data. Remote sensing along with GIS proved to be an efficient method for the classification of LULC data. Anthropogenic activities are the major reason for the LULC changes in the study area as it is an urban center. The main aim of the present work is to review the previous work and to analyze the spatio-temporal changes in LULC pattern of Bengaluru city. Many articles were reviewed for the process, which focused on LULC classification using software like ArcGIS, ERDAS and QGIS using supervised and unsupervised classification. Previous studies show that there has been a dramatic change of agricultural land use, water body and open areas to build up

settlement. Most of the open areas were converted into build up which is a major consequence of urbanisation and population explosion. As a conclusion the reviewed articles show that LULC is a result of human drivers which results in the increase in global urban temperature.

**Keywords:** LULC, ArcGIS, ERDAS, QGIS.

## INTRODUCTION

Change in land use and land cover (LULC) and increase in land temperature are one of the major ecological consequences due to the rapid urbanisation and industrialisation of an area.<sup>[1]</sup> Some of the major reasons for the LULC dynamics are mining, urban sprawl, population explosion, poverty, unplanned developments etc.<sup>[2]</sup> Urbanisation is both a boon a bane to the society. A boon as it helps to live people in a modern manner and a bane as it leads to environmental and climatic impacts<sup>[3]</sup>. Majority of the urban population expansion takes place in the developing countries than the developed countries<sup>[4]</sup>. There could be 72% expansion of population in the global urban population between 2000 and 2030 where built-up areas of cities increase by 175%<sup>[5]</sup>.

## Urbanisation

More than half of the world's population resides in cities<sup>[6]</sup>. There is a considerable change in land use and land cover caused due to urbanisation as many cities are

expanding. As the urbanisation increases people's accessibility to nature decreases. The impact of urbanisation on both environment including temperature, air and water quality, vegetation etc.) and humans (diseases) needed to be understood especially in the areas where development is taking in a fast pace [7].

Since urbanization frequently promotes a non-inclusive transition towards "global cities," it has been primarily portrayed as disenfranchising for city marginals [8]. There is room to examine sectoral and piecemeal effects on various marginalized classes because the effects of urbanization and the ensuing landscape changes on rural agrarian communities have frequently been examined through comprehensive and singular narratives of exclusion [9]. The green natural resources of forest cover, water bodies, and agricultural areas have been eroded by unplanned economic and industrial activities that have resulted in fast urbanization, industrialization, infrastructure development, and concomitant population growth. The existing literatures analyses an important urban phenomenon called Urban Heat Island (UHI) but have not mentioned about the Heat Stress Vulnerability Index (HSVI) which is addressed in the present study. The present methodology intends to study the spatial transformation of Bengaluru city over the period of study.

### **Remote Sensing and GIS**

Remote sensing is defined as the art and science of acquiring information about an event or phenomenon without actual physical contact with the event or phenomenon. Remote sensing is the most efficient technique that could be used for the estimation and analysis of land use land cover dynamics. The commonly used data in the remote sensing technique is the satellite images. The most commonly used ones are the Landsat satellite series especially for the time series analysis of the LULC changes. But these satellites often fall short of accuracy due to its low spatial resolution especially in the complex urban

rural landscapes [10]. As an alternative, high resolution satellites images like IKONOS, Quickbird and WorldView can be used.

LULC models can be created by utilizing land cover maps of both current and historic times which is used along with the forces responsible for the LULC changes [11]. Remote sensing data are perfect for modeling change because of a number of features, most notably repeated synoptic coverage with consistent observation at a comparatively low cost [12]. This raster representation of the surface of the world provides ease of use, comprehensiveness, and effective processing for study. These observations can subsequently be used to create empirical diagnostic models of LULC change. However, these statistics must be connected to socioeconomic data in order to comprehend the factors behind such apparent shift.

### **Impacts of Urbanisation**

#### **(a) LULC changes**

There has been an extensive change in the land use land cover in the study area due to rapid urbanisation and the growing demands in the area. There are a lot of previous studies that mention the impact of LULC changes in the study area with long term and short-term impacts. Some of the short-term impacts of the LULC changes include poor sanitation, air/water quality deterioration, ruined natural ecosystems, increased solid waste etc. Meanwhile the long-term impacts include Land Surface Temperature, Urban Heat Island, loss of biodiversity etc. [13]. The most used method for the assessment of LULC dynamics of an area is the remote sensing technology where satellite images are used. The most commonly used software for the assessment of LULC changes are ArcGIS, Erdas, QGIS etc.

Assessing land-cover changes over time and following alteration processes across huge areas and over extended periods of time can be challenging due to the large amount of data and technology required [14]. Considering the availability of contemporary processing and analysis, a

large portion of historical Earth Observation (EO) images has remained underused up to this point. A substantial portion of old EO imagery remains unutilized despite the constraints of conventional computers. EO research is further encouraged by the Google Earth Engine (GEE) platform [15]. In this approach, GEE easily resolves many of the constraints related to downloading, storing, and processing data, which typically arise when studying such a big volume of Geo Big Data. Using high-resolution, publicly available satellite data, Google Earth Engine (GEE) provides a platform that may be utilized to investigate more detailed elements of LULC and meteorological variables.

### **(b) Land Surface Temperature**

Unplanned urban growth with quickly shifting LULC modifies the Land Surface Temperature (LST), which has an impact on the urban setting's quality. The permanent loss of green space and open spaces as well as the expansion of built-up regions, which changes the urban temperature and natural environment, are some of the main problems associated with this uncontrolled development in urban areas [16]. One of the most critical parameters in assessing the urban climate and quality of urban environment is LST. The main causes of rising LST in urban settings include building expansion both horizontally and vertically, the amount of space between buildings, and the growth of grey infrastructure [17].

There are various methodologies mentioned in different literature for the estimation LST using remote sensing data. Different indices viz., Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI) can be used as the indicators of urban climate. Even though NDVI is used as an indicator, the high temperature exhibition of vegetation and open lands due to seasonal variation provides a hindrance in using NDVI alone as the indicator [18]. The significant contributors of LST are built up areas with

reflective surfaces and high surface radiant temperature. LULC classification is used to measure the extent of urbanisation. The factors considered in NDBI are the buildings, roads and other infrastructures like bridges and pavements, primarily the Impervious cover (IC).

### **(c) Urban Heat Island**

The urban areas have higher temperature both surface and air than the surrounding sub urban and rural areas. This phenomenon is known as Urban Heat Island (UHI) effect. Land surface properties, local climate, season, geographical location of the city, demographic features etc. are responsible for the phenomenon of UHI [5]. Additionally, compared to non-urban environments, cities typically have more buildings, asphalt walkways, roads, and less vegetation. These urban surface characteristics lead to higher heat storage during the day and, thus, more heating at night than natural surfaces. The lower evapotranspiration and higher Bowen ratio help the urban surfaces warm faster than the sub urban or rural areas [19]. Due to variations in the aforementioned controlling parameters, prior estimations show that UHI intensity is very geographically dependent and varies significantly among cities. On an annual scale UHI intensity is greater on daytime. Thus, it is important to focus on urbanizing cities in these emerging regions to find out why their UHI intensity is higher at night than during the day.

## **CONCLUSION**

The uncontrolled development of land use in the Bengaluru city, Karnataka, Southern India has adversely affected natural resources as well as the local ecology. One of the major reasons for this is the lack of public awareness regarding the negative impacts of LULC dynamics. Visualizing LULC dynamic patterns provides insights into the need for proper and planned development, particularly in urban areas. The present work highlights the impact of urbanization on changes in LULC and its

influence on land surface temperature, leading to the urban heat island phenomenon. The study also helps in understanding potential future LULC changes and the corresponding variation in urban temperatures. Consequently, the findings may support policymakers in planning cities and towns in alignment with the 11<sup>th</sup> Sustainable Development Goal.

**Declaration by Authors**

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