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Comprehensive Analysis of Land Use and Land Cover Change Detection Using Bhuvan Satellite Data: A Case Study of Karnataka State, India

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Abstract

This study sheds light on the dynamic patterns of land use and land cover changes in Karnataka State, India, utilizing Bhuvan satellite data. Over a span of three years (2005-06, 2011-12, and 2015-16), digital change detection techniques were employed to analyze and map the evolving landscape. The investigation utilized a combination of Bhuvan Geoportal and QGIS open-source software for data extraction, thematic mapping, and analysis. Statistical data, graphical representations, and pie diagrams were utilized to quantify and visualize the observed changes in land utilization. The analysis revealed significant fluctuations in built-up areas, agricultural lands, forests, and water bodies. These findings provide valuable insights into the evolving landscape of Karnataka, highlighting the need for sustainable land management practices. Decision-makers can utilize this information to formulate effective policies and strategies aimed at conserving natural resources, preserving biodiversity, and promoting sustainable development in the region.

Keywords: Land Use; Land Cover; Change Detection; Bhuvan Satellite Data; Karnataka

Introduction

Land use encompasses human activities and the diverse range of purposes for which land is utilized, while land cover refers to the natural features observed on the Earth's surface, including vegetation, water bodies, soil, rocks, and artificial structures (NRSA, 1989). Consequently, the alteration of land use and land cover has emerged as a focal point within the realm of environmental change studies⁽¹⁾

Within the research community, land cover pertains to the physical attributes

of the Earth's surface, encompassing aspects such as soil distribution, water bodies, vegetation, and other physical characteristics. On the other hand, land use denotes the manner in which land is utilized by human populations and their habitats, encompassing activities such as settlement establishment, agriculture, industrial development, recreational spaces, and parks, among others. Although land use often correlates with land cover, both terms are intricately linked yet interchangeable. For instance, while a settlement

constitutes a land cover, the inclusion of buildings, whether for residential or industrial purposes, indicates the land use component⁽²⁾.

Land, as one of the most vital natural resources, serves as the foundation for all human activities. Unlike geological processes, land use is subject to seasonal variations and continuous changes. The burgeoning population and increasing human activities have heightened the demand for limited land and soil resources, necessitated for various purposes such as forestry, agriculture, urban development, and industrial activities. Thus, understanding the rate and nature of changes in land resource utilization is imperative for effective planning, management, and sustainable utilization of these resources⁽³⁾.

According to Kotoky et al.⁽⁴⁾, Geographic Information System (GIS) provides an excellent platform for spatial data analysis and interpretation. It serves as a valuable tool not only for monitoring environmental changes and degraded lands but also facilitates the analysis of other environmental variables⁽⁵⁾.

In the current study, we conducted an examination in Karnataka State to detect changes in land use and land cover.

Study Area

Geographical Overview

Karnataka, located in the southwestern part of India, is known for its diverse landscape, encompassing coastal plains, lush forests, fertile plateaus, and the rugged terrain of the Western Ghats. The state is bordered by the Arabian Sea to the west, Maharashtra and Goa to the north, Telangana and Andhra Pradesh to the east, and Tamil Nadu and Kerala to the south.

Population

With a population of over 70 million people, Karnataka is one of the most populous states in India. The capital city, Bengaluru, is a major hub of technology and innovation and is known as the "Silicon Valley of India." Other significant cities include Mysore, Hubli-Dharwad, Mangalore, and Belgaum.

Climate

Karnataka experiences a diverse range of climates, ranging from tropical in the coastal regions to semi-arid and tropical wet and dry climates in the interior regions. The state receives heavy rainfall during the monsoon season (June to September), which supports agriculture and sustains numerous rivers and water bodies.

• Major Cities

- **Bengaluru:** The capital city and the largest urban center in Karnataka, known for its vibrant culture, IT industry, and educational institutions.
- **Mysore:** Renowned for its rich history, palaces, and cultural heritage, Mysore is a major tourist

destination.

- **Mangalore:** A coastal city known for its port, beaches, and diverse cuisine.
- **Hubli-Dharwad:** Twin cities known for trade, commerce, and educational institutions.
- **Belgaum:** A historic city located in the northern part of the state, known for its fort and temples.

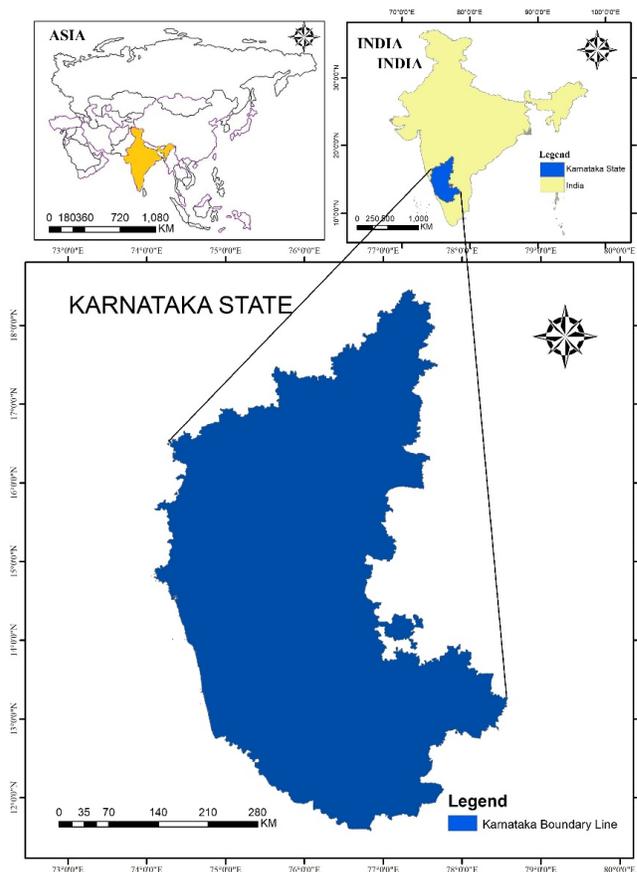


Fig. 1. Location map of Karnataka

• Water Bodies

Karnataka is blessed with several rivers, lakes, and reservoirs, which are vital sources of water for irrigation, drinking, and industrial purposes. Major rivers include the Krishna, Kaveri, Tungabhadra, and Sharavathi. Important water bodies include the Tungabhadra Dam, Almatti Dam, and Sharavathi Reservoir.

• Transportation

The state has a well-developed transportation network, including roadways, railways, and airways. Bengaluru serves as a major transportation hub, with an international airport connecting the state to domestic and international destinations. The Karnataka State Road Transport Corporation

(KSRTC) operates a vast network of buses connecting various towns and cities within the state and neighboring regions. The South Western Railway zone provides rail connectivity to different parts of the country.

• **Land Use and Land Cover**

The land use and land cover in Karnataka exhibit diverse patterns, reflecting the state's varied geography and human activities. Urban areas are expanding rapidly, especially in Bengaluru and other major cities, leading to changes in land cover such as the conversion of agricultural land and forest areas into built-up areas. Agriculture remains a dominant land use, with crops such as rice, sugarcane, and cotton cultivated in the fertile plains. Forested areas in the Western Ghats and other regions are vital for biodiversity conservation and watershed management. The state also has significant mining activities, particularly in regions rich in minerals like iron ore and manganese. Wetlands, rivers, and lakes are crucial for supporting ecosystems, providing water resources, and sustaining livelihoods. The study aims to analyze and understand the dynamics of land use and land cover changes in Karnataka over the specified time periods, using remote sensing and GIS techniques.

Objectives

The primary objectives of this study are as follows:

- To analyze the changes in land use and land cover in Karnataka State, India, for the years 2005-06, 2011-12, and 2015-16.
- To employ Bhuvan satellite data and QGIS software for extracting thematic maps and conducting change detection analysis.
- To quantify the observed land use and land cover changes in terms of area coverage using statistical methods and graphical representations.

Methodology

The study utilizes Bhuvan satellite data obtained from the National Remote Sensing Centre, Hyderabad, covering the periods of 2005-06, 2011-12, and 2015-16. Multi-temporal satellite imagery from Resourcesat-1 LISS III sensor is employed for each time period, capturing seasonal variations in land cover. The study area encompasses Karnataka State, with an area of interest of 192,051 square kilometers.

Using Bhuvan Geoportal and QGIS open-source software, thematic maps are extracted and analyzed to detect changes in land use and land cover over the study periods. The land cover categories include Built-up Urban, Built-up Rural, Agriculture, Forest, Barren lands, Wetlands, among others. Statistical analysis and graphical representations are utilized to quantify and visualize the observed changes in land cover classes.

Result and Discussion

The analysis of land use and land cover changes in Karnataka State, India, for the years 2005-06, 2011-12, and 2015-16 reveals significant temporal variations across various categories. The Figures 2, 3 and 4 the land use and land cover changes in Karnataka State.

Builtup Areas (Urban and Mining)

Urban built-up areas exhibited a steady increase from 2319.4 sq. km in 2005-06 to 2841.52 sq. km in 2011-12, followed by a slight decline to 2652.29 sq. km in 2015-16.

Similarly, mining areas witnessed substantial growth from 265.18 sq. km in 2005-06 to 552.68 sq. km in 2011-12, further increasing to 608.91 sq. km in 2015-16.

• **Agricultural Areas (Plantation, Crop land, Fallow)**

- The area under plantation agriculture increased from 12669.62 sq. km in 2005-06 to 17579.7 sq. km in 2011-12, before declining to 14899.28 sq. km in 2015-16.
- Crop land experienced a slight increase from 98661.31 sq. km in 2005-06 to 111481 sq. km in 2011-12, followed by a decrease to 91571.95 sq. km in 2015-16.
- Conversely, fallow agricultural land decreased from 22869.9 sq. km in 2005-06 to 3725.06 sq. km in 2011-12 and further decreased to 2759.61 sq. km in 2015-16.

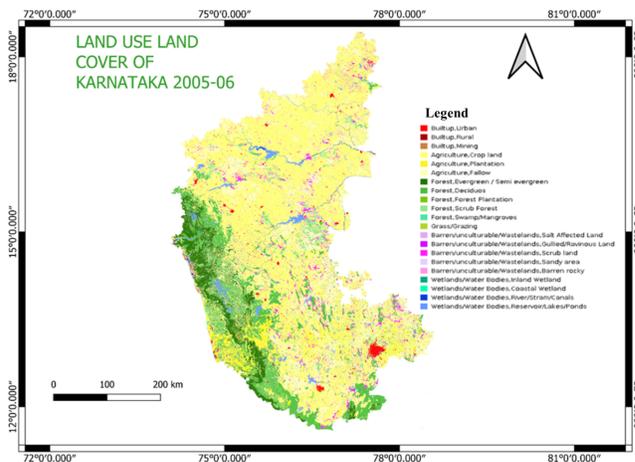


Fig. 2. Land use land cover of Karnataka 2005-06 Source: Bhuvan Geoportal

The land use and land cover of Karnataka State for the years 2005–2006, 2011–2012, and 2015–2016 are shown in terms of area (sq. km) in Figures 5, 6 and 7. The attribute table displays the area data for each land use type, which



Table 1. Land use land cover of Karnataka in the periods of 2005-06, 2011-12, and 2015-16

Sl. No	Land Use Land Cover	Area (Sq. Km)		
		2005-2006	2011-2012	2015-2016
1	Builtup, Urban	2319.4	2841.52	2652.29
2	Builtup, Mining	265.18	552.68	608.91
3	Agriculture, Plantation	12669.62	17579.7	14899.28
4	Forest, Evergreen/ Semi evergreen	10096.16	10951.5	9609.1
5	Forest, Forest Plantation	1545.52	2625.82	1778.75
6	Forest, Swamp/ Mangroves	19.46	6.29	6.25
7	Barren/unculturable/ Wastelands, Salt Affected land	520.99	682.06	524.99
8	Barren/unculturable/ Wastelands, Scrub land	6423.9	7076.06	6194.4
9	Barren/unculturable/ Wastelands, Barren rocky	1428.27	1943.22	1550.45
10	Wetlands/Water Bodies, Coastal Wetland	40.39	25.59	29.86
11	Wetlands/Water Bodies, Reservoir/Lakes/Ponds	5264.83	5305.48	4258.79
12	Builtup, Rural	1907.12	3462.27	2807.49
13	Agriculture, Crop land	98661.31	111481	91571.95
14	Agriculture, Fallow	22869.9	3725.06	2759.61
15	Forest, Deciduous	19953.37	15721.3	12475.66
16	Forest, Scrub Forest	5297.68	5345.64	6076.07
17	Grass/Grazing	647.74	313.08	235.31
18	Barren/unculturable/ Wastelands, Gullied/Ravinous Land	128.5	111.32	84.32
19	Barren/unculturable/ Wastelands, Sandy area	11.65	7.17	10.54
20	Wetlands/Water Bodies, Inland Wetland	26.64	31.16	23.98
21	Wetlands/Water Bodies, River/Stream/canals	1953.77	2003.02	1642.82

Source: Bhuvan Geoportal

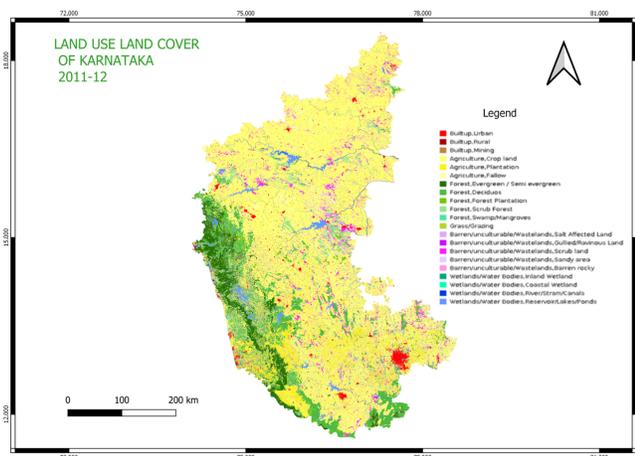


Fig. 3. Land use land cover of Karnataka 2011-12 Source: Bhuvan Geoportal

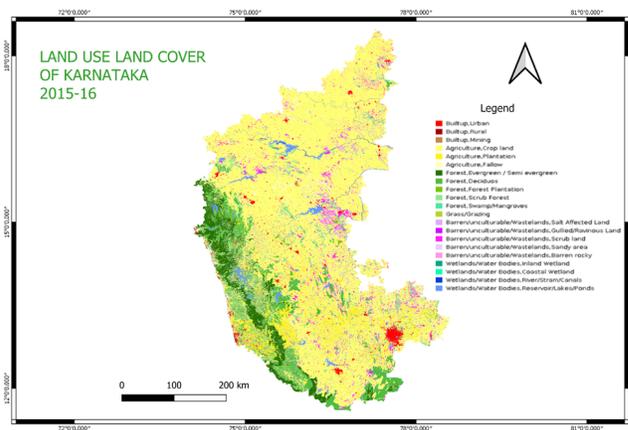


Fig. 4. Land use land cover of Karnataka 2015-16. Source: Bhuvan Geoportal

are computed in square kilometers. The classes of land use and land cover include Built-up Urban, Built-up Rural, Built-up Mining, Agriculture, Plantation, Forest (including Evergreen/Semi-evergreen and Forest Plantation), Barren/Unculturable/Wastelands (like Salt-Affected Land,

Scrub Land, and Barren Rocky), Wetlands/Water Bodies (like Coastal Wetland, Reservoir/Lakes/Ponds, Inland Wetland, and River/Stream/Canals), Agriculture (Crop Land and Fallow), Forest (Scrub Forest), Grass/Grazing, and Barren/Unculturable/Wastelands (Sandy Area and Gullied/Ravinous Land).



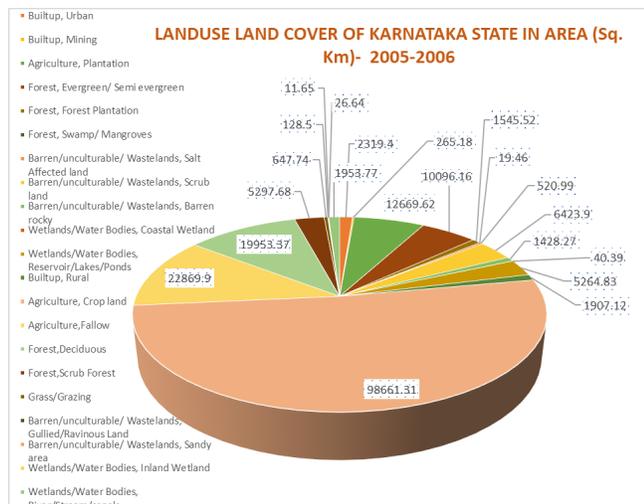


Fig. 5. Land use Land Cover of Karnataka State in Area wise (Sq. Km) 2005-2006

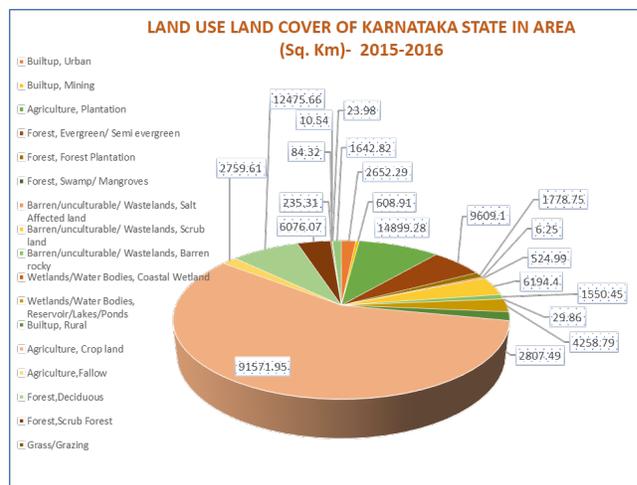


Fig. 7. Land use Land Cover of Karnataka State in Area wise (Sq. Km) 2015-2016

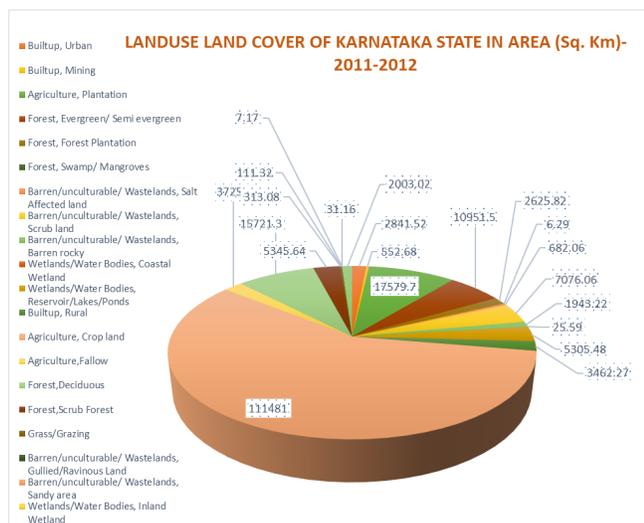


Fig. 6. Land use Land Cover of Karnataka State in Area wise (Sq. Km)- 2011-2012

The distribution and extent of various land use and land cover types throughout Karnataka State over the given time periods are shown visually in these figures. Informed decisions about land management and resource planning are made easier by the examination of these numbers, which provide insightful information about the region's evolving land use trends.

- **Forested Areas (Evergreen/Semi-evergreen, Forest Plantation, Deciduous, Scrub Forest)**
 - The forest cover exhibited mixed trends across different types. Evergreen/semi-evergreen forests slightly decreased from 10096.16 sq. km in 2005-06

- to 9609.1 sq. km in 2015-16.
- Forest plantation areas increased from 1545.52 sq. km in 2005-06 to 2625.82 sq. km in 2011-12, before declining to 1778.75 sq. km in 2015-16.
- Deciduous forests showed a consistent decrease from 19953.37 sq. km in 2005-06 to 12475.66 sq. km in 2015-16.
- Scrub forests increased from 5297.68 sq. km in 2005-06 to 5345.64 sq. km in 2011-12 and further increased to 6076.07 sq. km in 2015-16.

- **Barren Lands (Salt Affected, Scrub, Barren Rocky, Gullied/Ravinous, Sandy)**

Various barren land categories exhibited fluctuations over the study periods, with no consistent trend observed.

- **Wetlands/Water Bodies (Coastal Wetland, Reservoir/Lakes/Ponds, Inland Wetland, River/Stream/Canals)**

Wetlands and water bodies displayed varying patterns, with some categories showing a decline while others remained relatively stable.

Conclusion

The analysis of land use and land cover changes in Karnataka State highlights the dynamic nature of the region's landscape, influenced by both natural processes and human activities. The observed trends underscore the importance of continuous monitoring and management efforts to ensure sustainable land use practices and environmental conservation.

The increase in urban and mining areas reflects the ongoing urbanization and industrialization processes in the state,



posing challenges in terms of habitat loss and environmental degradation. Similarly, changes in agricultural land use patterns signify shifts in cropping patterns and agricultural practices, influenced by factors such as technological advancements and market dynamics.

The fluctuations in forested areas indicate the complex interplay between conservation efforts, natural disturbances, and anthropogenic pressures. Efforts to preserve and restore forest ecosystems are crucial for maintaining biodiversity and ecosystem services in the region.

Furthermore, the fluctuations in barren lands and wetlands/water bodies highlight the need for comprehensive land management strategies, considering the diverse ecological and socio-economic functions of these landscapes.

Overall, the findings of this study provide valuable insights for policymakers, land managers, and researchers to formulate informed strategies for sustainable land use planning, biodiversity conservation, and ecosystem restoration in Kar-

nataka State, India.

References

- 1) Meyer WB, Turner BL. Land-use/land-cover change: challenges for geographers. *GeoJournal*. 1996;39(3):237-240. Available from: <https://dx.doi.org/10.1007/bf00188373>.
- 2) Chaudhary BS, Saroha GP, Yadav M. Human Induced Land Use/Land Cover Changes in Northern Part of Gurgaon District, Haryana, India: Natural Resources Census Concept. *Journal of Human Ecology*. 2008;23(3):243-252. Available from: <https://dx.doi.org/10.1080/09709274.2008.11906077>.
- 3) Gautam NC, Narayanan ER. Satellite remote techniques for natural resources survey. *Management*. 1983;p. 177-181.
- 4) Kotoky P, Dutta MK, Borah GC. Changes in landuse and landcover along the Dhansiri River channel, Assam — A remote sensing and GIS approach. *Journal of the Geological Society of India*. 2012;79(1):61-68. Available from: <https://dx.doi.org/10.1007/s12594-012-0002-6>.
- 5) Reddy GPO, Maji AK, Srinivas CV, Velayutham M. Geomorphological analysis for inventory of degraded lands in a river basin of basaltic terrain using remote sensing and GIS. *Journal of the Indian Society of Remote Sensing*. 2002;30(1-2):15-31. Available from: <https://dx.doi.org/10.1007/bf02989973>.