GEOGRAPHICAL ANALYSIS

RESEARCH ARTICLE

Land Use Land Cover Change Detection Over Bantwala Taluka of South Canara District

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Abstract

For various decision support systems, the detection of land use and land cover (LULC) change based on remote sensing data is a crucial source of information. Land conservation, sustainable development, and the management of water resources all benefit from the information gathered through the detection of changes in land use and land cover. Therefore, determining the change in land use and land cover over Bantwala is the aim of this study. For images from Landsat 7 (MSS, TM) and Landsat 8 (OLI, TIRS) taken in 2000 and 2022, obtained from the USGS earth explorer website, supervised land use & land cover classification has been done. For the accuracy of the classification, user's and producer's accuracy are calculated, and it found that the accuracy of users and producers is well accepted, and the overall accuracy calculated was 87% and 88%, respectively. A massive change from forest cover to built-up (68.45 sq. Km) and agriculture (68.26 sq. Km) is seen. These changes are seen in the study region due to population growth and the need to practice agriculture.

Keywords: Land use and land cover; Change Detection; Accuracy

1 Introduction

Changes in LULC are regarded as one of the most pressing environmental issues of global concern [1]. Change detection is the technique of finding variations in the status of a feature or phenomenon by watching it at different periods [2]. LUCC is one of the primary causes of climate change through modifying carbon, water, and energy cycles. Quality data on LUC and LUCC are critical for understanding the current and future dynamics of deforestation and its causes, such as wildfires, urbanization, cropping, biodiversity loss, and the influence of LUCC on climate change [3]. Various LULC mapping and change detection techniques have been developed and applied worldwide over the last few decades [4]. For any sustainable development program in which LULC acts as one of the key input criteria, accurate, historical data regarding the LULC changes on the Earth's surface is crucial [2]. Researchers have also asserted that land use substantially affects socioeconomic and environmental systems, with crucial trade-offs for sustainability, food security, biodiversity, and the socioeconomic vulnerability of individuals and ecosystems [4].

Due to the importance of the problem, several worldwide interdisciplinary research initiatives have been established to track and analyze LULC changes, including the Global Land Project and the Land Use and Land-Cover Change Project (GLP). Both are collaborative initiatives of the International Geosphere-Biosphere Project (IGBP), which was established in 1987 to investigate the interactions and impacts of human systems on Earth's biological processes. To look into world growth from a social standpoint, the International Human Dimension Project (IHDP) was established in 1990 [1].

Several multi-date pictures are used in remote sensing change detection and monitoring to assess LULC variations between image acquisition dates caused by diverse environmental conditions and human activity [2]. Understanding the landscape characteristics, imaging equipment, and technique used in connection to the analysis's goal is essential for effectively using satellite remote sensing to detect LULC changes [2].

The supervised classification is expected to classify the entire Bantwal taluk into Forests, Agriculture, Waterbody, Barren land, and Builtup area. The study area comprises 81 villages, with a population of around 521,902 (2011 Census) and a 740 km^2 area.

2 Study area

One of the five taluks of the Dakshina Kannada district is Bantwal. It is located between latitudes 12°40' N and 13°15' N and longitudes 74°55' E and 75°15' E. The Bantwal Taluk has a total size of 735 km^2 (73,500 hectares). According to the 2011 Census, Bantval Taluka in the Dakshina Kannada district has a total population of 395,380. One hundred ninety-six thousand seven hundred eight are men, and 198,672 are women. In Bantval Taluka, there were 76,405 families all together in 2011. Bantval Taluka's typical sex ratio is 1,010.

The taluk has a humid monsoon climate. 3819 mm of rain, or roughly 124 rainy days, were obtained in an average year. The river The Netravati and its tributaries cross the taluk from east to west. Direction. Rice is the main agricultural crop (17,113 hectares). Other crops planted include cowpea, black gram, horse gram, and green gram. Even though it is grown here, sugar cane is only found in a few small places (Roughly 72 hectares.) However, as plantation crops, only small amounts of cashews, areca nuts, coconuts, and a lesser extent, rubber are farmed. In addition, mixed crops such as bananas, jackfruit, mangoes, sweet potatoes, tapioca, cocoa, and black pepper are also cultivated.

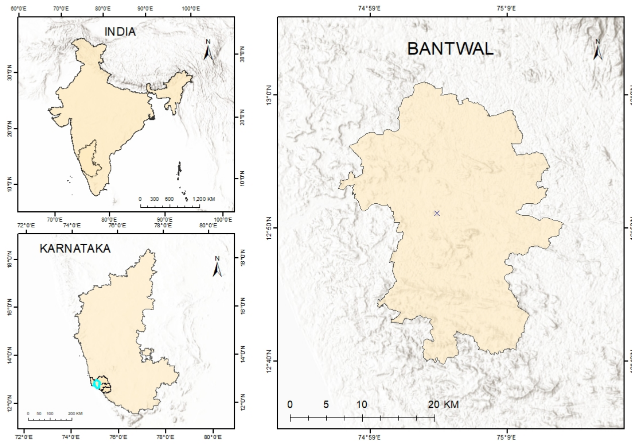

Fig. 1. Study Area

3 Data and Methodology

The Landsat 7 Multispectral Scanner System (MSS) and Thematic Mapper (TM) sensors, as well as Landsat 8's Operational Land Imager (OLI) and Thermal Infrared Sensors data, are used for the study for the year 2000 Landsat 7 and for the year 2022 Landsat 8s data is used

The table (Table 1) shows the data details, and the methodology chart (Figure 2) shows us the flow of the research.

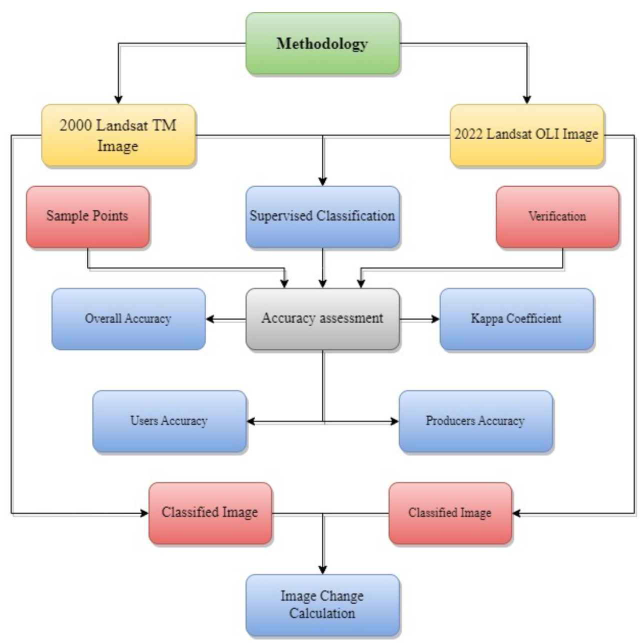

Fig. 2. Methodology

Table 1. Dataset Used

Data	Source	Spatial Resolution	Year
Landsat 7 (MSS, TM)	USGS Earth Explorer	30 m	2000
Landsat 8 (OLI, TIRS)	USGS Earth Explorer	30 m	2022

3.1 Supervised classification

Two types of classification techniques are present: supervised image classification technique and unsupervised image classification technique. In contrast, in the unsupervised after, the classification user can categorize the classified image. In this particular study supervised classification technique is used to classify the 2000 and 2022 images. Both images are classified with the help of a supervised classification technique. Various steps are followed to classify the image.

3.2 Land cover classification scheme

A categorization method that specifies the LULC classes was considered when creating the LULC map using satellite imageries. The ideal number of LULC classes depends on the specifications of a particular project for a particular application[4]. A total of five classes are considered for the classification, and the table below indicates the classes with descriptions.

Table 2. Classification Scheme

Class	Description
Agricultural land	Irrigated agricultural Area and agricultural fallow land,
Barren land	Areas devoid of vegetation; e.g., sediments, exposed rocks, landslide zones, degraded forest area
Built-up	Settlements and roads
Forest	Land with tree canopy
Water-bodies	Areas covered by perennial river

3.3 LULC Change Detection

Finding out the changes is an important process. This stage was part of the post-classification LULC evaluation. The main input for the rate of change detection procedure was supervised categorized images from 2000 and 2022. After the supervised map's raster map was transformed into a polygon (vector form), the region was determined. We first calculate the Area of each type of land cover for both photographs in order to evaluate the change over time using the below equation,

$C = [(At2 — At1)/At1 \times 100]$ (1)

where,

At1 = Area of one type of land cover at t1 time.

At2 = Area of one type of land cover at t2 time (latest)

C = Rate of change occurred in percent.

3.4 Accuracy Assessment

Accuracy evaluation is a key step in LULC classification. The completed classification may only be trusted and trustworthy after passing accuracy checks since thematic maps made from satellite scenes have a risk of inaccuracy owing to several factors, such as the procedures in classification to retrieve satellite data[4]. All the type of accuracy is calculated and reported in the table. The different accuracy is calculated using

$$1.\ \text{User Accuracy (i)} = \frac{\text{Number of correctly classified pixels in each category}}{\text{Total No.of classified pixels in that category (The Row Total)}} * 100 \quad (2)$$

$$2.\ \text{Producer Accuracy (j)} = \frac{\text{Number of correctly classified pixels in each category}}{\text{Total No.of classified pixels in that category (The Column Total)}} * 100 \quad (3)$$

$$3.\ \text{Overall Accuracy} = \frac{\text{Total No.of corectly classified pixels (Diagonal)}}{\text{Total No.of Refernce Pixels}} * 100 \quad (4)$$

$$4.\ \text{Kappa Coefficient (T)} = \frac{(TS*TCS) - \varepsilon\,(\text{Column Total}*\text{Row Total})}{TS\,2 - \varepsilon\,(\text{Column Total}*\text{Row Total})} * 100 \quad (5)$$

4 Result and Discussion

4.1 Land Use Land Cover Classification

There are two categories for the research field. First, in 2000, as seen in Figure 3. Additionally, Figure 4 displays the LULC categorization through 2022. Using images from Landsat 7 and Landsat 8, supervised classification was used to assess the change in LULC, shown in Table 3. The first categorization level includes forests, waterbodies, agricultural, barren land, and settlements. It is based on the LULC classification system.

Table 3. LULC Area Coverage

	Area in 2000(sq.Km)	Area in 2022(sq.Km)
Agriculture	136.757	137.983
Barren land	76.338	42.972
Builtup	53.852	170.491
Forest	401.360	311.791
Waterbody	3.785	8.852

Over the past 22 years, agricultural land and forest have not changed significantly, but there has been a large decline in bare land and an increase in built-up areas and waterbodies. Urbanization is one of the major threats to the region. Deforestation from various sources is seen in the study area.

Figure 5 depicts an intriguing outcome of changes over the past 22 years. The table lists the amount of territory transferred from one class to another, some of which pose major challenges to development and sustainability. The

2000's classified image shows how the entire region is covered in greenery and much less built-up land and the river is surprisingly seen with less water. The 2022nd year classified image shows quite the opposite results compared with the year 2000's classified image.

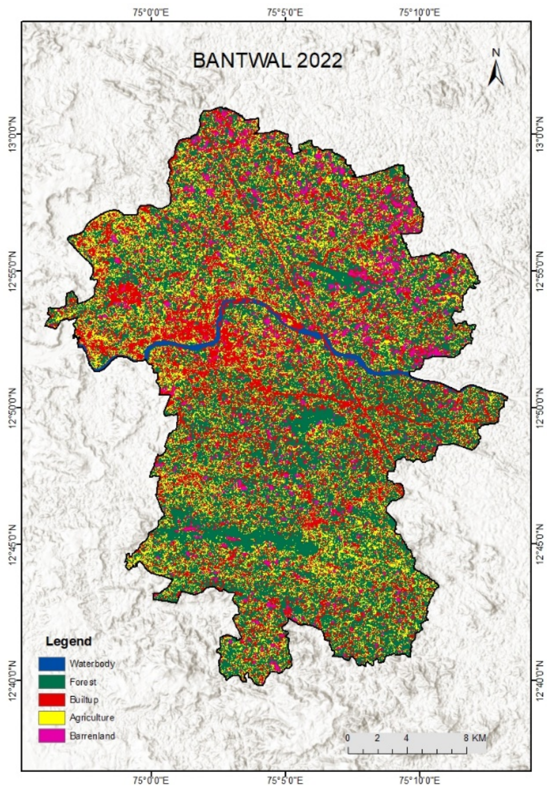

Fig. 3. LULC 2000

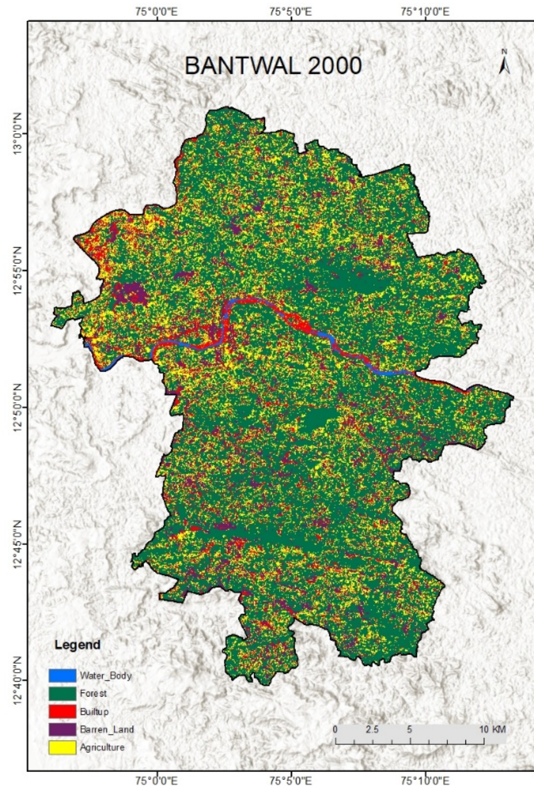

Fig. 4. LULC 2000

4.2 Change Detection

The quantitative evaluation of landscape dynamics is a crucial technique for evaluating the consequences of current land use and a device for figuring out the impact of anthropogenic activities on natural resources. In Figure 5, the LULC modifications that have occurred are visually shown.

The built-up Area and waterbody have dramatically increased in the photograph. A decrease in the percentage of arid terrain may facilitate urbanization. Approximately 68 sq km of once wooded Area have been converted to built-up, indicating an increase in urbanization, it has been noticed. By reducing the forest cover, agriculture has expanded by around 68 sq km, indicating the emergence of additional agricultural fields. A portion of the agricultural Area has also been transformed into developed and arid terrain, a symptom of urbanization.

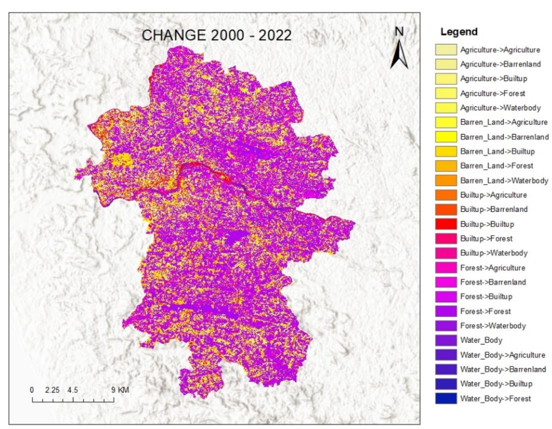

Fig. 5. Change (2000 – 2022)

Table 6. Accuracy Assessment for the year 2022

Users Accuracy		Producers Accuracy	
Waterbody	100%	Waterbody	100%
Forest	92%	Forest	92%
Builtup	88%	Builtup	88%
Barren land	77%	Barren land	91%
Agriculture	81%	Agriculture	76%
Overall Accuracy = 87%			

Table 4. Total Area (sq km) changes in LULC (2000 – 2022)

From	To	Area (sq. Km)	From	To	Area (sq. Km)
Agriculture	Waterbody	0.3258	Builtup	Agriculture	14.7267
Agriculture	Barren land	10.0413	Builtup	Builtup	23.1561
Agriculture	Builtup	39.7359	Forest	Waterbody	0.0855
Agriculture	Agriculture	44.721	Forest	Barren land	25.6239
Agriculture	Forest	47.2428	Forest	Agriculture	68.2677
Barren land	Waterbody	0.0657	Forest	Builtup	68.4522
Barren land	Barren land	4.5873	Forest	Forest	231.0165
Barren land	Forest	16.4565	Water Body	Forest	0.0018
Barren land	Agriculture	16.5636	Water Body	Barren land	0.0027
Barren land	Builtup	38.8944	Water Body	Agriculture	0.0072
Builtup	Barren land	3.3705	Water Body	Builtup	0.2124
Builtup	Waterbody	4.7079	Water Body	Water Body	3.5523
Builtup	Forest	9.8289			

4.3 Accuracy Assessment

Accuracy assessment is essential for any decision-making. These three types of accuracy are calculated to see how reliable and well-reliable the data is. According to the accuracy assessment conducted for the year 2000, overall accuracy was 88%. For the year 2022, the overall accuracy is calculated and resulted in 87%. For the users and producers, accuracy formulas are used, and the accuracies are displayed in the below Tables 5 and 6.

Table 5. Accuracy Assessment for the year 2000

Users Accuracy		Producers Accuracy	
Waterbody	100%	Waterbody	100%
Forest	88%	Forest	92%
Builtup	91%	Builtup	97%
Barren land	78%	Barren land	100%
Agriculture	81%	Agriculture	59%
Overall Accuracy = 88%			

5 Conclusion

The study indicates how GIS and Remote sensing can help us gather, classify, and obtain reliable information for future development and a sustainable future. With the help of 5 classes, the images are classified into agriculture, forest, waterbody, barren land, and built-up. In 2000, 60% of the land was covered with forest and only 13% with built-up Areas. However, in 2022, the forest has reduced by 46% and the built-up has increased to 55%, so there needs to be serious monitoring of urbanization, or else it might lead to huge disasters in the region.

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