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Remote Sensing and GIS for Mapping and Monitoring Land resources

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ABSTRACT:

Remotely sensed data is considered one of the main sources of information about the earth's cover. Land Use/ Land Cover (LU/LC) mapping is the earliest application of remote sensing technique. Since many years remotely sensed data has been used for LU/LC mapping in various parts of the India. LANDSAT–8 (OLI) data acquired on January 2018 has been downloaded and used for identification and classification of major LU/LC classes of Chopda Taluka, Dist: Jalgaon. On screen visualization and image classification were used to delineate the various LU/LC classes. Image classification is carried out in QGIS software. The various categories of LU/LC in the area recognized are forest, agricultural land, built up area, waste land, water bodies, fallow land. LU/LC mapping is very essential in finding out the soil erosion in any specific area, because; the vegetation cover has significant impact on soil erosion.

KEYWORDS: LU/LC, LANDSAT– 8(OLI), Image Classification and QGIS.

Introduction

Land use and land cover of the earth surface is changing continuously at local, regional, national and global level. These changes are wide and rapid and have significant impact on people, economy, and environment. In many cases the valuable information about urban areas, forest, agriculture, water resources etc. can be drawn just by looking at the image. Nevertheless, in some cases satellite image requires to be converted into a thematic map of different land use and land cover classes. Proper planning, management and monitoring of the natural resources depend on the availability of accurate land use information (Vijay Kumar et.al., 2004).

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. Viewing the Earth from space is now crucial to understand man's activities on his natural resource base over time. In situations of rapid and often unrecorded land use change, observations of the Earth from space provide objective information of human utilization of the landscape. Over the past years, data from the remote sensing satellites have become vital in mapping the Earth's features and infrastructures, managing natural resources and studying environmental change (Harshika A. Kaul and Ingle Sopan, 2012).

Land use and land cover mapping requires the use of other interpretation elements than just reflectance, particularly position in the landscape, size and association. In addition, knowledge of the land use systems and their extent is essential for attributing spectral reflectance curves to land cover types. A bottom-up land cover mapping approach, using classical interpretation principles, but facilitated with modern remote sensing software, is recommended. The procedure has been applied for mapping land use and land cover types of Chopda taluka from LANDSAT – 8(OLI) images.

Remote sensing data in combination with GPS and GIS technologies can give the fruitful information which can be used for planning and management of natural resources, while remaining cost- effective. (John Rogana, Dong Mei Chen,2004.)

Remote sensing technology and Geographic Information System (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. (Rane Gauri and Joshi Bhushan, 2014)

The remote sensing data source is a crucial factor for a successful land cover classification. Landsat satellite data are commonly used remote sensing data for land cover classification (Gumma et. al., 2011; Gong et al., 2013)

The successful launch of Landsat–8 on 11 February 2013 provides the continuity in the Landsat earth observation mission (Lulla et al., 2013). The Landsat–8 orbits the earth every 99min, covering the entire earth every 16days except for the highest polar latitudes. Landsat–8 follows a sun-synchronous orbit at an average altitude of 705km and 98.2° inclination. The Landsat–8 sensors include an Operational Land Imager (OLI) with nine bands, including the high-resolution panchromatic band, and a Thermal Infrared Sensor (TIRS) with two thermal bands (Kun Jia et. al., 2014)

Present study is carried out using QGIS software. It is an open source Geographic Information System which is user friendly and provides common functions and features.

Materials and Methods

Study Area

Chopda is a Taluka in Jalgaon district of Maharashtra. Maharashtra is a state in western India. Chopda extends from 21.15 to 21.45 degrees North and from 75.00 to 75.55 degrees East and has average elevation of 190 meters. It is situated in the bank of Ratnavati river and near Tapi river which is one of the major rivers in India. Most of the northern part of the study area is hilly and falls in Yawal wildlife sanctuary. The taluka is covered with excellent quality of soil which makes it increase its agricultural economy. Main crops taken in the study area include sugar cane, cotton, bananas, pulses etc.

Methodology

LANDSAT–8(OLI) images (Path 146, 147 Row 45, acquired on 03/01/2018 and 19/01/2018) (fig.2) are preprocessed in Quantum GIS software. After preprocessing 6 bands (2–7) of each image are merged to produce multiband images. Mosaic is prepared using both multiband images. The mosaic image is then clipped with the boundary of the study area. Then Classification of the image is carried out using Semi-Automatic Classification Plugin of the Q GIS. Different Land Use/ Land Cover classes are identified with the help of elements of image interpretation and high-resolution images of Google earth. Maximum likelihood technique is employed to get the land use land cover map.

Maximum Likelihood algorithm calculates the probability distributions for the classes, related to Bayes 'theorem, estimating if a pixel belongs to a land cover class. The probability distributions for the classes are assumed of form of multivariate normal models (Richards & Jia, 2006). To use this algorithm, enough pixels are required for each training area allowing for the calculation of the covariance matrix.

The discriminate function, described by Richards and Jia (2006), is calculated for every pixel as:

$$g_k(x) = \ln p(C_k) - 1/2 \ln|\Sigma_k| - 1/2 (x - y_k)^t \Sigma_k^{-1} (x - y_k) \quad (1)$$

where:
• Ck = land cover class k;
• x = spectral signature vector of an image pixel;
• p(Ck) = probability that the correct class is Ck;
• |Σk|= determinant of the covariance matrix of the data in class Ck;
• ${}^t\Sigma_k^{-1}$= inverse of the covariance matrix;
• yk = spectral signature vector of class k.

Therefore:

$$x \in C_k \Leftrightarrow g_k(x) > g_j(x) \forall k \neq j \quad (2)$$

Results and Discussions

The final classified map is shown in Fig.4. Result shows that out of total studied area 29% of the area is uncultivated agricultural land, 25% is cultivated land, 18% is hilly area, 10% is under forest, 7% is under built up area and only 2% area is covered by water bodies (Table 1). 54% of the total area is agricultural land.

Northern part of the study area is more prone to erosion because of topography and geomorphological features and has low fertile soil. Because of hilly region northern part has coarse soil structure with low water retention capacity. As we move down the line from north to south agricultural land increases and the coverage of fertile soil increases. Near hilly area lack of irrigation facilities enforces the rainfed agriculture. Hilly area falls under Yawal wildlife sanctuary and bears thick forest, but some patches of wasteland in the area shows deforestation and human encroachment. Some wasteland is also found near river banks and forest near river banks show patchy pattern due to action of erosion and deforestation.

Conclusions

- LU/LC classes in the study area are clearly discernable and distinct.
- The supervised classification technique though accurate for some classes like water sand but ground verification and knowledge of the area is required for improving the accuracy.
- Dominant Land Use in the study area is agriculture (54%). This could be partly due to single date image. The fallow land could be due to less fertile soil, resulted from high soil erosion in the area, lack of water for irrigation etc.
- Hilly area is predominant in the northern part (18%) and can be utilized for afforestation to arrest soil erosion.
- QGIS is user-friendly, compatible and freely available software which can be a good substitute for other costly GIS softwares.

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Author contribution:

Mohamad Hanif (research student) performing the research work and data collection. He is the corresponding author of the manuscript; P.R. Patil (Associate Professor) has a responsibility of guidance for the research work.

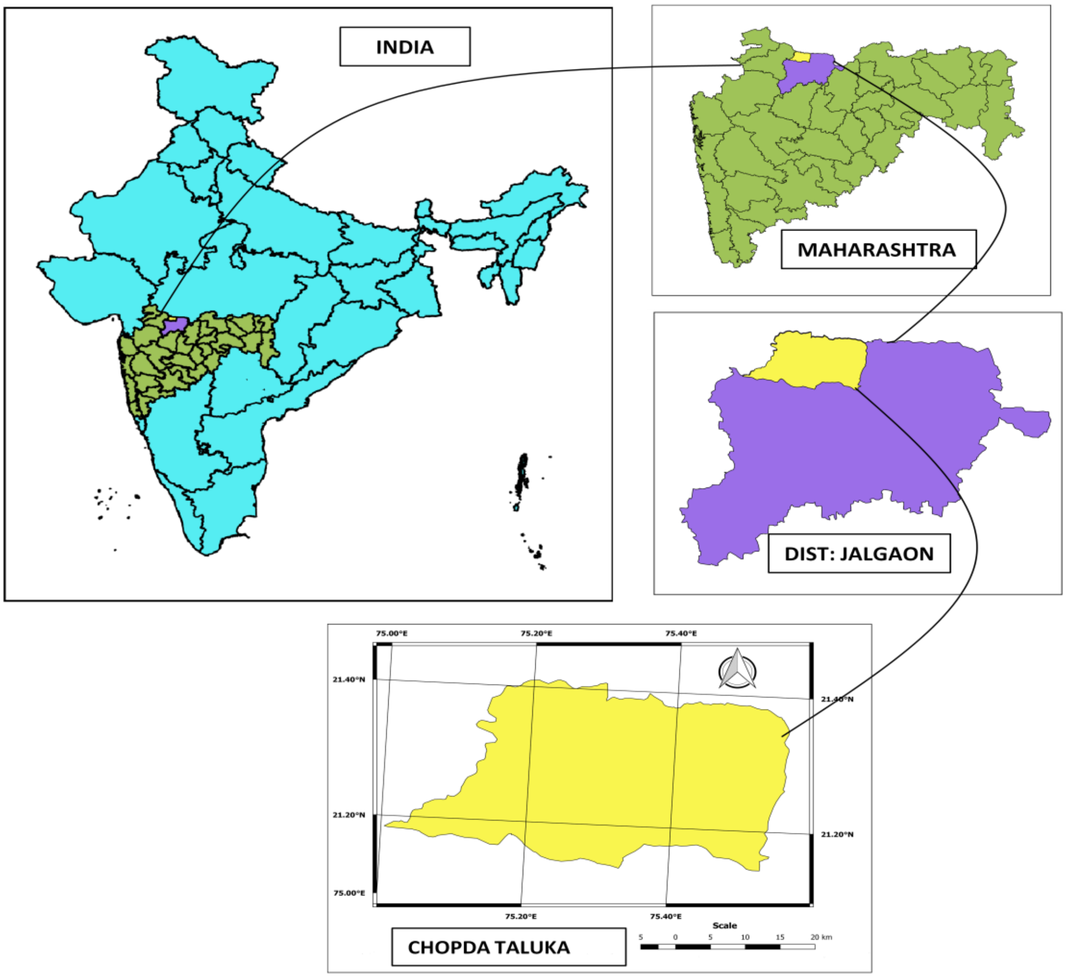

Table 1: Area Covered Under Different LU/LC

Sr. No.	LU/LC	Area in Square KM	Area in %
1	Built up	110.24	7%
2	Cultivated Land	401.56	25%
3	Fallow Land (Uncultivated Agriculture)	524.58	29%
4	Waste Land	122.67	8%
5	Water Body	32.43	2%
6	Forest	210.69	10%
7	Hilly Area	298.33	18%

Fig.1 Location Map of Study Area.

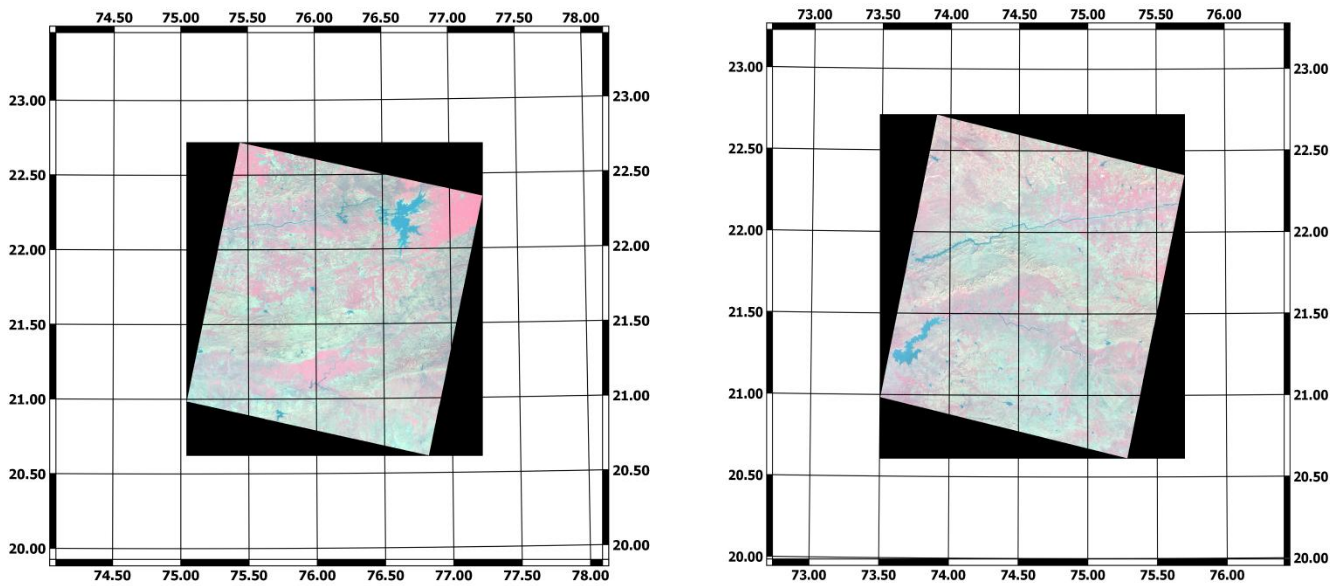

Fig.2 False Color Composite of LANDSAT – 8 (OLI) images (Path 146,147 Row 45) which Cover Study Area.

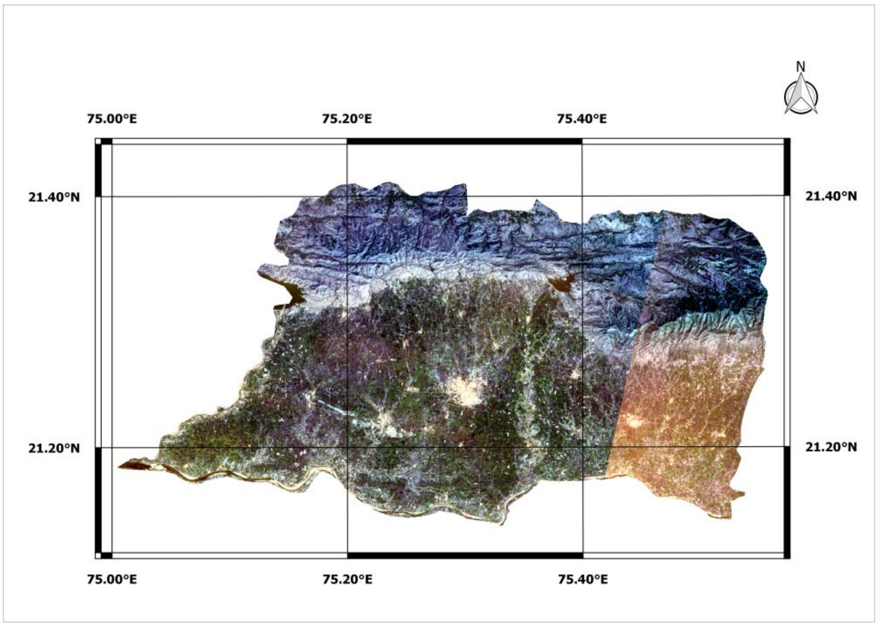

Fig.3 Clipped Multiband Landsat-8 (OLI) Image of Chopda Taluka, Dist: Jalgaon, Maharashtra, India.

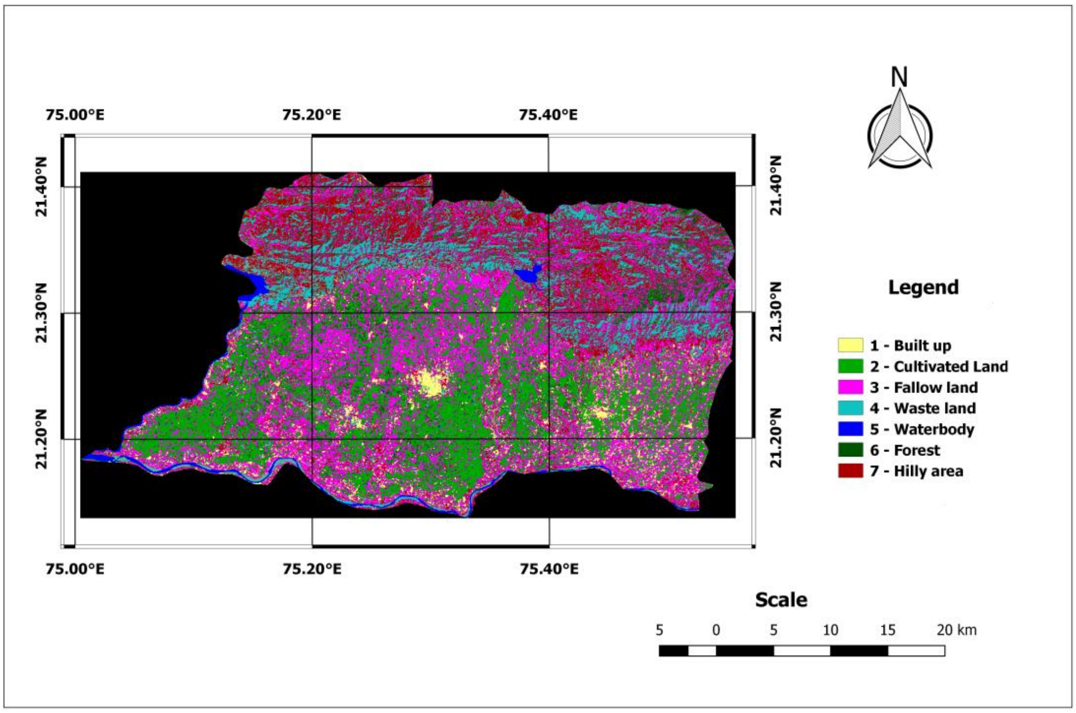

Fig.4 LU/LC Map of Chopda Taluka, Dist: Jalgaon, Maharashtra, India.

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