Land Use Classification and Change Detection by Remotely Sensed Imagery: The Case Study of Pathardi Tahsil of Ahmednagar District,Maharashtra, India

Lawande Gangadhar Bhaurao[a], Sonawane V R[b]

[a]Dadapatilrajale Arts, Comm. and Science College, Adinathnagar Tal-Pathardi, MS, India
[b]Ramesh Phirodia College of Arts, Science and Commerce, Sakur, MS, India

Abstract

The degraded Pathardi Tahsil has undergone various land use changes since 2000. Inthis study, land use changes of Tahsil were assessed from 2003 to 2018 by using Landsat TM and Landsat 8OLI/TIRS images. The ArcGIS v10.1 and ERDAS Imagine v9.2 were used to process satellite imageries and assessed quantitative data for land use change assessment of this study area. Maximum like lihood classification algorithm was used in order to derive supervised land use classification. It was found that small increase in water facilities also impact to increase in Vegetation and agricultural area. The overall supervised classification accuracy was found 92.16% for 2018 and 86.15% for 2003 with Kappa values of 0.89 and 0.82 2018 and 2003, respectively and these were fairly satisfactory. The results of this study would be helpful to plan and implement important management decisions in order to conserve the degraded land management.

KEYWORDS: Land use, Land cover, change detection. GIS and RS.

Introduction

Land use and land cover change (LULCC) is considered as animportant tool to assess global change in different spatio-temporal scales (Lambin, 1997). It is a widespread, accelerating,and significant process which is driven by human actions, and, inmany cases, it also drives changes that affect humans (Agarwalet al., 2001). The impacts of LULCC on the sustainability of the ecosystems are becoming increasingly important issues in globalchanges research. Human actions seem to lead to the greatest changes in the current state of the earth's surface.

Alterations inthe surface cover result in changes to the balance of energy, water, and the geochemical fluxes at the local, regional and global level and these changes will inevitably influence the sustainability of natural resources and socio-economic activities (Vescovi et al.,2002). With the increase in growth of population, pressure is exerted on limited natural resources of a country and contributes to the changes in land cover. The causes of LULCC are many (Agarwal et al., 2001; Geist,2005; Lambin, 1997; Lambin et al., 2001; Veldkamp and Lambin,2001; Zeng et al., 2008).Lambin et al. (2001)described tropical deforestation, rangeland modification, agricultural intensification, urbanization and globalization as the prime causes and factors for global and regional land use/land cover changes. Beside these, socio-economic and biophysical attributes are also contributing to this significant change in land cover (Aspinall, 2004; Zenget al., 2008).As land use change is a locally pervasive and globally significant ecological trend, these changes have important implications for future changes in Earth's environment and have for subsequentl and use change (Agarwal et al., 2001). The LULCC is a dynamicand continuous process (Mondal et al., 2016) and therefore, extensive research on LULC pattern is important along with their social and environmental implications at different spatial and temporal scales (López et al., 2001). Studies on the changes in different landuses are important for forest monitoring and in overall environmental monitoring (Lal and Margret Anouncia, 2015).

The present paper seeks to utilize remotely sensed data and GIS tool to analyse the LULC of Pathardi tahsil for the purpose of detecting change in the area by comparing between two dates images.

Study Area:

The Pathardi Tahsil of Ahmednagar District in Maharashtra state has selected for current study. The tahsil covers of 134 villages and 1 urban area spread over area about. The Tahsil is located in the east part of the Ahmednagar district. Shirur (Pune District), Beed&GevraiTahsil of Beed District which is located to the East of Pathardi Tahsil. Shevgaon and Newasatahsil of Ahmednagar District located in the North-West. Ahmednagar Tahsil in the West and in the South Pathardítahsil enclosed by AshtiTahsil of Beed District. Pathardi Tahsil lies in between 18^{0} 54’ to 19^{0} 12’ North Latitude & 74^{0} 54’ to 75^{0} 24’ East Longitude. Geographical area of the Tahsil is 117784.35 hector according to 2011 census, the total population of the Tahsil was 258109 and density of population was 219 persons per Sq. km. respectively. The geographical location indicate about the study area that located on drought prone area in Ahmednagar District.

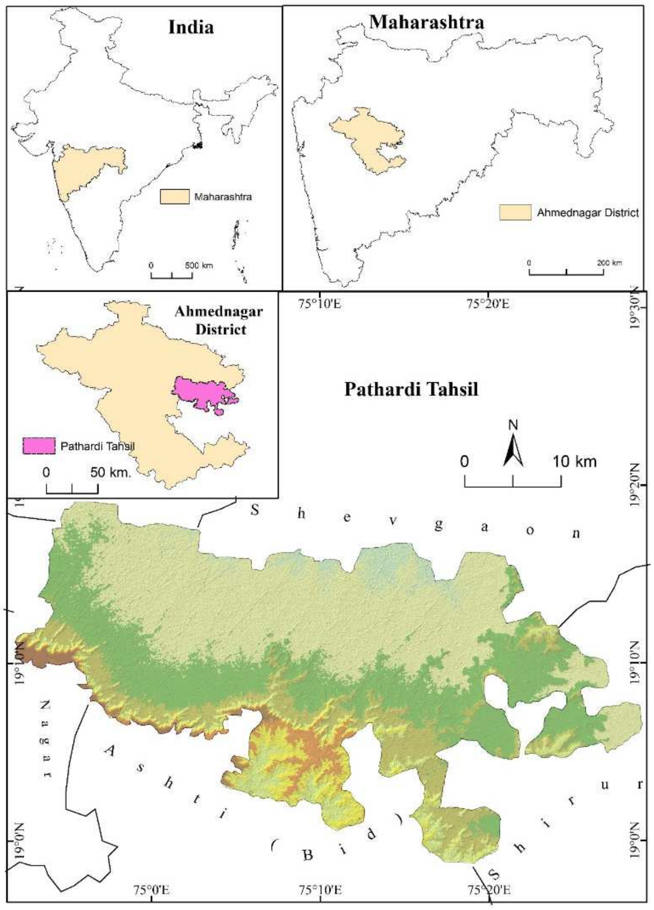


Figure shows location of study area

Methodology

Image Acquisition:

The achieved the aim of study Landsat 7 image has been taken for the year of 2003 with having spatial resolution 30 meters. The date of image acquisition were 02nd January 2003. As well as Landsat 8 image has taken for the year of 2018 with having same spatial resolution. The detail of image shows on table below.

Table shows the Satellite Image Details

Date of acquisition	Path and Row	Type of satellite image	Spatial resolution (m)
02 January 2003	146, 047	Landsat-7 Enhanced Thematic Mapper plus (ETM+)	30
20 February 2018	146, 047	Landsat-8	30

Image Pre-processing:

a) Layer Stacking: The layer stacking of bands was performed on the Erdas Imagine 9.2 software.
b) Mosaicking the layer stacked image tiles were mosaicked and then clipped with study are shapefile.
c) Image rectification was done to correct distortions resulting from the image acquisition process.
d) Projection: The image downloaded is in Universal Transverse Mercator projection and it isreprojected to Geographic WGS 84, spheroid and datum Everest.

Image Classification:

Image classification for year 2018 was performed through supervised classification using maximum likelihood classifier, which includes following steps:

a. Selection of signature of different features (training sites) by digitisation of selected area on the image. Selection of signature was based on field knowledge and existing literature and map.
b. Obtained signatures act as an input for digital image classification. On the basis of given signature, the whole study area was classified into four classes.
c. Based on the quality of results, training samples were refined until a satisfactory result was obtained.
d. Classified images were recorded to respective classes (i.e. Forest, Waterbody, Barren land agricultural field)
e. The normalised difference vegetation index was calculated on ERDAS Imagine 9.2 for the year 1990 and 2014 of land sat image. The results of both the years were also compared, which show significant changes in land use/land cover over a period of time in the study area.

Change Detection:

The base map of the study area was prepared by using satellite imageries from Google Earth 7.0v. Printed subset images from Google Earth were combined manually and used to recognize different features in the study area. For image interpretation, ERDAS Imagine 9.2 and ArcGIS 10.1v software were used to prepare land use category map of the study area considering field survey data using the base map to identify different categories of land uses. Maximum likelihood classification (MLC) approach is being widely used for land use change assessment. While reviewing literature it was found that MLC is mostly used and convenient to apply with satisfactory accuracy. The magnitude change for each land use class was calculated by subtracting the area coverage from that 2nd year and initial year as shown in Eq.

$$\text{Magnitude} = \text{magnitude of new year} - \text{Magnitude of previous year}$$

Percentage change (trend) for each land use type was then calculated by dividing magnitude change by the base year (the initialyear) and multiplied by 100

$$\text{Percent Change} = \frac{\text{Magnitude of change} * 100}{\text{Base Year}}$$

To obtain annual rate of change for each land use type, thedifference between final years to initial year which represents magnitude of change between corresponding years was divided by thenumber of study year i.e. 2003–2018 (15 years) as appropriateusing Eq.

$$\text{Annual Rate of Change} = \frac{\text{Final year} - \text{Initial year}}{\text{Number of Year}}$$

Accuracy assessment

An accuracy assessment for the supervised land use classification was done for the 2018 image by using Erdas Imagine v9.2. From the classifier, 153 and 130 points were generated randomly for 2018 and 2003 supervised images, respectively. Each and every point had specific color tone and the pixel value which was recognized by the software itself when the data sets were trained during supervised land use classification. These values were considered as reference values. All the randomly generated points were then identified by the user and assigned in different classes.

In the error matrix, the rows denote the categories as derived from the classified image whereas columns represent the categories identified from the reference values. The diagonal ofthe matrix shows the agreement of the 'from-to' categories for both the classified and reference values. The off-diagonal represents the dis-agreement of the 'from-to' categories which indicate the error (omission and commission errors) that remains between the classified and reference data (Afify, 2011).

Results and Discussion:

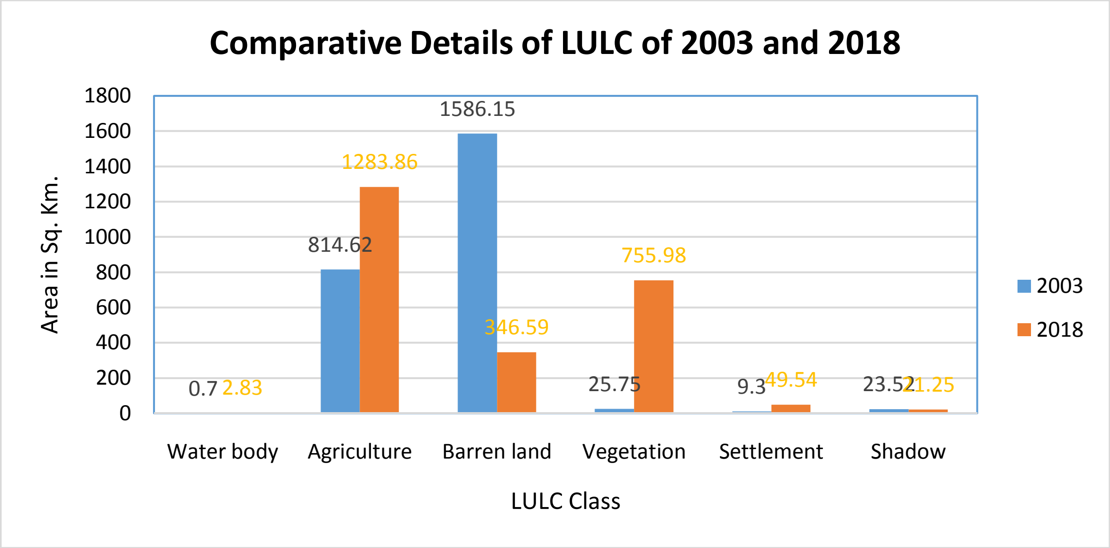
The purpose of this work was to improve a prompt method of generating temporal land use and land cover maps for change recognition analysis. The Pathardi Tahsil was classified using GIS technique in to Six Land use and Land cover classes. The composition and distribution of land use Land cover classes of image include Water body, Vegetation or Forest land, Barren land and waste land, Agriculture and Fallow land, Settlement or built up land and shadow part. The land use land cover map shows the spatial and temporal variation in the area. The finding reveals that there was an extreme and rapid increases in the built up land, agriculture and water body while decreases were distinguished in Barren land area.

The table shows the comparative distribution of land use and land cover classes. The results shows that in 2018 because of development of irrigation facilities in some part of tahsil increase the area under agriculture and vegetative part of the tahsil. While it reduces the barren land or waste land.

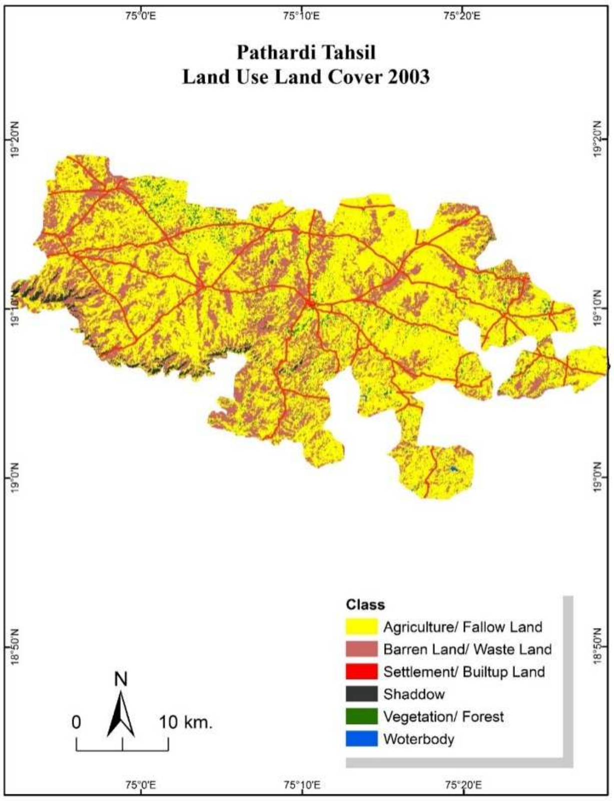
Table shows the Satellite Image Details

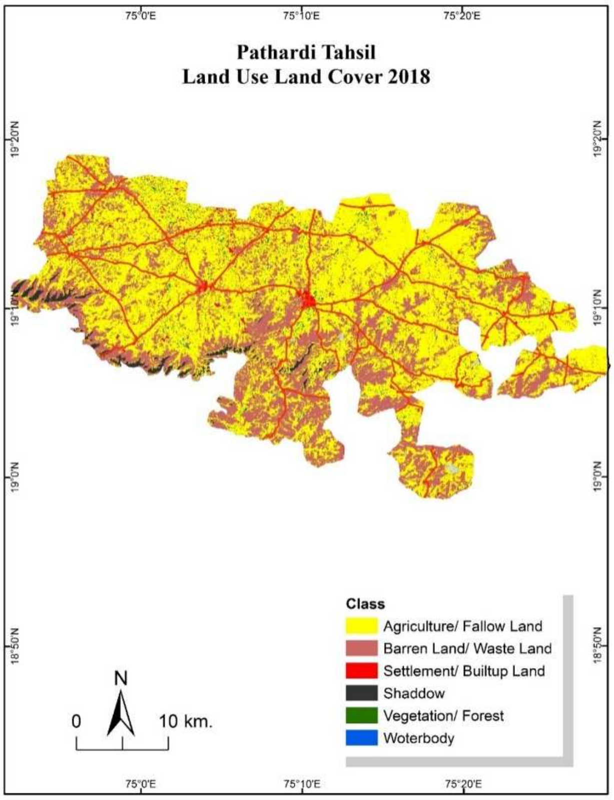
LULC Class	2003 (Area in sq. Km)	2003 Area in %	2018 (Area in sq. Km)	2018 Area in %
Water body	0.7	0.03	2.83	0.12
Agriculture	814.62	33.11	1283.86	52.19
Barren land	1586.15	64.48	346.59	14.09
Vegetation	25.75	1.05	755.98	30.73
Settlement	9.3	0.38	49.54	2.01
Shadow	23.52	0.96	21.25	0.86
Total Area	**2460.05**	100	**2460.05**	100

The Chart Shows the distribution of land use and land cover classes



The maps shows the land use and land cover details of 2003 and 2018 respectively. The map shows that most of northern area of the tahsil having agricultural and fallow land in both the years. The most of river flowing from south to north ward direction therefore in area under agriculture is more in northern part of the tahsil. While in southern the origin of these river and most of part having hilly region causing more area under barren land or waste land.





Conclusions and Policy Implications

The agriculture of the Pathardi have been under manifold because of water facilities from the surrounding area. Because of water facilities degradedland or barren land severely decrease and land has been fragmented and converted into various land uses. This study detected the extent of land use changes in the Pathardi tahsil with the application of remote sensing and GIS technique by using satellite imageries. The trend of land use changes found in this study, especially percentage increase in water body, agriculture and settlement land and decrease in barren land and waste land cover will be helpful to policy makers to take appropriate decision to the situation. For further the planning of water conservation facilities will help more utilization of land use purpose in future also.

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