Detection of Land-use/Land-cover Changesby Using RS and GISTechniques:A Case Study of ShrigondaTahsil, Maharashtra State, India

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Abstract

Land-use/land-cover change detection study plays a key role in a study endeavored for development and planning purposes. With timely satellite data, these studies are carried out with good accuracy. Throughout the world, the emphasis has been given on such studies because of the increasing demand for land as its limited availability. The present study attempts to focus on land use/land cover changes at the tahsil/block level. By using satellite images for the year 2000 and 2015the land-use/ land-cover was extracted in the study area with a supervised classification method. Appropriate training sites were taken for each LULC categories to achieve good accuracy in the classification. Accuracy assessment was performed after classification for finding the accuracy of the classification based on KAPPA analysis. The change detection of these classes for two images was computed. The most dominant category in terms of change was barren land. The study indicates that the study area has undergone substantial changes in land-use and land-cover particularly in the case of barren land and agriculture land use categories.

Keywords

Land-use/Land-cover,RemoteSensing,GIS,Change Detection,Kappa coefficient.

Introduction

The history of mankind has been closely related to natural resources. The land is one of the important components on which physical, economic, and social development depends. Land provides food and a variety of minerals and therefore, it needs judicious use of land. The land resource has very often been left in past entirely applications of traditional and primitive methods resulting in basic resources gradually deteriorated (Siddiqi, 1971). With the growing pressure of population on limited land resources, man has to use optimum usage of every acre of land. This necessitates the determination of the optimum use of every piece of land. There is a consequent need for a system of land utilization (Stamp, 1960). The importance of land classification is on the basis of the quality and intensity of Land-use (Mohammad, 1978).

Shafi in India has done pioneer work using a sampling method for Land-use study. Chatterjee (1940) stresses the need for Land-use surveys in India. He undertook the study of land utilization of 12 villages in Uttar Pradesh (1951) which were published from 1965 to 1966. Later on Ganguli (1964) and Jha (1965) has successfully found out land capability classification of the Kosi region. Jadhav, Kulkarni, and Bopegamage (1967) have prepared a land classification map of five villages in the fringe area of Pune city. The district and taluka level study of Land-use was studied by Pawar (1978), Continho (1980), More (1980), Karmarkar (1981), Datye (1984), Shinde (1989), Saptarshi (1993), Vaidya (1997). Vaidya (1997) has studied the Land-use pattern of Yashoda basin in the Wardha district at the micro-level. He suggested remedies for better agricultural planning and development. A study of Himalayan Land-use, Land-cover was carried by Pandit et al. in 2007and highlighted extensive deforestation having serious consequences on native biodiversity.

Study Area

The study area, Shrigonda tahsil is a located in southeastern part in Ahmednagar district and it extends between 18°26' 48"north to 18°52'14" north latitudes and 74°22' 55"east to 74°56' 9" east longitudes covering around 1571 sq. km. area and population 315975 (2011). The region consists of 115 villages. When we consider the climate of the area, it experiences hot summer and general dryness during the major part of the year except during the southwest monsoon season. Annual rainfall is 448 mm which is very low and hence the area is also called the *rainfed* area. Cold seasons commence from December and ends in February. The period from March to the first week of June is the hot season followed by monsoon season which lasts till the end of September. October and November constitute the post-monsoon or retreating southwest monsoon season. The average annual temperature ranges between 9°C in the month of December to 41°C in April/ May. The major crops grown are Wheat and Jowar. Bajara, Onion, and Sugarcane are also grown in the study area where irrigation is available. Due to limited irrigation, farmers depend totally upon monsoon rainfall for their agricultural production. Due to scanty rainfall, the study region experiences drought-prone conditions frequently. Irrigation is mainly done by wells although recently initiated river Ghod valley project has ushered in canal-irrigation into this tract.

Objective

The objective of the present study is to assess the change detection of Land-use/Land-cover in the study area. This major objective may be achieved with following sub-objectives

- To extract the Land-use/ Land-cover in the study area
- To examine change detection in Land-use/ Land-cover in the study area

Database and Methodology

The present study is based on IRS's (Indian Remote Sensing) LISS-III (Linear Imaging Self-scanning Sensors) satellite images obtained for the years 2000 and 2015. The Survey of India (SOI) toposheets were also used for delineation of village boundary and preparing physiography and drainage network.

The following data were used in the present study

(i) The SOI toposheets with 1:50000 scale were also used as the base data i.e. 47/J/5, 47/J/6, 47/J/7, 47/J/9, 47/J/10, 47/J/11, 47/J/13, 47/J/14 and 47/J/15.

(ii) IRS's LISS-III satellite images imagery with 23.5 meter spatial resolution.

The IRS's LISS-III satellite images (2000 and 2015) data were downloaded from ISRO's BHUVAN portal. Imagery acquired was used for the Rabi season to find out changes in Land-use and Land-cover in the study area. To remove the distortions or errors in the satellite images like stripping, cloud disturbance, geometric errors, etc remote sensing techniques were used to enhance the quality of images e.g. spatial enhancement, spectral enhancement, radiometric correction, geometric correction, etc. Further, images were mosaicked and masked to get the area of interest out of the entire image. The maximum likelihood classifier algorithm was used in the supervised classification technique as it is an efficient algorithm of satellite image classification in Erdas Imagine software. And at the same time, it is very well known and has already been successfully applied to a broad range of remote sensing problems (Lillesand and Kiefer, 2000).

On the basis of the visual interpretation of images, the study area is mainly categorized into five Land-use/ Land-cover categories.

1) Agricultural Land 2) Barren Land
3) Fallow Land 4) Waterbodies and
5) Built-up Area

Land-use/ Land-coverClassification

Image classification replaces visual interpretation by quantitative decision making. Thus the classified image is a thematic map in which each pixel occurring in the original imagery classified into one or several themes or categories. In multispectral classification, the spectral data are analyzed and then pixel categorized in different themes or classes (Lillisand and Kiefer, 2004). In the present study, LISS (Linear Imaging Self-scanning Sensors) imagery was used for the classification of Land-use/Land-cover. Supervised classification method used to classify imagery in Erdas Imagine software. The maximum likelihood classifier algorithm was applied for parametric rule and the parallelepiped method was applied for the non-parametric rule. Training sites are the group of signature taken for a particular Land-use class on a satellite image. For supervise classification methods, training sites are relevant, and hence sufficient training sites were taken for each class of Land-use/ Land-cover to increase the accuracy of Land-use classification. For the classification of images, Erdas Imagine software was used.

After the classification of satellite images; we may observe some facts about Land-use/ Land-cover of the study area. Firstly; the dominant Land-use which covers most of the land in the study area is barren land followed by agriculture. The built-up area occupies the least percentage of area. There are substantial changes that occurred in the area under Land-use/ Land-cover over the period from 2000 to 2015. The study area is under a semi-arid climatic region and hence it is frequently suffered from water scarcity. Therefore; many irrigation practices are being adopted by the farmers which certainly responsible for the change in the Land-use pattern of the study area e.g. Dams, Canals, KT weirs, Farm ponds, CCT, etc.

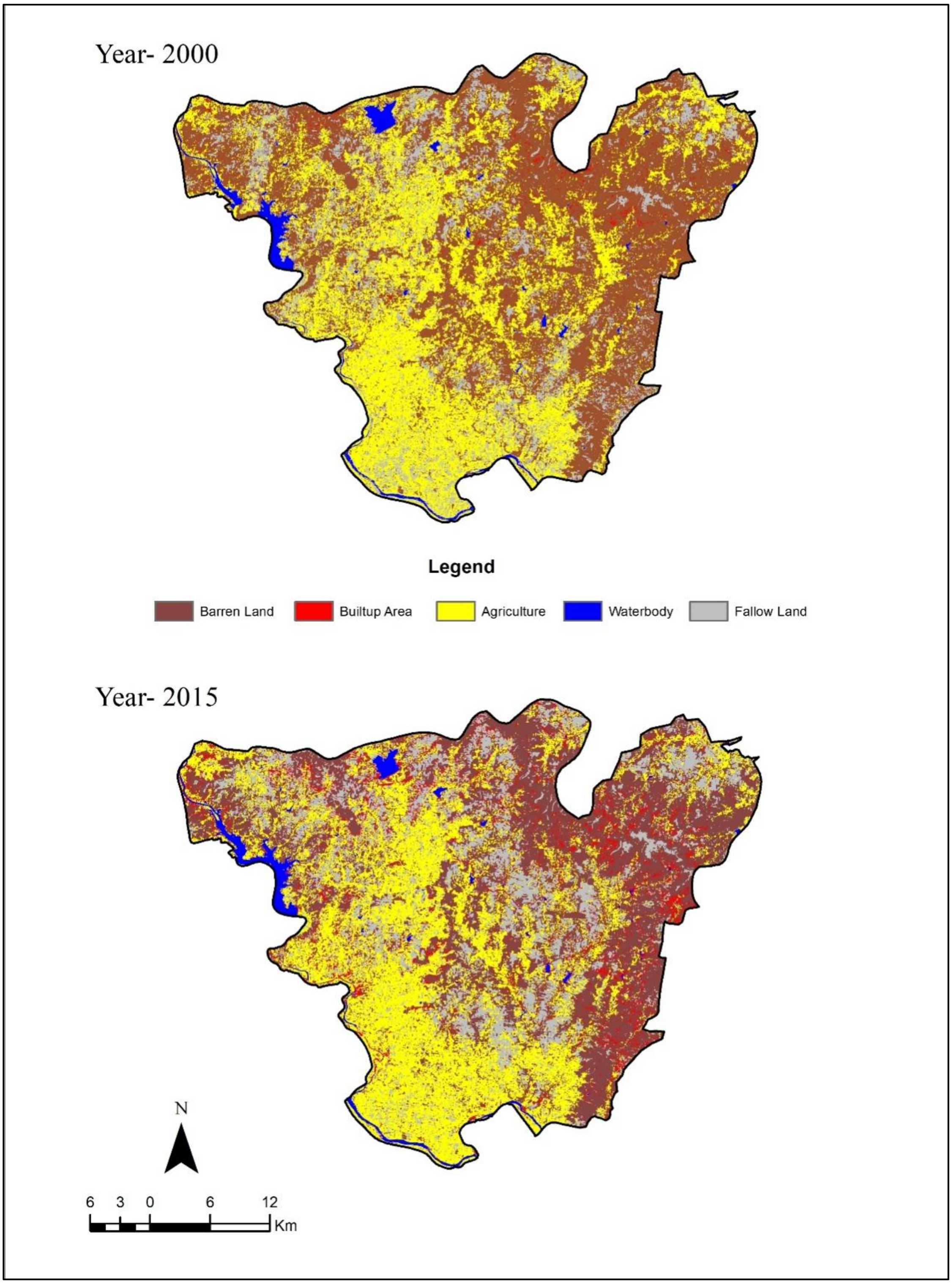

Figure 1: Land-use/ Land-cover of Shirgonda Tahsil (2000-2015)

Change Detection

After the calculation of the area under Land-use/ Land-cover classes, there are considerable changes are observed. The area under agriculture has decreased considerably from 527.26 sqkm in 2000 to 345.57 sqkm in 2015, which accounts for around 34 percent. The second most changed Land-use is the built-up area which has increased more than 200 percent from 2000 to 2015. The reason behind this may be the increase in the industrial area and urbanization in the study area. The area under barren land has been decreased by about 38 percent which may be due to the conversion of barren land into other Land-uses e.g. built-up area, agriculture or water-bodies (dam, weir, etc). The area under fallow land has been increased (around 24 percent) may be due to an increase in the area under the agriculture category. Moreover, it is noteworthy that area calculated from satellite image classification may not match with the actual ground situations because there are limitations of satellite data. This means, there are conflicts between some of the Land-uses when we try to classify it due to their similar appearances and spectral signature e.g. built-up area and barren land, agriculture and forest, etc.

Table 1:Land-use/ Land-cover change

Sr. No.	Class	Area in sq.km.		Change in Land-use/ Land-cover	
		2000	2015	In sq.km.	IN percent
1	Agriculture	527.26	345.57	-181.69	-34.47
2	Forest	0.00	0.00	0.00	0.00
3	Built-up Area	9.24	31.15	21.91	+238.15
4	Water-bodies	25.57	23.43	-2.14	-8.56
5	Barren Land	698.94	969.29	270.36	+38.67
6	Fallow Land	204.04	269.07	65.02	24.17

Accuracy Assessment

For classified satellite images, an accuracy assessment was performed to check the accuracy of supervised classification. For both of the images accuracy achieved is more than 75%. Hence the classification is said to be acceptable. But still due to coarse resolution; small geographical features get generalized e.g. settlements, buildings, etc. With high-resolution imagery; a more accurate classification of Land-use can be done. The overall accuracy of classified images is 92.39 % and 90.83 % for the year 2000 and 2015 respectively. The Kappa coefficient is 0.86 and 0.85 for the year 2000 and 2015 respectively.

Conclusions

The present study indicates that IRS's LISS-III satellite images data is an appropriate choice to study Land-use change study. The present study shows that the change detection study can be successfully applied to identify Land-use/ Land-cover change using remote sensing data. On the basis of classified images, barren land is found dominant category in the study area (45%) it has increased substantially may be due to an increase in the population in the study area. The area under agriculture has decreased significantly from 527 sq km to 345 sq km from the year 2000 to 2015.

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