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Land Use Land Cover Changes Using Remote Sensing and GIS Technique: A Case Study of Navsari District, Gujarat

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ABSTRACT

Land use affects land cover and changes in land cover affect land use so the Land use and Land cover change has become a central component in current strategies for managing natural resources and monitoring changes. Change detection with application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with enhance accuracy in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval. It is very useful because of its synoptic view, repetitive coverage and real time data acquisition. The present study illustrates the land use/ land cover changes from 2000 to 2011 of Navsari district in Gujarat. Two time (January, 2000 and 2011) Landsat satellite imageries (TM) were acquired from United States Geological Survey (USGS). The unsupervised classification methodology has been employed using the software ERDAS imagine 2013. In the present analysis images of the study area were categorized into eight different classes namely Built up area, Forest, Orchards including other vegetation, Agriculture field with crops, Open field without crops/vegetation, Water bodies, marshy area and barren land to highlights the changes of the land use pattern . It was also found that the overall classification accuracy is more than 80 percent where as the overall kappa statistics is more than 0.74 per cent for both the years.

Key Words:

Classification, GIS, Landsat Imageries, Land use cover, Remote Sensing

INTRODUCTION

Land use/cover is two separate terminologies which are often used interchangeably (Dimyati et al. 1996). Land use affects land cover and changes in land cover affect land use. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere (Riebsame et al. 1994). Land use/cover change detection is very essential for better understanding of landscape dynamics for a known

period of time having sustainable management. Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement (Rawat and Kumar 2015). Today, earth resource satellites data are very applicable and useful for land use/cover change detection studies (Yuan et al. 2005). Currently, integration of Geographical Information System (GIS) and Remote Sensing (RS) is one of the most important methods for detecting LULC's change, which includes image processing (such as geometrical-rectifying, supervised-classification, *etc*.), change detection (post-classification) *etc.* (Fan et al. 2008). Landsat-TM images represent valuable and continuous records of the earth's surface during last three decades. Moreover, all most all Landsat archive is now available free-of-charge to the scientific community; it represents a wealth of information for identifying and monitoring changes in manmade and physical environments (Chander et al. 2009 and El Bastawesy 2014). In the present study an attempt is made to map the status of land use/cover of Navsari district of Southern Gujarat, along with the land use changes during last one decade using geospatial techniques.

STUDY AREA

Navsari district is spread over 2212 sq km, situated between 20° 45'- 21° 00 latitude and 72° 45'- 73° 15'E longitue. The district is surronded by Arabian sea on the west, Dang district to its east, Surat district to its north and Valsad disrict in the South (Fig. 1). The district can be distinctly divided into three Agro-climatically divisons, forest and hilly tracts of the Eastern parts comprising Vansda block; saline soils due to sea water ingress in western parts which comprises parts of Gandevi and Jalalpore blocks; black fertile soils in central parts comprising of Navsari, Gandevi and Chikhali Blocks. The district has a population of 1,329,672 and is adminstratively divided into 6 talukas, Navsari, Jalalpore, Gandevi, Chikhli, Khergam and Vansda.

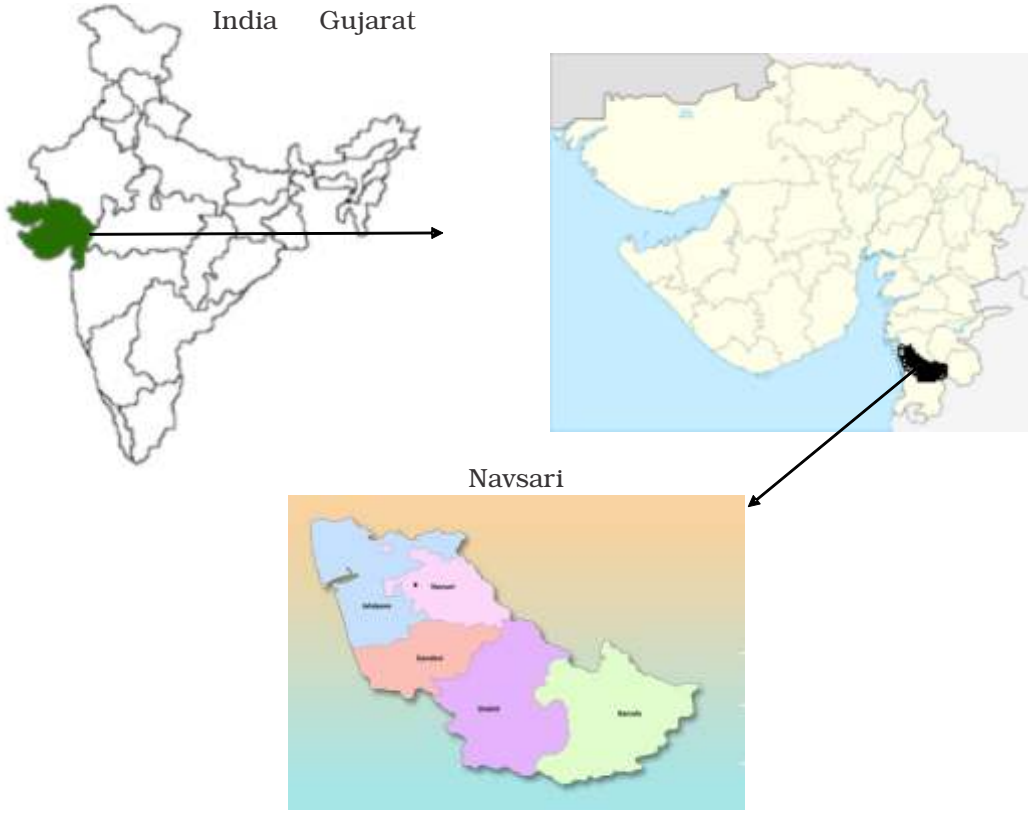

Fig. 1. Location map of study area

MATERIAL AND METHODS

Land use land cover classification

To work out land use land cover classification (LULC); unsupervised classification method was followed using ERDAS imagine 2013 software. Landsat Thematic Mapper (TM) of 30 m resolution was used to classify LULC for the year 2000 and 2011. The satellite data covering the study area of the January month was obtained from United States Geological Survey (USGS). These data were imported in ERDAS Imagine, image processing software. The layer stack option from raster tool was used to generate false colour composite to the study area. The sub-setting of satellite images were performed for extracting the study area from both images from the boundary line of Navsari district (Source: DIVA-GIS). The eight groups of land use land cover classes are classified, namely Water bodies including shallow water and deep water, Agriculture field with crops, Open field without crops, Other vegetation with orchards, Forest, Built up area, Barren land, and Marshy area.

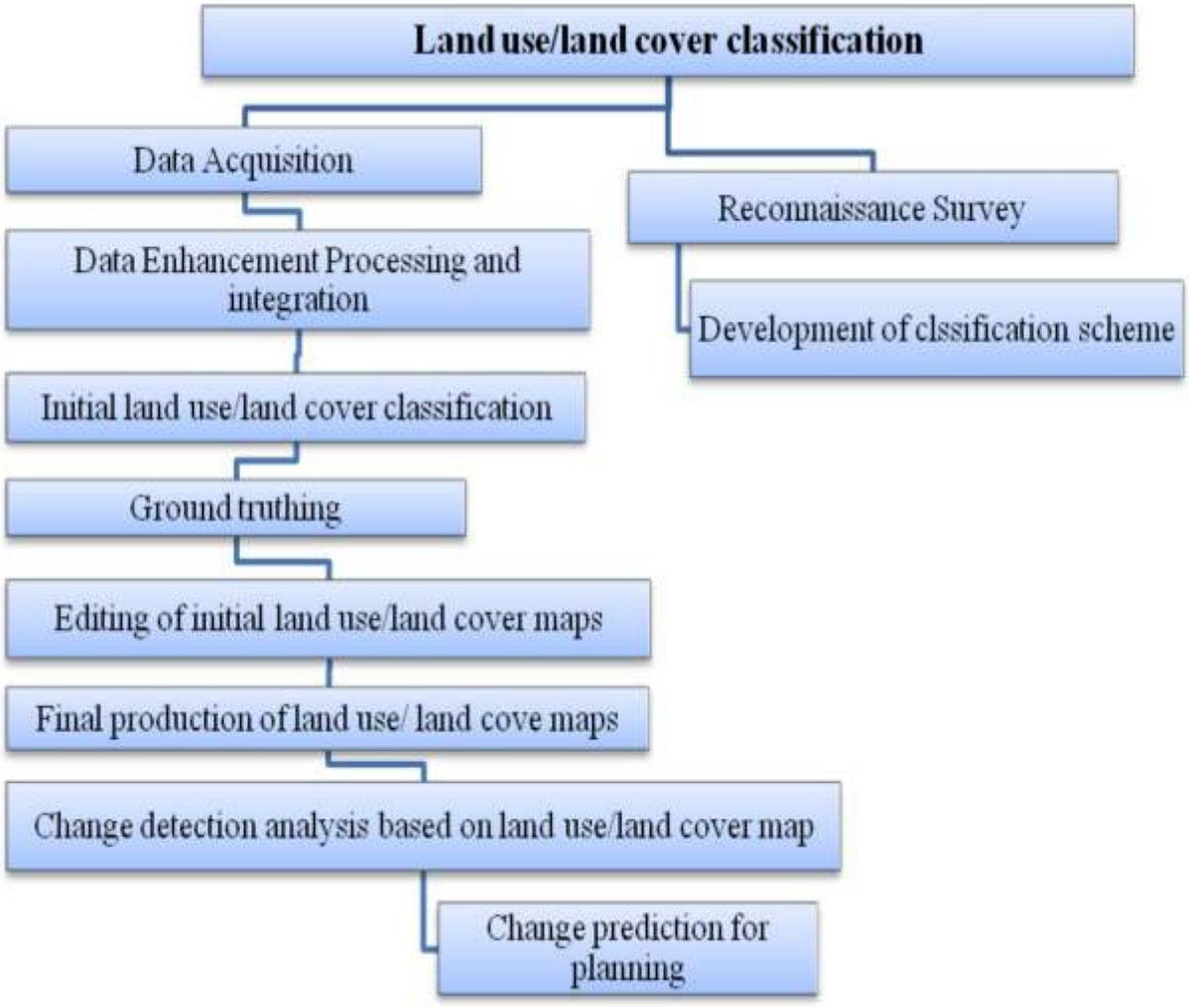

Fig. 2. Flow chart for change detection

Data used

Satellite data viz., Lt51470462000025 XXX03, LT51480452000016XXX02, Lt51480 462000016XXX02, LT51470462011023KH C00, Lt514804 52011014KHC00 and Lt5148046 2011014KHC00 were downloaded from USGS for analysis.

Change detection

To perform land use land cover change detection, a post classification detection method was employed. A pixel based comparison was used to produce change in information on pixel basis and thus, interpret the change more efficiently. Fig. 2 gives the flow chart used for change detection.

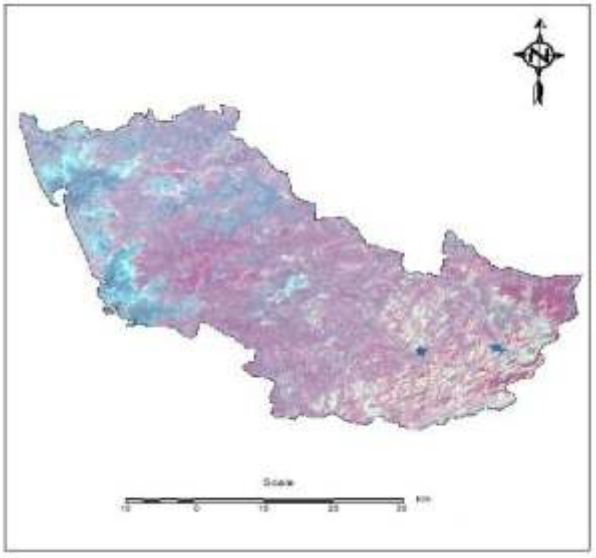

Fig.3. False colour composite satellite image of Navsari district for the year 2000

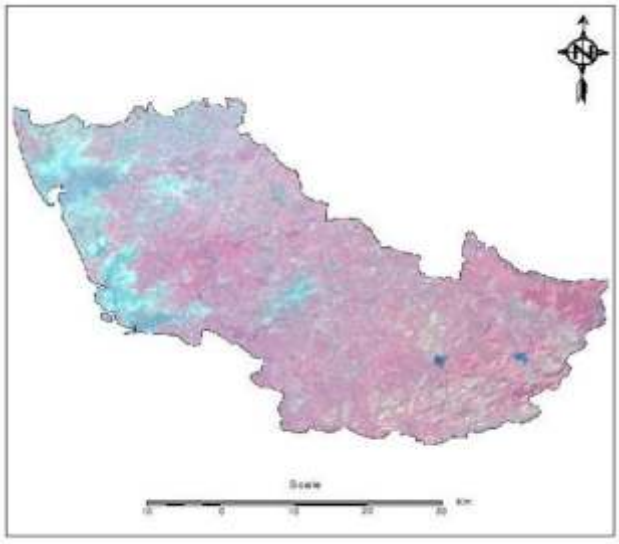

Fig.4. False colour composite satellite image of Navsari district for the year 2011

RESULT AND DISCUSSION

The land use pattern and its spatial distribution are important for the land use strategy required for the appropriate development and organization of any area. False Colour Composite (FCC) of the district for the year 2000 and 2011 is given in fig 3 and 4 respectively. The land use map and change detection map prepared through remote sensing data and their spatial distribution is shown in fig.5, 6 and 7.

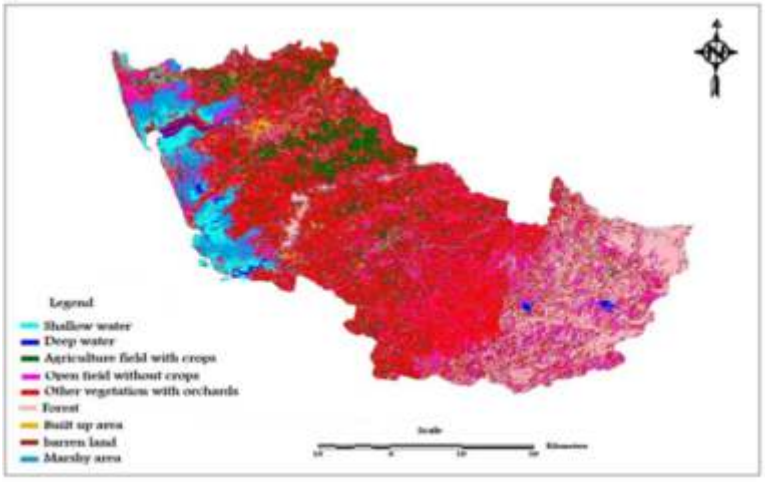

Fig.5. Land use land cover during 2000

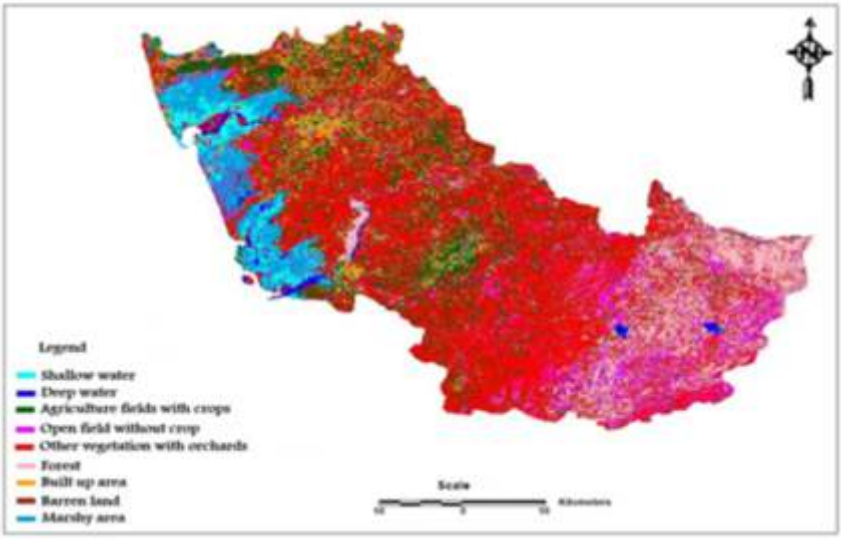

Fig.6. Land use and land cover during 2011

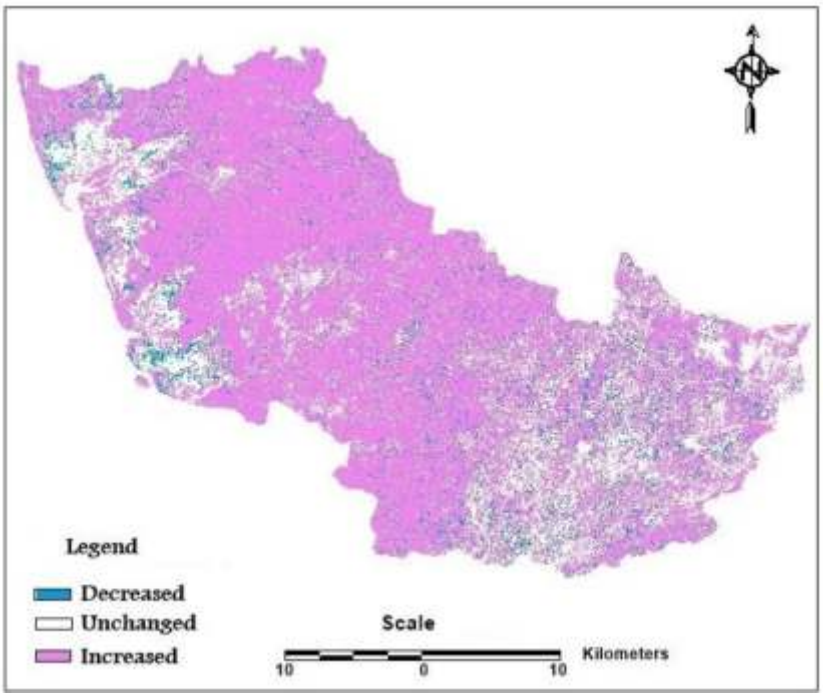

Fig.7. Land use and land cover change detection from 2000 to 2011

Table 1. Land use land covers change during 2000 and 2011

Sr. no.	Class name	Area(ha) in 2000	Area(ha) in 2011	Change detection
1.	Shallow water	9623.25	7941.6	-1681.65
2.	Deep water	2552.31	3857.31	1323
3.	Agriculture field with crops	28388.57	34422.84	6034.27
4.	Open field without crop	28225.28	16681.23	-11544
5.	Other vegetation with orchards	94359.58	96911.15	2551.57
6.	Forest	33886.13	27389	-6497.13
7.	Built up area	9753.66	16492.05	6738.39
8.	Barren land	2269.44	2539.44	270
9.	Marshy area	9769.23	12592.4	2823.17
	Total geographical area (ha)		**2, 18,827**	

The data obtained from analysis of satellite imageries is provided in the Table 1. The study showed that district has geographical area of 2,18,827 ha as per the district administrative boundary of DIVA GIS. In the classification, 12,175.56 ha and 11,798 ha area was under water bodies during the year 2000 and 2011 respectively. It clearly shows that shallow water bodies decreased during the decade; whereas, in deep water category it increased 2000 to 2011, it could be inferred that shallow water bodies were dug up into thus increase in deep water bodies and also that some area were filled up for other uses or either it might be due to continuous soil erosion. Marshy land in the district increased by 2823.17 ha, during the decade, it indicates ingress of sea water, tidal inundation and vanishing of coastal vegetation. These are the main reasons of coastal erosion (Munoz and Blanco 2008, Udoka et al. 2015). It was also found that the overall classification accuracy is more than 80 percent for both the years; whereas the overall kappa statistics is 0.74 per cent for the year 2000 where as the 0.77 per cent is estimated during 2011 (Table 2).

Table 2. The overall accuracy assessment for land use classification of Navsari district

Sr. no	Classified class	2000 Percentage	2011 Percentage
1.	Overall classification accuracy	81.40	83.61
2.	Overall kappa statistics	0.74	0.77

In Navsari district area under agriculture (6034.27 ha) and horticulture (2551.57) ha has increased and that under forest (-6497.13 ha) decreased. The results are similar as reported by Fan et al. (2008) and Anon. (2012) that the LULC influences the population growth and multiple man made uses of land resources. However, there is a need to understand further using high resolution satellites analysis at the farm scale to ascertain crops and plantations present, which is a limitations of the currently used satellite imageries.

In the classification, Vansda region showed more forest area in the district. Decrease in forest area shows harvesting of trees for fuel wood, fodder and grazing as well as other such uses. The barren land is slightly increased during last decade. There is increase in built up area by 6738.39 ha due to the rapid development of human habitation due to increase in area of buildings, road transportation and communication. Similar findings were also reported by various researchers for land use and land cover assessment using earth observations satellite (Yuan et al. 2005, Chander et al. 2009, Prakasam 2010, Tiwari et al. 2011 and El Bastawesy 2014).

CONCLUSION

The study revealed that remote sensing and GIS techniques can be effectively used for development of land use/land cover plan map. The study shows that agriculture area has increased, but the forest area has decreased so there is need to conserve the forest area to maintain ecological balance and environmental stability. The study also shows that remote sensing coupled with GIS can be effectively used for real time and long term monitoring of the environment. The baseline information generated on land use/land cover pattern of the area would be of immense help in formulation of policies and programmes required for developmental planning.

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