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Assessing Land use and Land cover Changes in South Gujarat

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ABSTRACT

Land use land cover (LULC) change detection based on remote sensing data is an important source of information for various decision support systems for important to land conservation, sustainable development and management of water resources. The land use/ land cover mapping has been utilised for identifying the current land use pattern and changes occurred during 2000 and 2011 using satellite remote sensing technology and GIS tools. LANDSAT satellite imageries for the period 2000 and 2011 were used to prepare the land use/land cover (LULC) maps. Study area was characterised into nine classes. The classified images showed that Shallow water, Agriculture field with crops, open field without crop and Forest areas which have been decreased while Deep water, Marshy area, Orchard with other vegetation, Barren land and Built up area have increased during this period. This research highlights that remote sensing and GIS techniques could be effectively used for development of land use/land cover plan.

Key words : *Classification, Change detection, GIS, Land use/ land cover and Remote sensing.*

Introduction

Human activities are one of the main driving forces of land use and land cover changes, and generally in natural environments. Land-use change affects the nature of the climate, cause natural hazards and socio-economic dynamics on a global and local scale (Dires and Temesgem, 2020). Land use land cover data play a central role in climate change assessment (Peter *et al.*, 2011). Change detection is the process of identifying differences in the state of a feature or phenomenon by observing it at different times. This is useful in many applications related to land use and land cover (LULC) changes (Tesfa *et al.*, 2018). Land use land cover (LULC) changes are mostly influenced by increase and decrease in population growth in the system economic growth, and physical factors including topography, slope condition, soil type, and climate (Dires and Temesgem, 2020). Also, Landuse land cover influenced due to rainfall pattern which has direct linked to runoff generation (Pampaniya and Tiwari, 2018).

Further changes in land cover continue to impact local to global scale weather and climate by altering the flow of energy, water and green house gases between the land and atmosphere. Remote sensing data is the most common source for detection, quantification, and mapping of LULC patterns due to its repetitive data acquisition, suitable for processing, and accurate geo-referencing. Quantification of such changes is possible through GIS techniques even if the resultant spatial datasets are of different scales/ resolutions (Nayak *et al.*, 2017). Such studies have helped in understanding the dynamics of human activities in space and time. This information on LULC and prospects for optimum use is crucial for

the choice, planning, and implementation of land use schemes to satisfy the increasing demands for basic human needs and welfare (Zekeng *et al.*, 2019).

Remote sensing technology and geographic information system (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modelling. By understanding the driving forces of land use development in the past, managing the current situation with modern GIS tools, and modelling the future, one will be able to develop plans for multiple uses of natural resources and nature conservation. To understand how LULC change affects and interact with global earth systems, information is needed on what changes occur, where and when they occur, the rate at which they occur, and the social and physical forces that drive those changes. The information needs for such a synthesis are diverse. Remote sensing has an important contribution to making and documenting the actual change in land use/land cover in regional and global scales.

Materials and Methods

Study area

The south Gujarat consists of Sahyadri's Mountains adjoining Maharashtra in the east, series of foothills, and flat alluvial plains in the middle and coastal saline soils in the west. Due to these topographic and climatic variations land use is dominated by forests in the east, agriculture in the mid plain and uncultivable coastal plains. South Gujarat covers an area 17,500 sq. km the region has sub humid climate, with temperature variations ranging from 6 to 45 ^{0}C, annual rainfall varying from 250 mm in the North West and to more than 1500 mm in South Gujarat. Due to industrialization and urbanization lot of changes have taken place in the recent past that is directly affecting climate of the region. These changes have impacted the crop physiology of most of the crops in turn affecting crop productivity that is making it difficult to sustain the crop productivity in the region.

Image Pre-processing and Classification

Landsat Thematic Mapper (TM) of 30 m resolution satellite imagery was used to classify LULC for the year 2000 and 2011. The satellite data covering the study area of the month January obtained from USGS Data were pre-processed in ERDAS imagine 2013. 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 mosaicking and sub-setting of satellite images were performed for extracting the study area on the basis of Area of Interest (AOI) unsupervised classification method was followed for image classification in ERDAS imagine.

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, inter-

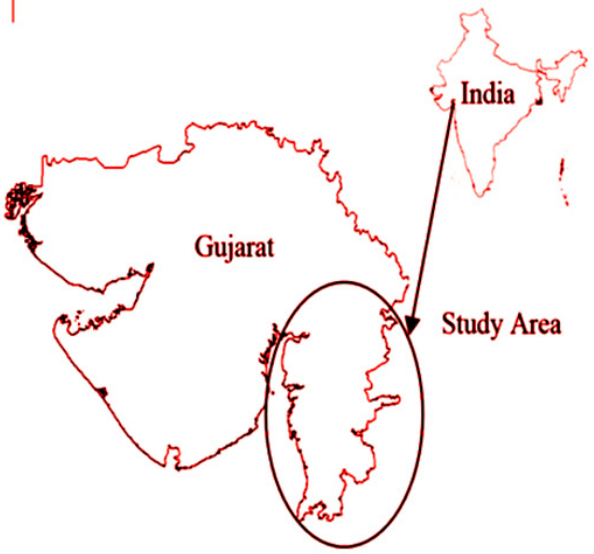

Fig. 1. Study area

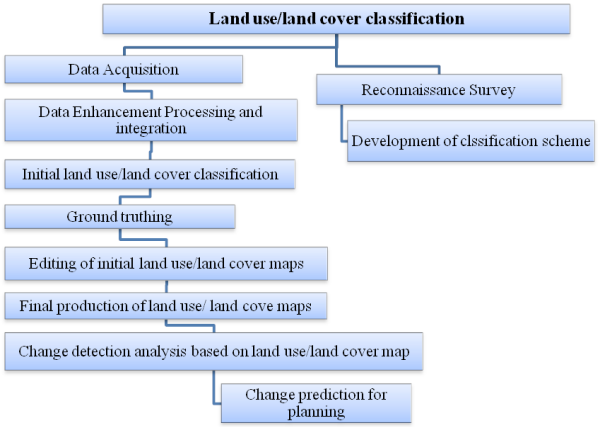

Fig. 2. Flow chart used for land use/ land cover classification

pret the change more efficiently. Fig. 2 gives the flow chart used for change detection.

Accuracy assessment

Many methods of accuracy assessment are available, but assessment was done using Cohen's Kappa often simply called Kappa coefficient) for South Gujarat. As per the classification, all the classified districts are > 0.60 which shows that the accuracy, Kappa coefficient, is in "good agreement" (Sophia *et al.*, 2017).

Results and Discussion

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. Land use/cover change detection is very essential for better understanding of landscape dynamics for a known period of time for sustainable management. As evident that land use of watershed changes by building/roads or soil sodicity in the farmlands (Nilam *et al.*, 2015) and further LULC influence due to effective watershed planning and conservation (Lakkad *et al.*, 2017; Bhanderi *et al.* 2022). Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision making. Hence, land use pattern and its spatial distribution are important for the land use strategies required for appropriate development and planning of any area. The land use and change detection is prepared through remote sensing and GIS data. The data obtained from analysis of satellite imageries is documented in the graph 3 to 6. The study showed that South Gujarat have geographical areas 23,44,512 hectare during the 2000, however there is a slight increase of 137.1 ha during 2011. The increase of the total geographical areas in the Bharuch district could be due to silting in sea or mining / industrial residue deposits. The total shallow water of the region 74314.89 ha in 2000 where as it is decreased to about 9558.15 ha during 2011. The shallow water land use class almost decreased in the all the district which ranges from 4.02 percent (Narmada) to 54.66 percent (Dang). However, the deep water use class increased in almost all the district except Valsad district. The highest gain of marshy area with 28.90 percent was noted in

Table 1. Classification accuracy assessment report of South Gujarat

Sr. No.	Name of districts	Accuracy assessment			
		Overall accuracy (%)		Kappa coefficient	
		2000	2011	2000	2011
1.	Bharuch	82.46	76.27	0.72	0.67
2.	Dang	86.86	92.42	0.58	0.71
3.	Narmada	77.65	83.84	0.70	0.79
4.	Navsari	81.40	83.61	0.74	0.77
5.	Surat	72.55	76.40	0.66	0.69
6.	Valsad	82.69	75.93	0.74	0.69

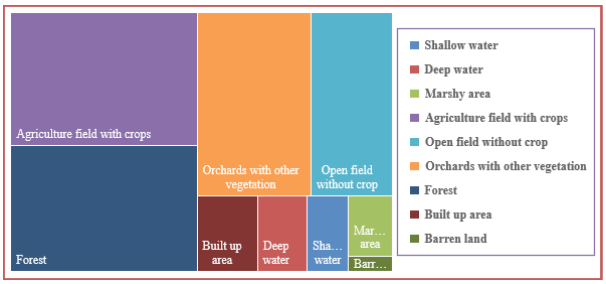

Fig. 3. Graph showing Different land use systems of South Gujarat in the year 2000

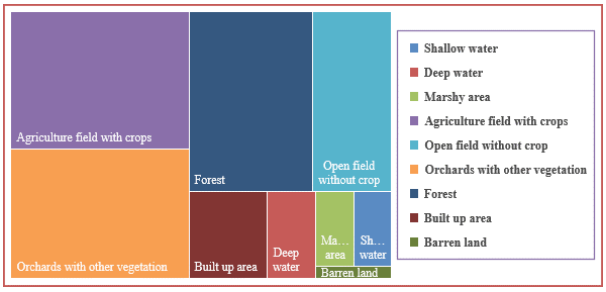

Fig. 4. Different landuse systems of South Gujarat in the year 2011

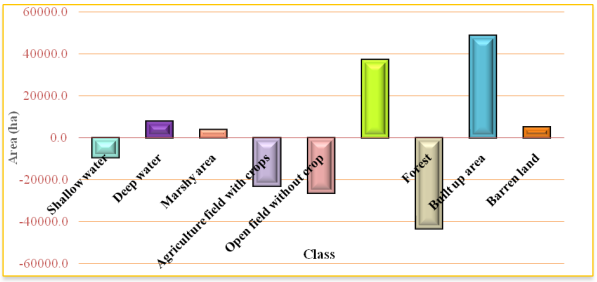

Fig. 5. Difference in land use land cover changes during the year 2000 and 2011

Navsari district, whereas, in Valsad district maximum decrease (62.13 %) was observed in coastal South Gujarat.

The land use class of agriculture with crops decreased by about 23079.29 ha from the 587480.6ha during 2000. The highest decrease (17.13 %) for agricultural field with crops was found in Narmada district, while Navsari districts have gained 21.26 % during 2011. In case of open field without crops also decreased about 26386.81ha during 2011 from 2000. In this category, Narmada and Dang districts have increased more open lands as compared to other districts.

However, orchards and other vegetations have increases from 455239.4 ha in 2000 to 532396.8 ha in 2011 with 37757.3 ha in South Gujarat region. Highest orchard and plantations increases with 31.96 percent in Dang followed by Surat district (18.25%). About 43489.59 ha have decreased from total forest areas from 2000 (557120.1 ha) to 2011 (436226.5 ha) in South Gujarat. But, Bharuch district have highest gain the total forest areas with 10.03 during the reporting period. However, the built up area increases

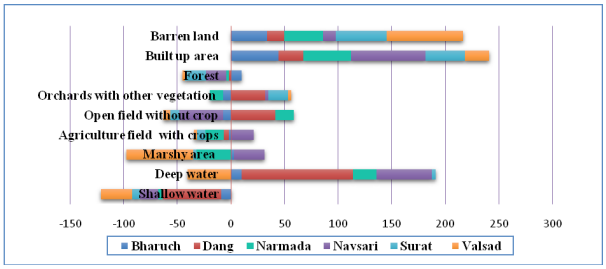

Fig. 6. Change of land uses (% Increases/decreases) in South Gujarat

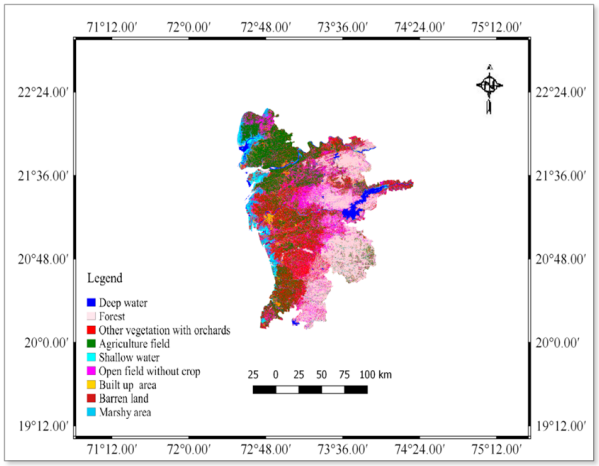

Fig. 7. Land use land cover classification of South Gujarat in the year 2000

48792.5 ha from 2000 (108632.2 ha) to 2011 (157424.7 ha). In addition to this, almost all the districts have positive gain which ranges from 22.34 percent to 69.09 percent in the class; which shows that faster urbanization in the Navsari may be due to the creation of new district from Valsad as well as other educational institutions. Meanwhile, the total increase in barren land land use classes were 5181.05 ha and highest was in Valsad (71.07 %) followed by Surat with 47.65 percent among all the districts.

Imageries indicate construction of deep water bodies in South Gujarat, which validate the work of pond digging and construction of check dams done during the period. There is shift in forest area to Orchards and other vegetation, in Surat (18.25%) district there is major shift, could be due to avenue plantations, orchards and development of gardens. Forest area has decreased in almost all districts except in Bharuch. Barren land has increased in most

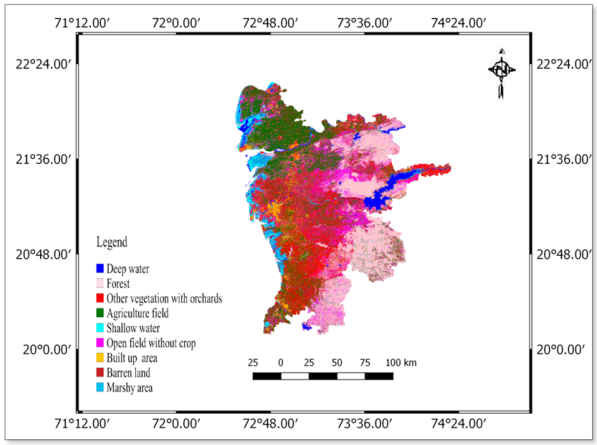

Fig. 8. Land use land cover classification of South Gujarat in the year 2011

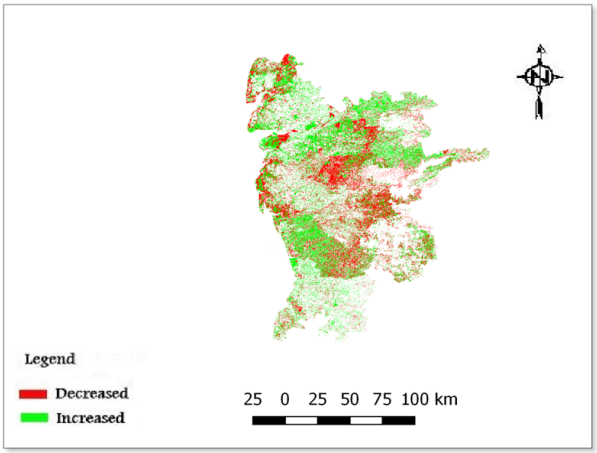

Fig. 9. Change detection map of South Gujarat

of the districts which could be due to development of salinity and alkalinity levels along the sea coast, mining and increase of waste dumping sites and conversion of forest land into degraded forest lands. In Navsari district barren land has increased by 16.50% to 27.5% in last 15 years and Conversion of barren land and vegetative land to sweet water aquaculture farming was also reported during the study. Marshy lands have increased in Navsari (28.90%) and Bharuch (2.38%) district. Increase in build up area proves construction of new residential societies, road network, industry in the regions. The rising population in Navsari district followed by Narmada, due to formation of new districts in South Gujarat.

Conclusion

The study reaffirms that remote sensing and GIS techniques could be effectively used for development of land use/land cover plan. It shows that agricultural and forest areas have decreased, but orchards and other vegetations have increased, in most of the districts, during the reporting period. There is shift in forest area to Orchards and other vegetation, in Surat (18.25%) district there is major shift, could be due to avenue plantations, orchards and development of gardens. Forest area has decreased in almost all districts except in Bharuch. Barren land has increased in most of the districts which could be due to development of salinity and alkalinity levels along the sea coast, mining and increase of waste dumping sites and conversion of forest land into degraded forest lands. Marshy lands have increased in Navsari by (28.90 %). Built up areas has shown significant increase in the region confirming construction of new residential societies, road network, industry in the region, rising population, the maximum increase is in Navsari district followed by Narmada due to formation of new districts in South Gujarat.

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Conflict of Interest

There is no conflict of interest among the all author.

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