Change Detection of Land Use/Land Cover of Sardar Sorovar Command Area, India, Using Arc-Gis Tools

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Abstract The accelerated advancement of urbanization in India is one of the prime alarming concerns for the country. For the better and promising urban development of the nation, this cause is taken into consideration by the town planners. The relentless advancement of the urban sector has inferred in acute variations land use/land cover. Focus on the wide use of remotely sensed data and geographical information systems (GIS) has commenced along with the initiation of land use/land cover variations. The current study examines the built-up growth and headway in Sardar Sarovar Singh Command Area, Gujarat, utilizing data from IRS satellite for the years 1992, 2000, 2008 and 2016. The four satellite images of 15 April 1992 to 1 April 2016, path row 148/44, were acquired from the USGS website. The technique applied to classify the land use/land cover was unsupervised classification method. The several layers pertaining to various land uses recognized from remotely sensed data were adopted through GIS. After the review and analysis of the data, it is resolved that there is a rigorous hike in the urban division and the green cover within the study area extent is abbreviated.

Keywords Urban · Land use/land cover · Change detection · Remote sensing · Geographical information system

1 Introduction

The land is numerously lowering resource even though all the ecological activities are based on it. The agribusiness, woodland, urban and modern area employments are advancing due to the increment in the growth rate of population, thereby pressurizing the constrained land. To regularize the utilization of before-mentioned resources, it

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should be obligatory that the erudition of the scale and variety of variations in the exertion of area resource should be appropriately sorted, consistently conducted [1]. Also, grading and acknowledging the severity and spatial configuration of land use/land cover is a significant undertone to the review of environmental modification at several extents. Furthermore, this sort of analysis identifies and offers to model a relevant tool and heightens the turnout of land cover and area applicability and to flinch the abrogating environmental and societal holdings. Land use intimates to man's employment and numerous pertinence that are conducted aground, for example, farming, industrialization, urbanization and so on. The land cover features to the material permanence, e.g. vegetation, water bodies, soil and diversity arising due to area variations. Even though land use can be figured out by taking the cover into reflection, however, both of the integrities land use and land cover are parallel in connection and are interchangeable [2]. In relation to land use/land change interpretation, it has been perceived that the superior and most controlling factor for land use/land cover transition is the accession of the population, which heads to urbanization.

For the modern world, urbanization plays a vital role as it dominates the economic growth and development of any country. India, being the fastest developing country in the world, it can be judged that the industrial extension in the country is affected by urbanization. However, fewer than one-third of the country's population dwell in urban stretches but these aggregate more than two-thirds of country's GDP. Furthermore, more than 85% of government revenues are accounted by the urban regions. In past two decades, changes over urbanization have been observed and are remarked as strange in the history. It has been seen that the built-up area in the country, considering all town and cities, has been on a slow hike all the way through the nineteenth and twentieth century. In the primitive times, the population stabilized along the river ledges, religious cores and agricultural centres, the object signifying the facile and elementary availability of water for various social and domestic uses. However, in the recent years, the metropolitan and new cities have mainly resolute the advancement in the population.

Therefore, there has held a shift in the trend of land use/land cover and thereby one of the considerations for landscape ecological plans is change detection. Change detection can be circumscribed with the help of planning landscape characteristics maps [3].

The land is remaking into a limited resource due to extensive agricultural and demographic exercises. Thus, knowledge of land use/land cover and credible upshots for their absolute distinction is indispensable to the assortment, devising and regulation of land use strategies to match the accreting demands for requisite human necessities and well-being cover modifications likewise involve the arrangement either linear or radical of typical habitats and their impact on the environment of the stretch. Therefore, a meticulous effort was made by [4], to generate land use/land cover classification plot for Hyderabad district. The research was done for a duration of six years (2013–2016) employing multi-temporal satellite imagery. The study region was incorporated into four groups, namely water bodies, built-up area, barren land and vegetation region. Through the study, it was resolved that the land

use/land cover alterations of the subject area are a consequence of both natural and socioeconomic components and their application by the man in time and space.

Farming practices, mechanical sand winning procedures and the allocation of land to recommended contractors encompassing the catchments boundary of the Owabi Dam, which is the study area. These practices have driven the forest cover and the lifespan of the dam vulnerable to peril. The purpose of this examination was to dissolve and identify the alteration of land cover target the forest cover in the study region, utilizing Geographic Information System (GIS) integrated methods and multi-temporal Remote Sensing (RS) data for a time interval of 22 years (1986–2007). The images were processed, and land use/land cover maps were recognized and acquired from inclusive eight classes, namely water, barren land, built-up area, wetlands, forest, croplands, high-density forest and grasslands, based on land use/land cover identification. The study resolved that the forest cover had dwindled to 39%. The analysis inferred that the reduction in the region was due to the human exercises and population growth rate within the catchment area [5].

2 Materials and Methods

2.1 Study Area

Narmada command (Gujarat state, India) has been divided into 13 homogenous agroclimatic zones, based upon important physical characteristics such as rainfall, land irritability class, groundwater quality and quantity and drainage condition (Operational Research Group, Narmada Project, 1981–1982), the present study area is one of these of Narmada project command, namely having geographical area of 295,700 ha out of which 70% land is cultivable, i.e. 206,990 ha is cultivable command area. Extending from 72°35′ to 73°20′E longitude and 22°40′–23°10′N latitude, it covers nine talukas of state within its boundaries, River Sabarmati and River Shedi serve as two hydraulic boundaries to this triangle-shaped basin on two sides. A lined canal runs along the third side (Fig. 1).

2.2 Land Use Classification

The association of abiotic and biotic components on the covering of the earth can also be expressed as land cover, and it is unique amidst the most significant possession of the framework of the earth. The land cover consolidates snow, water bodies, exposed soil, forests and grasslands. Land use comprises a built-up area, farming area, particular engagements county also called recreational land, wildlife zone, etc. Therefore, land use is related to the manly activities while the land cover related to natural and human prospectus like built-up area, farms, forest, lakes, etc. present
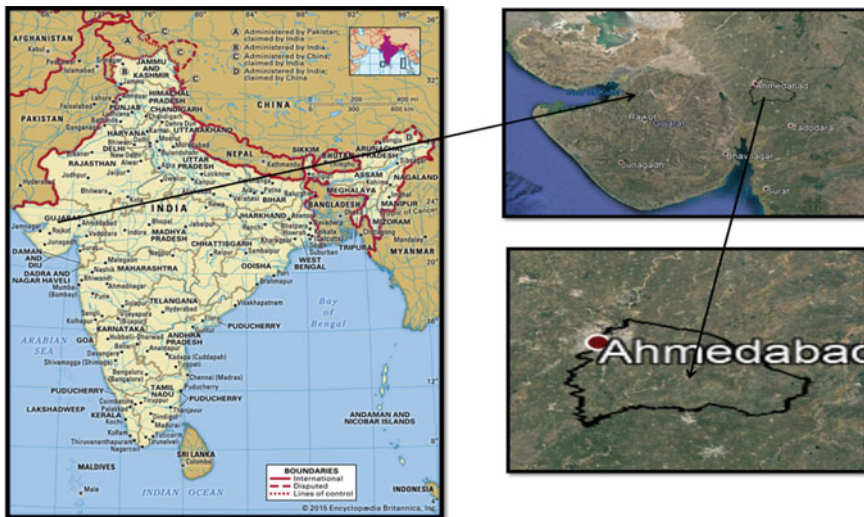
Fig. 1 Study area showing Sardar Sarovar command area region-V

on the face of the earth. Nowadays, the main exercises that constitute land cover changes are agriculture expansion, burning activities or fuel wood consumption, deforestation, some construction works and urbanization.

The satellite images of the year 1992, 2000, 2008 and 2016 were processed in ERDAS IMAGINE (version 9.2), which is powerful image processing software, and a land use/land cover map was adopted. The resolution of the digital land cover categorization is to have a significant data class content, which can estimate the landscape in an absolute manner [6]. Mainly land use classification is done in two methods, namely unsupervised and supervised classification. An unsupervised method is used when the group's cases have their relative spectral similarity, and the other method being supervised method of classification is centred on the relationship of the state to an asset of pre-fixed classes which have been distinguished spectrally. In this study, an unsupervised method of classification has been opted, which resulted in accurate and precise classification.

2.3 Preparation of DEM

The Digital Elevation Model (DEM) for the study area was generated by using ArcGIS software, as shown in Fig. 2. The elevation data used for generating DEM map were of the range of 30-m interval. The several coloured sections epitomize the zone of interpolation amid two contours, and the different colours describe diverse zones of interpolation. The recent topography of contours and resolution is the function of the accuracy of results obtained. 30 × 30 m resolution was taken for DEM generation,
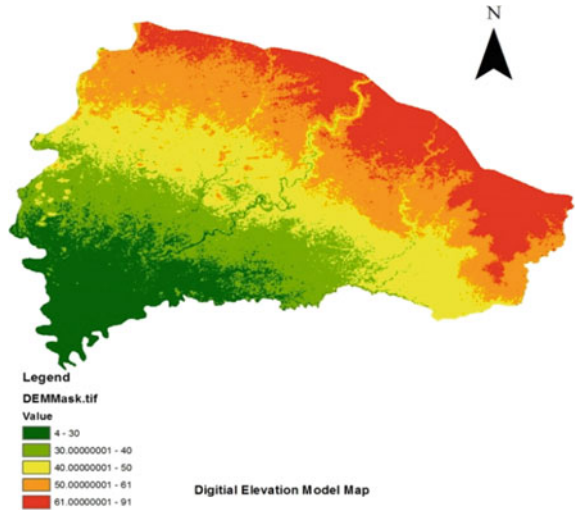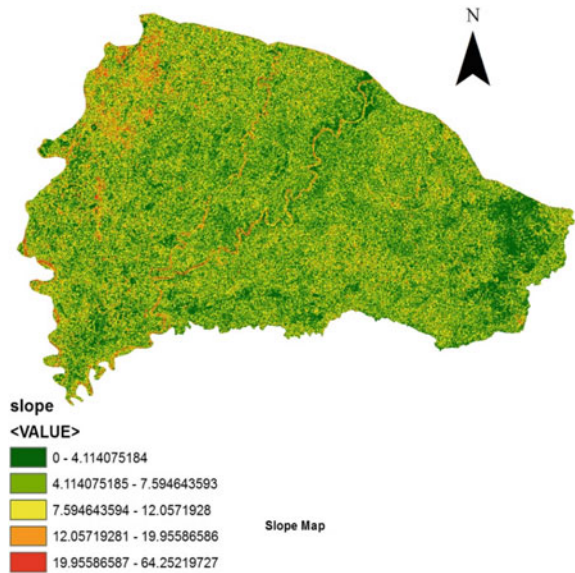
Fig. 2 DEM of the study area

Legend

DEMMask.tif

Value

- 4 - 30
- 30.00000001 - 40
- 40.00000001 - 50
- 50.00000001 - 61
- 61.00000001 - 91

Digitial Elevation Model Map

Fig. 3 Slope map of the study area

slope

<VALUE>

- 0 - 4.114075184
- 4.114075185 - 7.594643593
- 7.594643594 - 12.0571928
- 12.05719281 - 19.95586586
- 19.95586587 - 64.25219727

Slope Map

and the interval was found to be satisfactory. A mass of knowledge regarding the morphology of land surface by virtue of algorithms in raster processing operations can be selected using DEM and other side operations. The information it provides can be made useful to prepare flow direction, drainage network, slope aspect and drainage density map, contour map. Slope map indicates the change in elevation, as shown in Fig. 3.

3 Results and Discussions

The processed images of the path and row 148/44 for different years are used as listed in Table 1 with their data acquisition and resolution for study. Classified images are shown below:

In this era, it is desirable to have the knowledge of land use/land cover constituents prior hand, so that the issues related to loss of dynamic ecosystems, biodiversity, environmental degradation, fall of agricultural lands, reduced water bodies, etc. can be noticed, marked and eventually stopped. LU/LC changes involve rapid advancement in population as one of its prime and foremost cause [7, 8]. The current study area, Sardar Sarovar Command Area Region-V, has a part of Ahmadabad city engulfed within boundary limit, which is one of the rapidly growing and developing towns in the country as being the largest city of the country. As being the industrial hub and important economic element of the state, during the past few decades, the city has absorbed the significant hike in population, economic advancement and industrialization. Consequently, land use/land cover reckoning and analysis were executed to acquire the land use/land cover map for the study area by the arbitration of several data sets, remote sensing and GIS [9, 10]. With the help of remote sensing imagery and present study area statuses, we have divided the study area into five classes, namely, urban area, water bodies, vegetation, agriculture land and barren land, as shown in Fig. 4. The area to be examined for the analysis is approximately 2373.1 km^2, and land use/land cover alterations were analysed for a period of 24 years (1992–2016). Table 1 shows the statistics of land use/land cover shifts. It is manifest from Table 2, that the land use/land cover variations were principally in urban and agriculture class from 1992 to 2016.

Correlating the land use/land cover in 1992 and 2016 opted from satellite imagery interpretation signifies that urban area, consisting human habitation advanced for non-agricultural applications like building, transport, recreation, etc. hiked from 20.96 to 61.39%, i.e. urban area has increased from 496.72 to 1456.88 km^2. This is because the study area during the study period had undergone population increase which directly resulted in urban advancement and industrialization. When taking into consideration the agriculture land for the study period, the change in this very

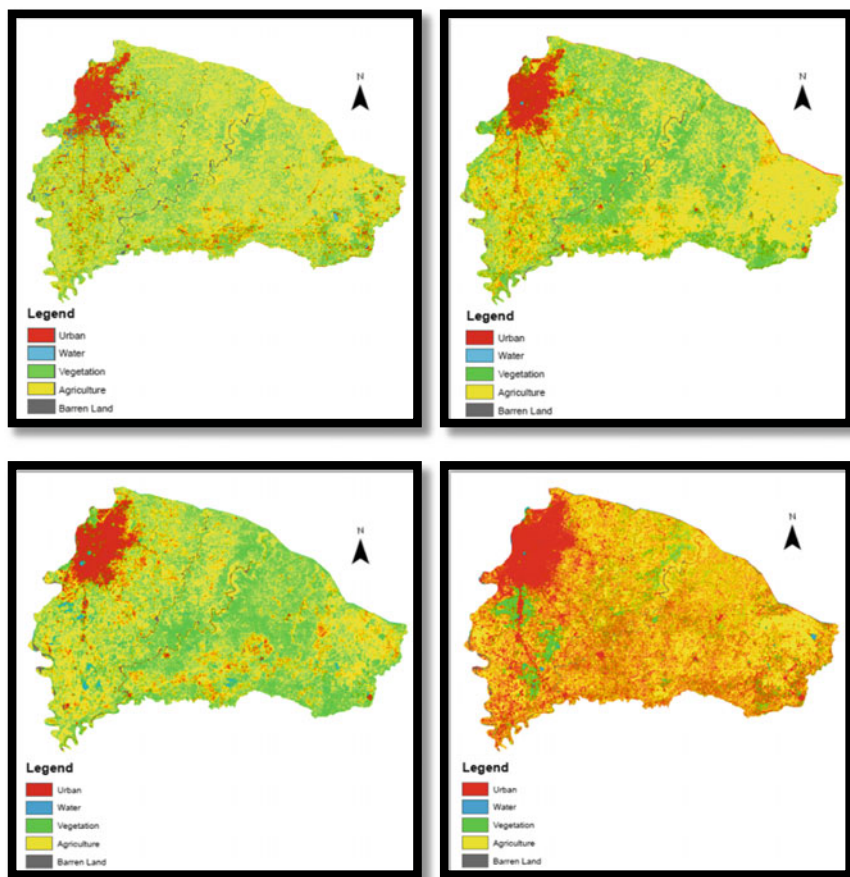| Table 1 Detail of data acquired	S. no.	Date of acquisition	Data	Resolution (m)
	1	14 April 1992	Land sat data	30
	2	21 April 2000	Land sat data	30
	3	27 April 2008	Land sat data	30
	4	1 April 2016	Land sat data	30

Fig. 4 Land use/land cover map of the study area

Table 2 Land use and land cover statistics of Sardar Sarovar Command area (in sq. km)

Class	1992		2000		2008		2016	
	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)	Area (%)	Area (km^2)
Urban	20.93	496.72	22.47	533.31	53.47	1268.89	61.39	1456.88
Water	4.18	99.13	2.40	57.05	1.53	36.31	0.93	22.04
Vegetation	60.35	1432.08	62.19	1475.82	24.23	575.01	12.27	291.18
Agriculture	9.57	227.11	10.20	242.15	18.74	444.72	24.07	571.21
Barren land	4.97	118.05	2.73	64.76	2.03	48.17	1.34	31.79

class is from 9.57 to 24.07%, as it has increased from 227.11 to 571.21 km^2. This is due to the enhanced irrigation facility which has been provided through canals, sub-canals of Narmada Waters. Even though there is an increase in agriculture sector but, however, some part of agriculture and vegetation has been settled into urban development exercises [11, 12]. Furthermore, the study area experienced significant variation in water bodies and vegetation cover. The water bodies have decided from 4.18 to 0.93%, which computes to a decrease in area from 99.1 to 22.04 km^2. Also, vegetative cover has been declined from approximately 60–12%, indicating a variation of 1432.08–291.18 km^2. This is mainly attributed to human involvement and settlements along the region and an increase in agricultural activities.

We wish that this work can bring attention about the present scenario of land use/land cover change of the Sardar Sarovar Command Area Region-V and benefit the promotion of issue that certainly represents crisis of the land as a resource. Adopting basic management exercises in addition to proper use of knowledge, a lot could be achieved to regulate the decent and appropriate use of land as a resource and in turn result in sustainable environment.

4   Conclusion

The results of the current study act as both as a scientific characterization and as an origin of information for associates functioning for the formation of favourable and enhanced land use/land cover management strategy [13, 14]. Since land use/land cover study is in its inception stage when recognizing the country and numerous other study perspectives, it is proposed that land use/land cover knowledge should be conveyed all the way for proper, efficient and enhanced working of social-environment elements. The variations in land use/land cover bring forth the necessity of use of management techniques for land as a resource. The need of applying and adopting these management techniques is probable from the increasing and unplanned population growth and unprecedented industrialization. The importance of land as a resource should be made a priority and operations over the resource should be executed accordingly.

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