LAND USE LAND COVER CHANGE ANALYSIS USING REMOTE SENSING AND GIS TECHNIQUES: A CASE STUDY OF SALUMBAR SUB-DIVISION, DISTRICT UDAIPUR, RAJASTHAN

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Abstract

Digital change detection techniques by using multi-temporal satellite imagery helps in understanding landscape dynamics. The present study illustrates the spatio-temporal dynamics of land use land cover change of Salumber sub-division, Udaipur district, Rajasthan, India during 1975 to 2016 were analysed using temporal remote sensing data with geographic information system (GIS). Landsat satellite imageries of two different time periods, i.e., Landsat Thematic Mapper (TM) of 1975 and 2016 were acquired by Global Land Cover Facility Site (GLCF) and earth explorer site and quantify the changes in the Salumber Sub-division from 1975 to 2016 over a period of 4 decades. Supervised classification methodology has been employed using maximum probability technique in ERDAS 20.14 Software. The images of the study area were categorized into five major classes and seven different sub-classes namely forest, crop land, open scrub land, fellow land, scrub land, habitation (settlement) and water body. The results indicate that during the last four decades, Crop land (agriculture), water bodies and Habitation (built-up) land have been increased by 15.02% (189.40 km2), 3.99% (47.83 km2) and 0.13% (1.56 km2) while forest and scrub land have decreased by 14.31% (170.52 km2) and 5.62% (68.26km2), respectively. The paper highlights the importance of digital change detection techniques for nature and location of change of the Salumber Sub-division.

Paper Identification

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1. Introduction

Land is defined as a place on which all human activity is being conducted. Use of land resources by the people gives rise to “land use" which varies with the purposes it serves, whether they be food production, provision of sanctuary, recreation, pulling out and processing of materials and the bio-physical characteristics of land itself. Hence, land use is being shaped under the influence of two broad sets of forces– human needs and environmental features and processes. The terms land use and land cover are not synonymous and the literature draws attention to their use and land cover change. Land cover is the biophysical state of the earth’s surface differences so that they are used properly in studies of land and immediate subsurface (Turner et al. 1995). Land use/cover is two separate terminologies which are often used interchangeably (Dimyati et al., 1996). Land cover refers to the physical characteristics of earth’s surface, captured in the distribution of vegetation, water, soil and other physical features of the land, including those created solely by human activities e.g., settlements. While land-use refers to the way in which land has been used by humans and their habitat, usually with accent on the functional role of land for economic activities. The land use/cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. Information on land use/cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population. 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 cover deals with the quantity and type of surface vegetation, water and earth materials (Meyer and Turner, 1994).

Understanding landscape patterns, changes and interactions between human activities and natural phenomenon are essential for proper land management and decision improvement. Today, earth resource satellites data are very applicable and useful for land use/cover change detection studies (Yuan et al., 2005; Brondizio et al., 1994). With the invent of remote sensing and Geographical Information System (GIS) techniques, land use/cover mapping has given a useful and detailed way to improve the selection of areas designed to agricultural, urban and/or industrial areas of a region (Selcuk et al., 2003). Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy (Kachhwala, 1985) in association with GIS that provides suitable platform for data analysis, update and retrieval (Chilar, 2000).

In the disaster prone areas of landslides, the destruction of forests and the vegetative cover that binds the top soil at an increasing pace and the conversion of forest land into agricultural and horticultural holdings (Khan et al., 2017) brings changes in land use and land cover. Landsat-TM images represent valuable and continuous records of the earth’s surface during the last 3 decades (USGS, 2014).

Daniel et al. (2002) have compared land use/ land cover change detection methods and made use of 5 methods, viz., traditional post-classification cross tabulation, cross correlation analysis, neural networks, knowledge-based expert systems and image segmentation and object-oriented classification. They observed that there are merits to each of the five methods examined and that, at the point of their research, no single approach can solve the land use change detection problem. El Gammal et al. (2010) have used several Landsat images of different time periods (1972, 1982, 1987, 2000, 2003 and 2008) and processed these images in ERDAS and ARC-GIS software’s to analyze the changes in the shores of the lake and in its water volume.

In India, researches on land use/land cover have been done by various scholars, especially by using remote sensing data. Pooja et al. (2012) have quantified land use/cover of Gagas watershed, district Almora using survey of India topographic sheet of the year 1965 and LISS III satellite data for the year 2008 over a period of 43 years. Mehta et al. (2012) presented an integrated approach of remote sensing and GIS for land use and land cover study of arid environment of Kutch region in Gujarat in between year 1999 and 2009. Sharma et al. (2012) introduced land consumption rate (LCR) and Land Absorption Coefficient (LAC) to aid in the quantitative assessment changes between the years 1976 and 2008 in Bhagalpur city in the state of Bihar in India. Land use and Land cover data provides useful information regarding developmental, environmental and resource planning applications at regional as well as global scale (Ramachandra et al., 2012). LULC dynamics are analysed through changes in the state of an object or phenomenon by observing it at different times. Accurate and timely detection of change in natural resources provides the basic understanding of the relationships and interactions between human and natural phenomena. Satellite Remote Sensing data, which are a useful source of information and provides timely and complete coverage of any specific area, have proven useful in assessing the natural resources and monitoring the land use or land cover changes (Satyanarayana et al., 2001).

A remote sensing device records response which is based on many characteristics of the land surface, including natural and artificial cover. An interpreter uses the element of tone, texture, pattern, shape, size, shadow, site and association to derive information about land cover. The generation of remotely sensed data/images by various types of sensor flown aboard different platforms at varying heights above the terrain and at different times of the day and the year does not lead to a simple classification system. It is often believed that no single classification could be used with all types of imagery and all scales. The successful attempt in developing a general purpose classification scheme compatible with remote sensing data has been carried out by Anderson in 1976, which is also referred to as United States Geological Survey (USGS) classification scheme.

2. Objectives:

The main aim of our present study is to understand the landscape ecology of the study area through.

I. Quantification of LULC
II. Assessing LULC changes during 1975-2016
III. Analysis of the agents of land use/ land covers change

3. Study Area:

The study area (Fig. 1), viz., the Salumber sub-division is one of the eleven sub-divisions and development blocks of District Udaipur of the Rajasthan state lies in the Southern aravalli hills terrain in India. Salumbar is 75 Km. south of the Udaipur city and bordered by Dungarpur, Banswara and Pratapgarh district of Rajasthan. Salumbar sub division extends between 23º 45’ 05’’ N to 24º 22’ 10’’ North latitudes and 73º 55’ 07’’ E to 74º 16’ 48’’ East longitudes and encompasses an area of 1203.88 km2 (120388.43 hectare). It consists of population of 248,337 or 50,813 households with overall population density of 371 persons per sq. km^2 and Urban density 4106 km^2 (2011). Total literacy is 47.63 per cent and sex ratio is 1028 in the sub-division. Tribal population constitutes 53.34 percent and scheduled castes persons make 5.05

percent of the population. It is thus nearly an equally mixed sub-division in terms of combination of scheduled and non-scheduled population.

The sub-division has on the whole a dry climate the cold season is from November to February and is followed by the hot season which lasts till about the middle of June. Mid June to mid September constitutes the South-west monsoon season. The post-monsoon period from the middle of September to end of November is one of transition from monsoon to winter conditions. The climate here is considered to be a local steppe climate. During the year there is little rainfall. According to Köppen and Geiger, this climate is classified as BSh. In Salumbar, the average annual temperature is 26.4 °C. About 622 mm of precipitation falls annually. There is a difference of 201 mm of precipitation between the driest and wettest months. Throughout the year, temperatures vary by 15.4 °C. May is the warmest month of the year. The temperature in May averages 33.9 °C and January is the coldest month, with temperatures averaging 18.5 °C. The driest month is February, with 0 mm of rain. Most of the precipitation here falls in August, averaging 201 mm.

The main rivers of the sub-division are the Som, Jakham. Som River is rising in the hills near Som village in Kotra tehsil of the Udaipur district, the river flows through hilly tracts in south-easterly direction and joins the Mahi river near the village of Baneshwar. Its total length in the district is about 138 km. It is a perennial river and its main tributaries are the Gomti and the Jakham. No major utilization of its runoff was envisaged in the past except by a very old tank named Jaisamand on Gomti. Tidi River near village palodra for supple-menting the water to Jaisamand canal system. In the total of 54 Gram Panchayats of Salumbar Sub-Division, Udaipur district, the tribal settlements are located in all 54 Gram-Panchayaths and Town. There are 27104 tribal households scattered over 288 tribal settlements of this Sub-division. Study area included in tribal sub plan

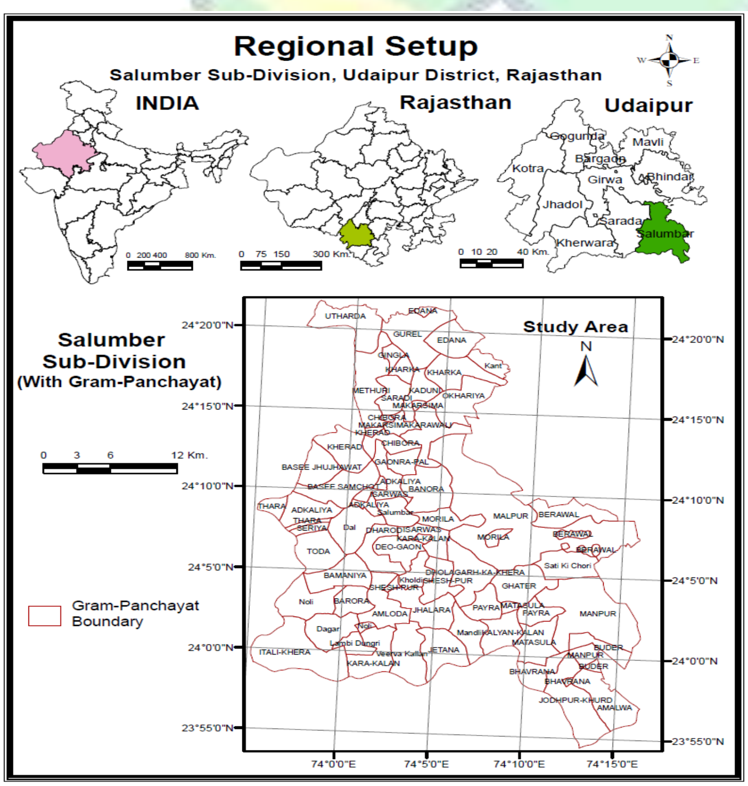


Fig. 1 Key map of study area

area of Rajasthan

4. Materials and Methods:

The procedure that we have followed in our present study is shown in Fig 2.

4.1. Data:

Remote sensing data Landsat MSS (1975), ETM+ (2016) acquired from public domains at *(http://glovis.usgs.gov/)* and Google Earth *(http://earth.google.com)* was used. The details of the remote sensing data are given in table 1.

Table: 1 Detail of Remote Sensing Data.

Year	Satellite	Date of Acquisition	Resolution
1975	LANDSAT MSS	12/01/1979	~60m
2016	LANDSAT ETM+	13/01/2013	30m

In addition to this the topographic maps at a scale of 1:50000 were used to provide the base map and boundary layers of the study area. These maps provide the additional information to assist the interpretation of different land use types.

4.2. Data Pre-processing

The remote sensing data is processed to get the good insight into land use land cover analysis. The pre-processing of remote sensing data includes atmospheric correction and geometric correction in order to enable correct area measurements, precise localization and multi-source data integration. The data obtained was geo-referenced with WGS-84 datum, rectified and cropped pertaining to the study area using Udaipur district and Salumber sub-division boundary layer. The band correction was made using GRASS GIS *(http://grass.osgeo.org/)* in order to get the better and accurate results. The bands namely band-2 (Green),

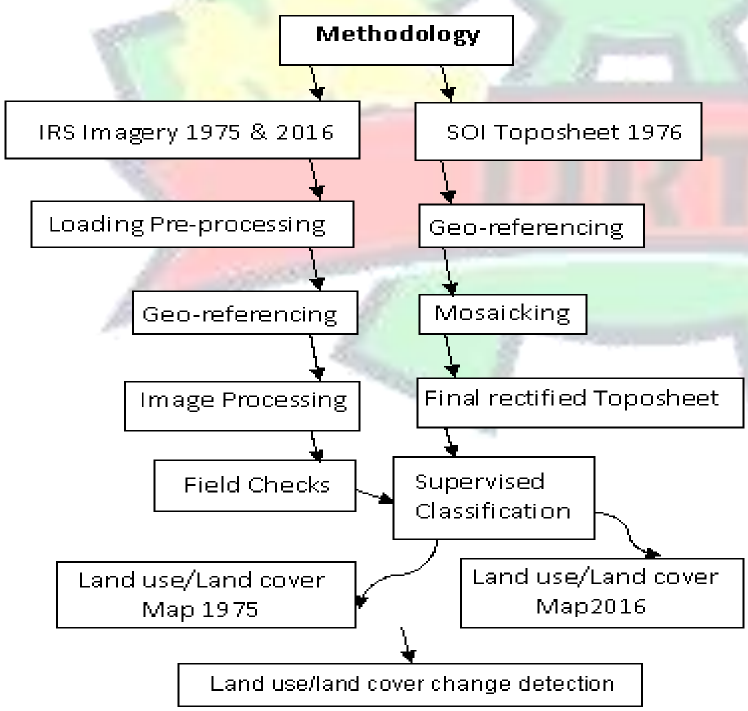


Fig 2: Flow chart of methodology followed in the study.

band-3 (Red) and band-4 (Near infrared) were used to produce the FCC (False Colour Composite). Google earth data was used for classification and validation.

5. Results and discussions:

The results obtained through the analysis of multi-temporal satellite imageries were diagrammatically illustrated in Figs. 3 to 5, data are registered in Tables 1-2 and graph. A brief account of these results is discussed in the following paragraphs.

5.1. Land use/cover status

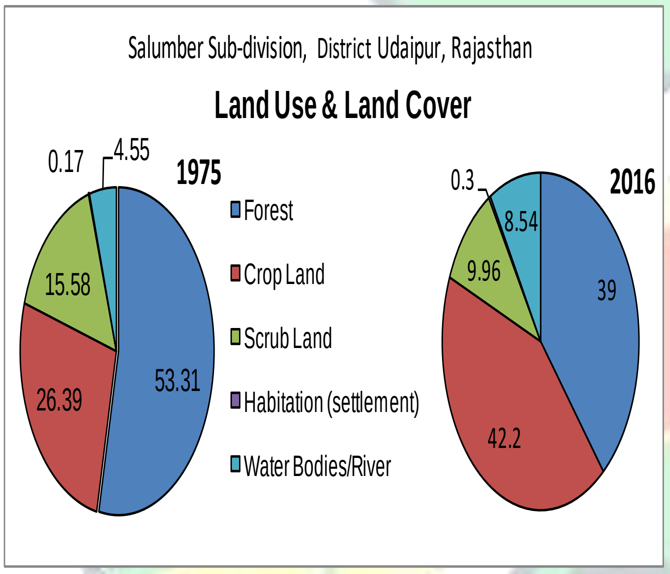
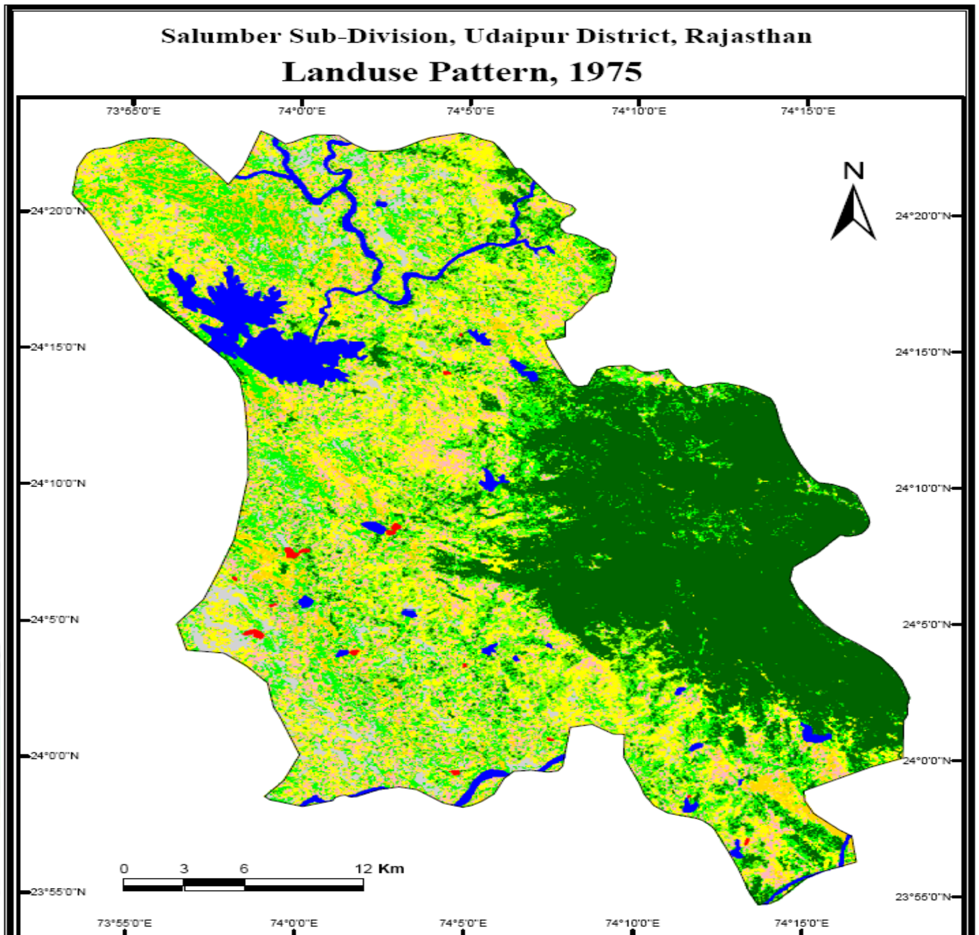


Fig. 3 Land use Land Cover in the Salumber in 1975

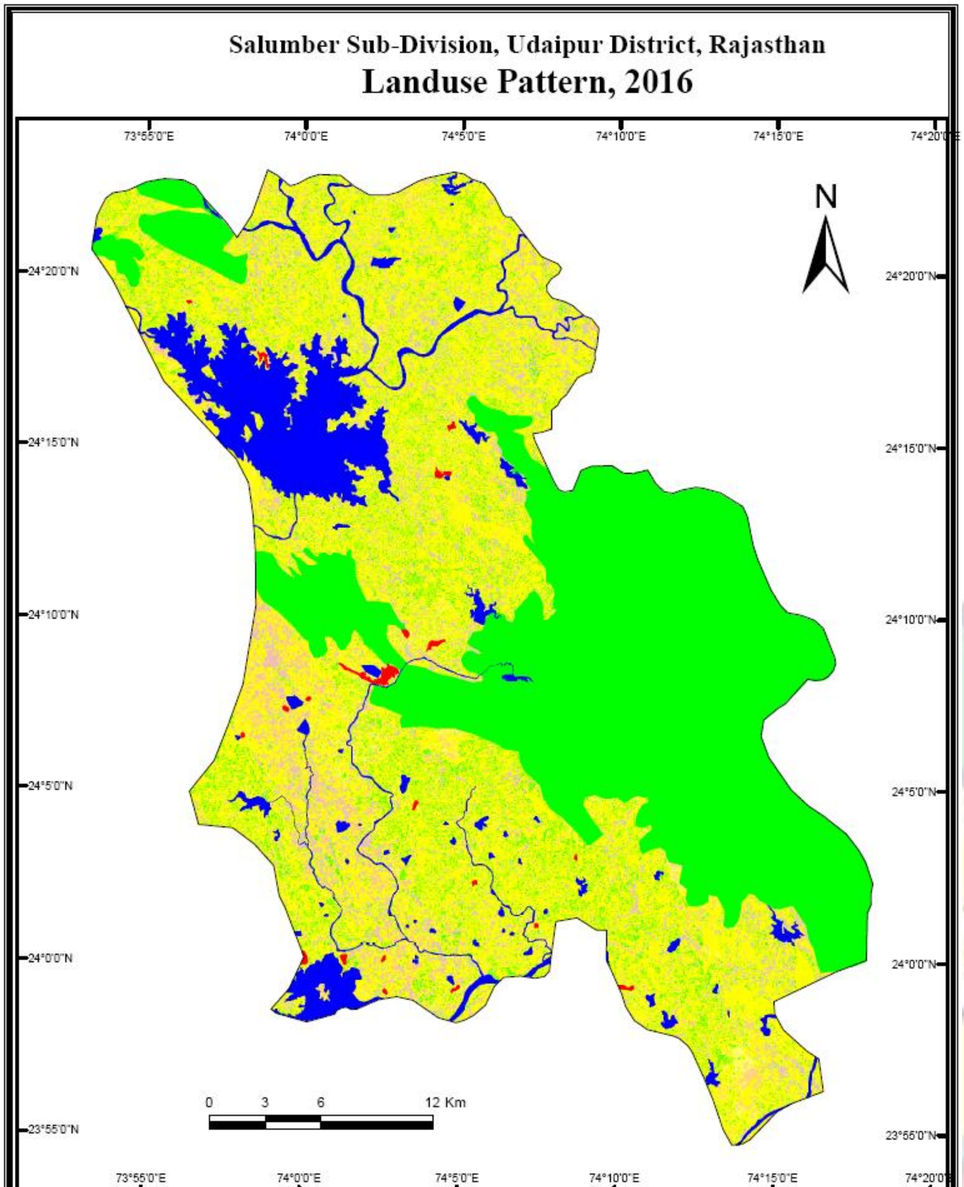
Accuracy assessment of the land use/cover classification results obtained showed an overall accuracy of 88.69% for 1975 and 96.21% for 2016. The Kappa coefficients for 1975 and 2016 maps were 0.823 and 0.912 respectively. Fig. 3 depicts spatial distributional pattern of land use/cover of the Salumber sub-division for the year 1975 while Fig. 4 for the year 2016.

These data reveal that in 1975, about 53.31percent (640.05 km^2) area of Salumber sub-division was under forest, 26.39 percent (318.75 km^2) under crop land, 15.58 percent (188.11km^2) under Scrub land, 0.17 percent (2.07km^2) under habitation land and 4.55 percent (54.922 km^2) under water bodies/river sown in fig.5. During 2016 the area under these land categories was found about 39.00 percent (469.53 km^2) under forest, 42.21 percent (508.14 km^2) under crop land, 9.96 percent (119.85 km^2) under scrub land, 0.3 percent (1.55 km^2) under habitation land and 8.54 percent (102.75 km^2) under water bodies and river land (Table 2 and chart 1).



Color	Classes Name	Area (Hec.)	% (Area)	Color	Classes Name	Area (Hec.)	% (Area)
	Forest Plantation	30242.99	25.05		Fellow Land	6392.41	5.29
	Forest	34123.27	28.26		Scrub Land	5464.82	4.53
	Crop Land	25480.61	21.10		Habitation	206.96	0.17
	Open Scrub Land	13346.57	11.05		Water Bodies/River	5492.43	4.55
					Total	**120750.06**	**100**

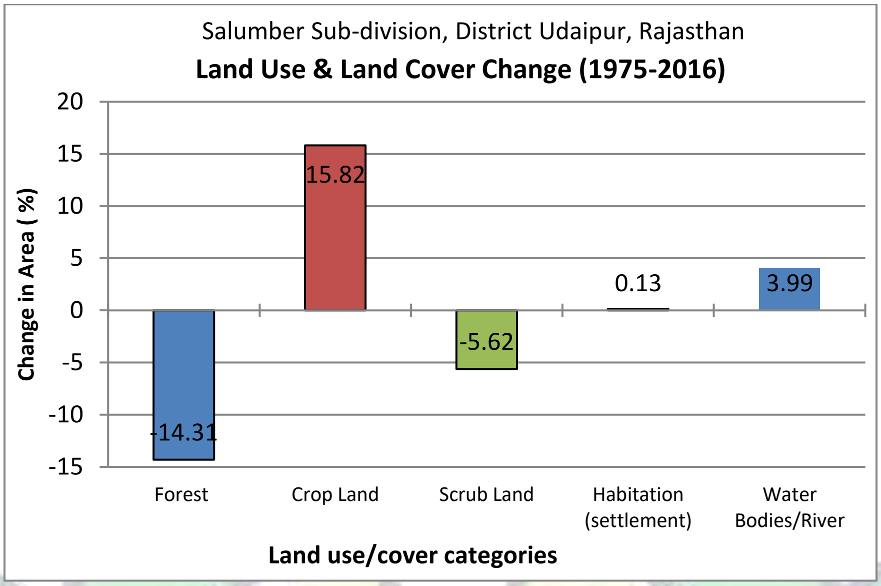
Fig. 4 Land use Land Cover in the Salumber in 2016



Color	Classes Name	Area (Hect.)	% (Area)	Color	Classes Name	Area (Hect.)	% (Area)
	Forest	46952.57	39.00		Scrub Land	5440.41	4.52
	Crop Land	49199.90	40.87		Habitation	361.73	0.30
	Open Scrub Land	6544.89	5.44		Water Bodies/River	10275.32	8.54
	Fellow Land	1613.61	1.34		**Total**	**120388.43**	**100**

The forest has decreased from 640.05 km^2 in 1975 to 469.53 km^2 in 2016 which accounts for 14.31 percent of the total study area. The habitation area has increased from 2.07 km^2 in 1975 to 3.62 km^2 in 2016 which accounts for 0.13 percent. The scrub land has been decreased from 188.11 km^2 in 1975 to 119.85 km^2 in 2016. This decrease in scrub land accounts for 5.62 percent. The water body of the study area has also increased from 54.92 km^2 in 1975 to 102.75 km^2 in 2016 which accounts for 3.66 percent of the total study area.

Fig. 5 LULC change during the last 4 decades (1975–2016) in the Salumber.



5.2. Land use/cover change

Data registered in Table 2 and Figs. 3 and 4 reveal that both positive and negative changes occurred in the land use/cover pattern of the Salumber sub-division. During the last four decades the crop land in the study area has increased from 318.73 km^2 in 1975 to 508.14 km^2 in 2016 which accounts for 15.82 percent of the total study area.

Table: 2 Area change in Salumber sub-division during 1975 to 2016.

S. No.	Land use/cover categories	1975		2016		Change 1975 to 2016	
		Area Square Km.	Area %	Area Square Km.	Area %	Area Square Km.	Area %
1.	Forest	640.05	53.31	469.53	39	-170.52	-14.31
2.	Crop Land	318.73	26.39	508.14	42.21	189.40	15.82
3.	Scrub Land	188.11	15.58	119.85	9.96	-68.26	-5.62
4.	Habitation (settlement)	2.07	0.17	3.62	0.3	1.55	0.13
5.	Water Bodies/River	54.92	4.55	102.75	8.54	47.83	3.99
	Total	1203.88	100	1203.88	100	0.00	0.00

Source: Computed by the author.

Comparative study of Land Use/Land Cover from 1975 to 2016 according to Satellite imagery and Field observation (last 20 years)

A comparative study of land use and land cover in Salumber tehsil in last four decades shows interesting insights. If one looks at statistical analysis of satellite imagery taken in 1975 one finds that it was 53.31% for Forest, 26.39% for Crop land, 15.58% for Scrub land, 4.55% for Water bodies/River and 0.17% for habitation as percentage of total study area.

In last four decades this land use has changed significantly in some aspects. Due to more and more of forest cover now being used for cultivation the forest area in Salumber tehsil has reduced by 14.31% in 2016 as compared to 1975. It now stands at around 39% of total study area. Naturally the crop area in 2016 has increased to 42.21% thus marking an increase of 15.82% in the period under study. Due to construction of more dams, check dams, anicuts to serve increased crop area the land under cover of water bodies/rivers has increased by 3.99% in period under study and in 2016 stands at 8.54%.

Though the population has increased in corresponding period the ways of life of substantial adivasi population that inhabits Salumber Sub-division has resulted in a situation where there is not much change in habitation area in Salumber Sub-Division in last four decades. It has not changed much and stands at 0.3% of total area in 2016. (As shown in Table 2 and Chart 3)

6. Conclusion

The study conducted of the Salumber sub-division, Udaipur district in Rajasthan state (India) advocates that multi temporal satellite imagery plays a vital role in quantifying spatial and temporal phenomena which is otherwise not possible to attempt through conventional mapping. The study reveals that the major land use in the study area is forest and crop land (agriculture). During the study period (i.e., 1975–2016), forest land has been decreased by 14.31% due to conversion in crop land, habitation and water bodies/river land. The area under fourth category of land, i.e., the habitation land (built-up land) has increased by 0.13% (1.56 km^2) due to mainly expansion of the Salumber town area during the last two decades.

The Indian Remote Sensing Satellite (IRS) data, image processing and Geographical Information System techniques were used to identify the land use categories such as built-up lands, cultivated lands, forest lands, water bodies and uncultivated lands.

Satellite images in combination with predated topographic sheet of Survey of India were used for analyzing land use and land cover change detection. The crop lands are well spread all over the study area and it covers 508.14 sq. km (42.21per cent). Forest occupies 469.53 sq. km and sharing about 39.0 per cent of the total land use land cover of the study area. The habitation (settlement) land occupies 3.62 sq. km (0.3 per cent) and there was a fast growth of habitation lands. Scrub land occupies 119.85 sq. km (9.96 per cent). A water bodies occupy 102.75 sq. km (8.54 per cent).

References:-

Begum, N., Narayana, J., & SL, A. K. (2010). Land Use/Land Cover Changes in the Catchment of Water Bodies in and Around Davangere City, Karnataka. International Journal of Ecology and Environmental Sciences, 36(4), 277-280.

Dhinwa, P. S., Pathan, S. K., Sastry, S. V. C., Rao, M., Majumder, K. L., Chotani, M. L., ... & Sinha, R. L. P. (1992). Land use change analysis of Bharatpur district using GIS. Journal of the Indian society of Remote Sensing, 20(4), 237-250.

Erle, E., & Pontius, R. (2007). Land-use and land-cover change. Encyclopaedia of Earth.(Eds.). Cutler J. Cleveland (Washington, DC: Environmental Information Coalition, National Council for Science and the Environment). Last Retrieved January, 19, 2008.

Javed, A., & Khan, I. (2012). Land use/land cover change due to mining activities in Singrauli industrial belt, Madhya Pradesh using remote sensing and GIS. Journal of Environmental Research And Development Vol, 6(3A).

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., ... & George, P. (2001). The causes of land-use and land-cover change: moving beyond the myths. Global environmental change, 11(4), 261-269.

Mark, M., & Kudakwashe, M. (2010). Rate of land-use/land-cover changes in Shurugwi district, Zimbabwe: drivers for change. Journal of Sustainable Development in Africa, 12(3), 107-121.

Meyer, W. B. (1995). Past and present land use and land cover in the USA. Consequences, 1(1), 25-33.

Meyer, W. B., & Turner, B. L. (1992). Human population growth and global land-use/cover change. Annual review of ecology and systematics, 23(1), 39-61.

Moser, S. C. (1996). A partial instructional module on global and regional land use/cover change: assessing the data and searching for general relationships. GeoJournal, 39(3), 241-283.

Otterman, J. (1974). Baring high-albedo soils by overgrazing: a hypothesized desertification mechanism. Science, 186(4163), 531-533.