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The Scenario of Land Use /Land Cover Change of Udaipur District, Rajasthan : Study Using Remote Sensing and GIS Technology

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ABSTRACT

The pattern of Land use/land cover has been changing pretty much consistently in Udaipur district because of urbanization and further more from deforestation. The examination assesses the Land use/land cover change in Udaipur area by utilizing Remote Sensing and GIS technology. Lands at scenes of year 2001, 2015, 2010, 2015 and 2018 were taken and administered order system was utilized to arrange the Land use/land cover classes into Built up, Forest, Scrubland, Agriculture, Fellow land, Barren/Rocky, Water. The outcomes infer outstanding development of developed and significant abatement in the forest cover. Remote Sensing and GIS advances give the information to study and screen the earth and the climate. The after-effects of the examination additionally helps in the planning deforestation locales which must be recuperated by doing estate and gives genuine situation of Land use/land cover in remote areas.

Keywords Land use /land cover, Deforestation, Urbanization, Remote Sensing.

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INTRODUCTION

The segment information of the most recent couple of many years uncovered an expanding propensity of urbanization in many states, including Rajasthan. Udaipur city, being an instructive center point just as a place of interest of worldwide significance. The current investigation is intended to (i) determine the changing situation of land use and land cover design, (ii) learn the adjustment of the forest front of the district and (iii) change in the natural magnificance of the scene of the natural beauty. The investigation of land use and land cover change is one of the pre-eminent fields to comprehenced the level of cooperation among man and climate. The investigation of land use and land cover change is one of the principal fields to comprehenced the level of connection among man and environment (Deka and Sharma 2012). The actual backwoods are dynamic in nature and are going through consistent changes because of both normal and anthropogenic powers(Singh *et al.* 2018). The forest is under danger from regular and anthropogenic powers prompting forest degradation, fundamentally because of top-kicking the bucket illness and over-abuse of woodland assets. The land-cover changes happen normally in a reformist and steady manner, anyway once in a while it could be quick and sudden because of anthropogenic exercises (Giriraj *et al.* 2008). Remote sensing detecting information at various time span help in investigating the pace of changes just as the causal components or drivers of changes (Santhosh Baboo and Renuka Devi 2010). Forests have significant and indispensable world wide natural just as financial assets and they require a feasible administration (Muhammad Asim Rizwan 2011). The investigation of satellite symbolism permitted us to test the general effect of population and settlements on forest cover (Simula and Mansur 2011). Satellite information have become a significant application in forest change recognition on account of the redundant inclusion of the satellites at short spans (Gunaid *et al.* 2013). Forest cover today is modified essentially by direct human use and any origination of worldwide change should remember the unavoidable impact of human activity for land surface conditions and cycles (Boisier *et al.* 2012). Planning LULC is presently the standard method to monitor changes and to monitor land use change and advancement, a change recognition investigation was performed to decide the nature ; degree and pace of land cover change over the time period (Eric K Forkuo and Adubofour Frimpong 2012). The International Union of Forest Research Organizations (IUFRO) characterizes forest detecting as 'the occasional estimation or perception of chose physical, compound and natural boundaries of forest for building up baselines for recognizing and measuring changes over the long haul'. Observing the areas and circulations of land-cover changes is significant for building up joins between strategy choices, administrative activities and ensuing area use exercises. Maps delivered utilizing satellite information enjoy upper hands over conventional ground based guides because of the nonstop inclusion and interior consistency of distantly detected informational collections. Land use order is indispensable in light of the fact that it gives information which can be utilized as contribution for demonstrating, particularly the one managing climate, for example models manages environmental change and approaches advancements (Disperati *et al.* 2015).

Supervised, Per-Pixel, Maximum-Likelihood Spectral classifiers are the most regularly applied automated land-cover classification strategies due to some extent to a very much created hypothetical base, ease in automation and demonstrated history (Al-sharif and Pradhan 2014). Spatial information in a GIS have been displayed to further develop grouping precision and help in the extraction of data from classification (Muhammad Asim Rizwan 2011). Techniques incorporate fuse previously, during, or after a greatest probability grouping (Pielke *et al.* 2011). Significant drivers of tropical deforestation incorporate enormous scope forest extraction, agrarian extension and foundation advancement, all of which have expanded drastically in many parts inside the forest in the course of recent many years (Dewan and Yamaguchi 2009). Landsat classification for the most part gives an unmistakable depiction among forest and non-forest cover types and permits both manual and semi-computerized translation (Bharadwaj 2014). The error matrix and kappa coefficient have become a standard method for evaluation of image classification accuracy. The absence of handily got to, peer explored information sources might add to the clashing insights with respect to timberland cover and deforestation in Udaipur district. In this paper we employ a simple yet accurate time-series satellite change detection method to monitor forest change in the Udaipur district. The overall objective of this study is to map out and analyze the structural changes of forest cover using lands at imageries of the study area.

Study area and data preparation

Study area

The study area (Fig.1) chosen for present investigation is Udaipur district having all out geological region covers as per Forest Survey of India is 11,724 sq km. Udaipur is a southern district arranged among the Aravalli territories which is rich of natural flora and fauna of Rajasthan. Udaipur area is a piece of South-East Rajasthan and arranged between matches 23°26', 26°20' North scopes and 73° 09', 74°45' East longitude at normal heights of about 579.4 meter above mean ocean level. Udaipur has an all encompassing setting given by a few lakes and limited on the northwest by the Aravalli Range. Udaipur was established in 1559 by Maharana Udai Singh and was the capital of Mewar State. It is bound in the north by Rajsamand and Pali areas, in the south by Dungarpur and Banswara in the east by Bhilwara and Chittorgarh and on the west by Pali and Sirohi locale and Sabarkantha region of Gujarat.

Landsat scene acquisition

A requirement of time series change detection is

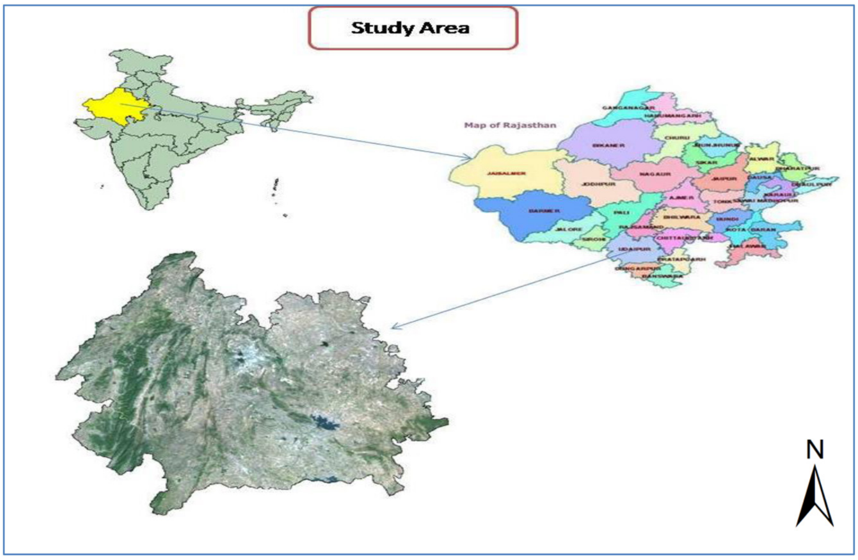

Fig. 1. Study area map.

the availability of relatively cloud free data satellite imagery of each date (Jamal Suliman Alawamy *et al.* 2020). Scenes from October were used to coincide with winter dry season. This season minimize the error of classification results.

Image data

Landsat subscenes covering the study area were used having path- and row- .The first subscene was acquired in 2001 by Landsat Thematic Mapper (TM), second subscene was acquired in 2005 by Landsat 7 Enhanced Thematic Mapper (ETM), third subscene was acquired in 2010 by Landsat 7 Enhanced Thematic Mapper (ETM) and the forth subscene was acquired in 2015 by Landsat 8 Operational Land Imager (OLI). All the satellite imagery (Level-2, Reflectance imagery) was downloaded from the USGS Earth Explorer (https://earthexplorer.usgs.gov/). Satellite data specifications have been shown in the Table 1.

MATERIALS AND METHODS

Landsat scene normalization

There was no much need of normalization because we used atmospherically corrected scene of the Landsat which was ready to analysis scene (Level-2, Reflectance imagery).

Image classification

The classification was performed with the standard maximum likelihood estimation approach at 30-meter (m) spatial resolution and was verified and improved using existing maps and field data. Post-classifica-

Table 1. Satellite data specifications.

Sl. No.	Data	Date of acquisition	Bands	Spatial resolution	Source
1	Landsat 5	2001/10/17	Multispectral	30 m	USGS Earth Explorer
2	Landsat 7	2005/10/20	Multispectral	30 m	USGS Earth Explorer
3	Landsat 7	2010/10/26	Multispectral	30 m	USGS Earth Explorer
4	Landsat 8	2015/10/24	Multispectral	30 m	USGS Earth Explorer
5	Landsat 8	2018/10/16	Multispectral	30 m	USGS Earth Explorer

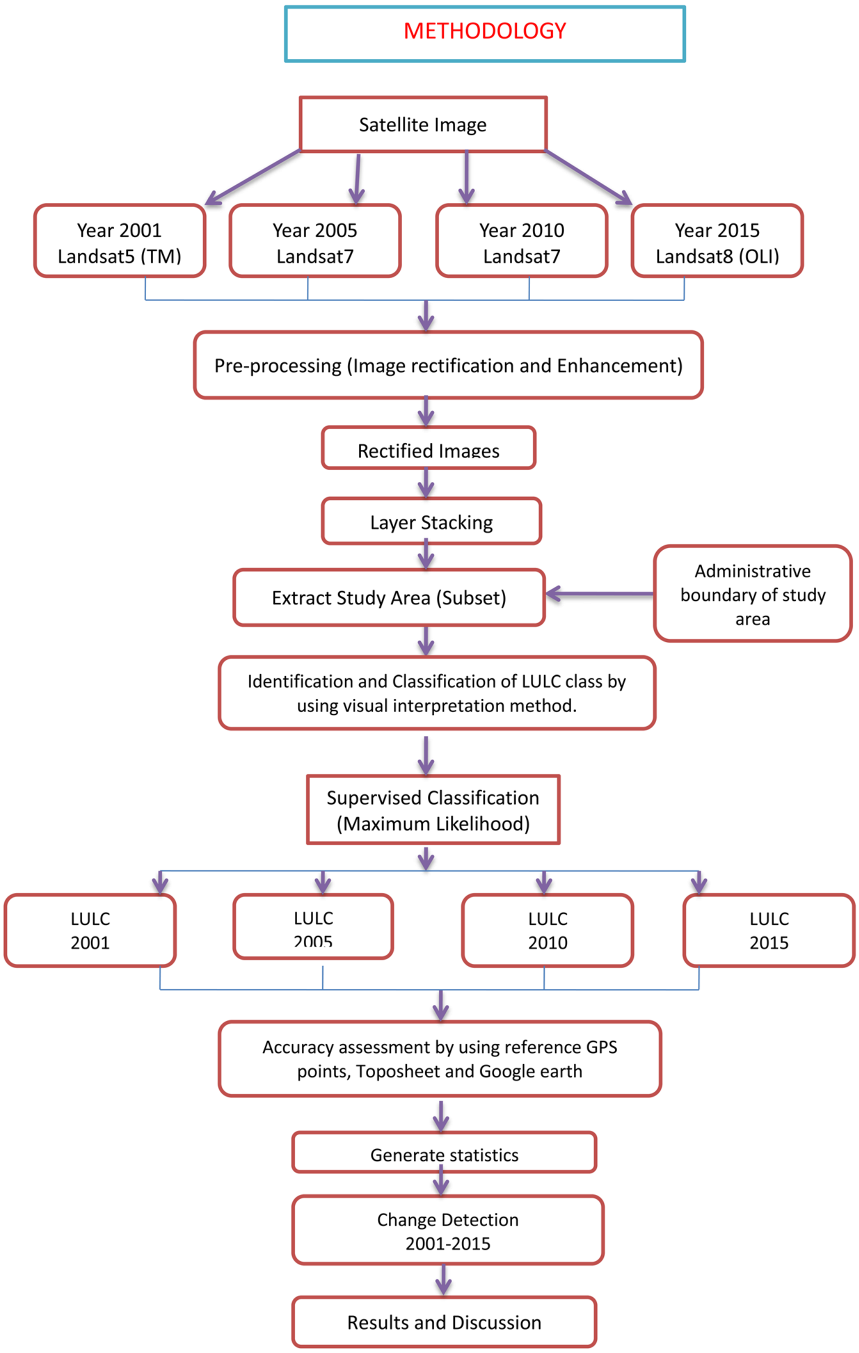

Fig. 2. Methodology chart.

tion comparison was found to be the most accurate procedure and presented the advantage of indicating the nature of the changes (Kushwaha 2012). On the basis of GPS survey points and field knowledge the signatures were assigned for each particular class. A stepwise work design is showed in the Fig. 2. False

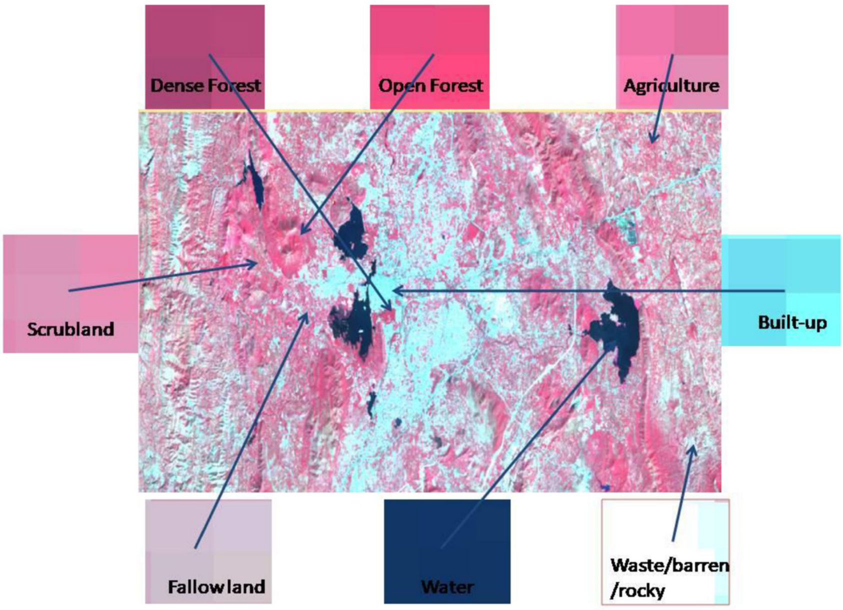

Fig. 3. False color composite of landsat 8 MSS showing pixels of the different land use/ land cover class of the study area.

color composite map presented in Fig. 3. Details of the different Land use/land cover class were given in the Table 2.

Data Processing- The raw data and imagery was processed using software -

- ERDAS Imagine
- Arc GIS

Accuracy assessment

A standard overall accuracy for land-cover and land-use maps is set between 85 (Anderson *et al.* 1976) and 90% (Lins and Kleckner 1996). Details of ground control points for the accuracy assessment is presented in Fig. 4. Accuracy statistics for the classification result of the October 2018 were presented in Table 3 and accuracy of the previous image years selected for the study was more than 85%.

Table 2. Land use/land cover class details.

Sl. No.	Class	Remark
1	Dense forest	Moderate dense forest. Lands with a forest cover with canopy density of 40-70%
2	Open forest	Lands with forest cover with canopy density of 10 to 40%
3	Scrubland	Lands generally in and around forest areas, having bushes and or poor tree growth, chiefly small or stunted trees with canopy density less than 10%
4	Agriculture	Agricultural land
5	Fallow land	Cropland that is not seeded for a season; it may or may not be plowed
6	Barren/Rock	Unproductive bare soil including rocks barren land includes areas of bare soil, sand and exposed rocks. In a barren area, less than one-third of the area has vegetation or other cover (Anderson *et al.* 1976)
7	Built up	Any land on which buildings and/or non building structures are present, normally as part of a larger developed environment like – Urban and Rural Residential, Commercial, Industrial, Roads, Mining, , building material
8	Water	Rivers, Lakes, Ponds

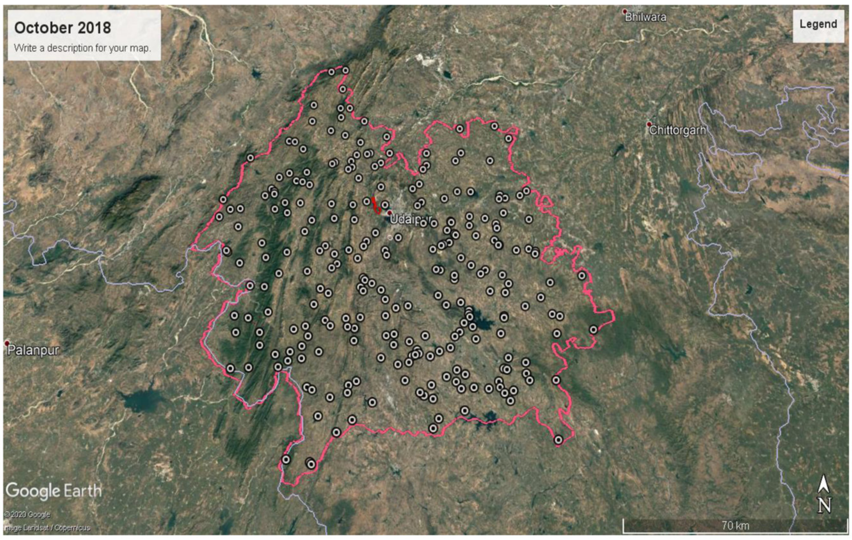

Fig. 4. Image showing ground control points taken for the accuracy assessment in the October 2018.

RESULTS AND DISCUSSION

The year wise change in the area of different classes of land use in Udaipur district (Table 4). The classified land use maps were prepared by using Erdas Imagine (Fig. 5). The table depicts the area wise change detection in different classes like dense forest was 62923.1 hectares in the year 2001 whereas it reduced to 51339.1 hectares in 2005. Similarly continuous decrease in dense forest has occurred during consecutive years from 2005 to 2010 and further in a spell of next five years there is sharp decrease in forest cover. Likewise open forest also disturbed which was 116401 hectares in the year 2001 whereas it reduced to 97996.1 hectares in the 2018 (Fig. 6) which shows great loss. A later report covering a piece of the southern side of the Al-Jabal Al-Akhdar district announced a sensational change in LULC somewhere in the range of 1984 and 2005, where forest and shrub covers lost about 21% and 46%, respectively, while farmlands and urban areas have expanded by about 58% and 75%, individually. The investigation likewise indicated that, in 1984, there was irrigated cultivation inside the examination zone while inundated farmlands involved about 3.8% of the absolute region in 2005 (Mansur and Rotherham 2010).

The areas covered by agriculture and built-up

Table 3. Accuracy statistics for the classification result (October 2018). Overall Classification Accuracy = 99.61%, Overall Kappa Statistics = 0.9943.

Sl. No.	Class name	Reference totals	Classified totals	Number correct	Producers accuracy	Users accuracy	Kappa statistic
1	Dense forest	5	5	5	100	100	1.0000
2	Open forest	24	24	24	100	100	1.0000
3	Scrubland	97	98	97	100	98.98	0.9836
4	Agriculture	19	18	18	94.74	100	1.0000
5	Fallow land	2	2	2	100	100	1.0000
6	Waste/ Barren/Rocky	102	102	102	100	100	1.0000
7	Built up	3	3	3	100	100	1.0000
8	Water	4	4	4	100	100	1.0000

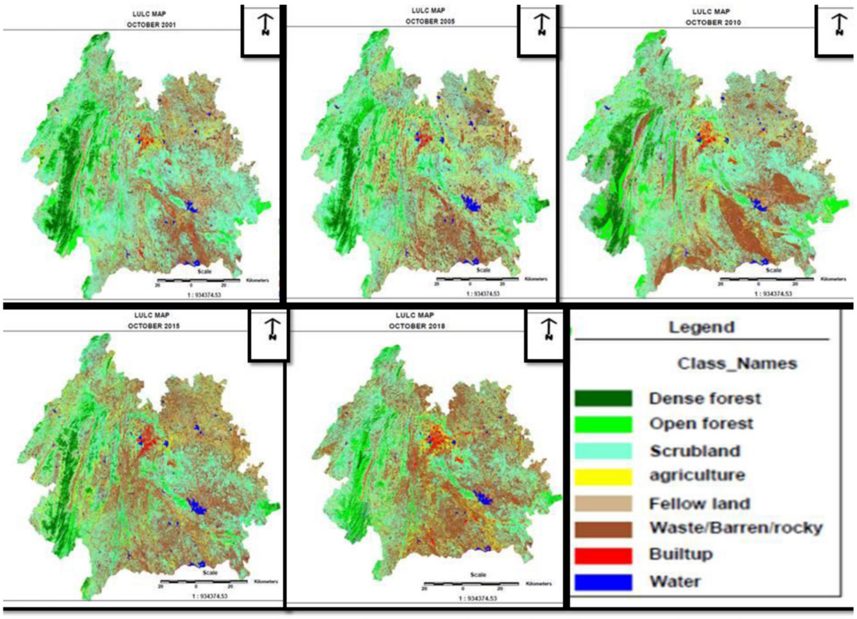

Fig. 5. LULC maps of different time period.

area have increased simultaneously. The outcomes unmistakably uncovered that the built-up land (settlement) has radically expanded from about 8.08 km^2 in the year 1999 to 8.62 km^2 in year 2004 (Giriraj and Nadhi 2010). There is some vacillation in the absolute areas covered by every one of these land cover types, however the Dense and Open forest, scrubland classes in general show a diminishing pattern while Agriculture, Fallow land, Wasteland and Built-up have an expanding pattern (Fig. 7). Remotely sensed data are a helpful apparatus and have logical incentive for the investigation of human environment interactions, particularly land use and land cover changes (Boori *et al.* 2014). Huge human disturbances in and around the forest limit are the potential reasons for decreases in dense and open forest since this zone is the significant wellspring of timber. Likewise, the feet of the nibbling steers greatly affect fragile ecosystem,

Table 4. Year wise change in LULC area of different class of the month of October.

Sl. No.	Land use / land cover class	Area in hectares (2001)	% Area	Area in hectares (2005)	% Area	Area in hectares (2010)	% Area	Area in hectares (2015)	% Area	Area in hectares (2018)	S % Area
1	Dense forest	62923.1	5.36	51339.1	4.37	50277.5	4.28	48060	4.09	43013	3.66
2	Open forest	116401	9.92	118226	10.07	110378	9.40	96791.8	8.25	97996.1	8.35
3	Scrubland	529888	45.14	507860	43.27	488981	41.66	438050	37.32	419699	35.76
4	Agriculture	72217.7	6.15	95114.7	8.10	89541.7	7.63	109004	9.29	112494	9.58
5	Fallow land	91467.2	7.79	103108	8.78	95569.5	8.14	59413.2	5.06	59777.4	5.09
6	Waste/ Barren/ Rocky	283623	24.16	271777	23.15	313391	26.70	390636	33.28	409458	34.88
7	Built up	7857.45	0.67	12541.4	1.07	15393.1	1.31	18741.3	1.60	21862.7	1.86
8	Water	9376.92	0.80	13789	1.17	10222.7	0.87	13057.9	1.11	9454.86	0.81
Total		1173755	100	1173755	100	1173755	100	1173755	100	1173755	100

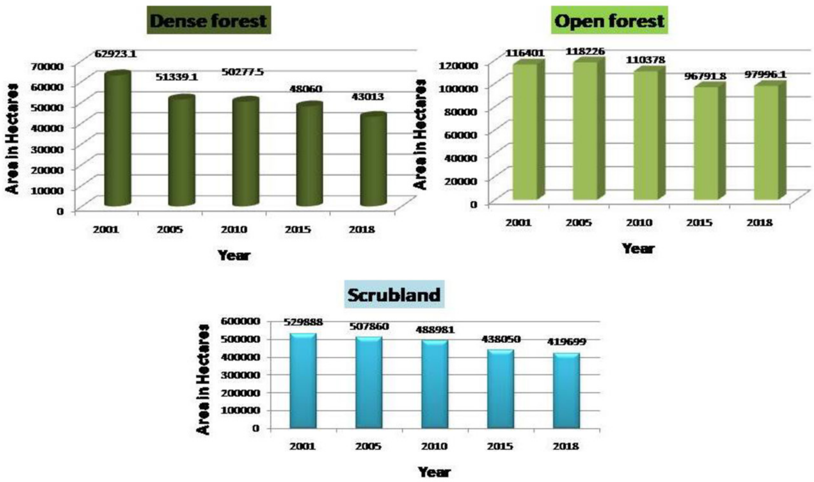

Fig. 6. Graphic of year-wise decreasing land use/land cover of the study area in the month of October.

making vegetation misfortune and land degradation. Forest degradation, along with deforestation, are set second to consuming of petroleum derivatives regarding adding to ozone depleting substance (GHG) emissions (Simula and Mansur 2011) a vital driver of global climate change Intergovernmental Panel on Climate Change (IPCC). Deforestation, forest degradation and peat land fires represented around 15% of global anthropogenic emissions of carbon dioxide (CO_2) somewhere in the range of 1997 and 2006 (Van der Werf *et al.* 2009). Details of the change detection matrix were given in the Tables 5 and 6.

The plausible reasons of dense forest degradation during the most recent decade can be many out of which the anthropogenic activities are one of the significant reason. Expansion in the monetary development of the region the anthropogenic activities zone additionally expanding connected to the utilitarian utilization of land and populace development, are applying similarly gigantic tension on the natural resources particularly to the forest. The developing demand for space of human settlement, agriculture, grazing, mechanical, business and the travel industry design are steadily disparaging the green front of the

Table 5. Change detection matrix in LULC class in between October 2001 to 2015.

	Class	Dense forest	Open forest	Scrub-land	Agri-culture	Fallow land	2001 Waste/ Barren/ Rocky	Built up	Water	Grand total
	Dense forest	**17970.3**	6976.53	3954.06	217.53	166.41	253.98	28.35	137.34	29704.5
	Open forest	24023.4	**37162.9**	20258.5	1491.39	176.58	1619.19	67.32	135.9	84935.18
2015	Scrubland	17379.9	52462.1	**227097**	27731.2	12078.2	55505.7	354.6	706.23	393314.93
	Agriculture	1386.72	3027.33	17219.2	**12531.9**	3327.66	13705	661.14	978.48	52837.43
	Fallow land	1142.46	3469.68	38124.6	3890.34	**10490.5**	20968.6	566.82	263.52	78916.52
	Waste/ Barren/ Rocky	939.33	13166.3	219835	24990.7	61693.1	**183962**	3230.01	3251.52	511067.96
	Built up	68.76	126.09	3155.4	1224	2817.27	6979.68	**2907.27**	287.37	17565.84
	Water	12.24	10.53	243.36	140.76	717.48	628.74	41.94	**3616.56**	5411.61
	Grand total	62923.11	116401.46	529887.12	72217.82	91467.2	283622.89	7857.45	9376.92	**1173753.97**

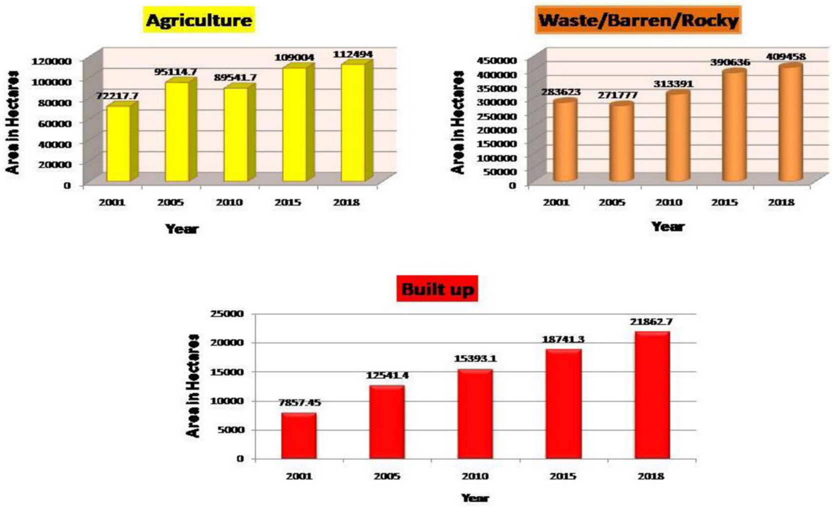

Fig. 7. Graphic of year-wise increasing land use/land cover of the study area in the month of October.

zone. It is expected that controlling hydrological, biotic and landscape interactions and cycles, through utilizing for example vegetation and its natural administrations for environmental quality improvement (phytotechnology) add to improve ecosystem protection from stress, to the upkeep of a homeostatic harmony inside an ecosystem and to the chance of expanding ecosystem flexibility to anthropogenic changes. It can likewise give financial advantages all alone (Pongratz *et al.* 2009).

CONCLUSION

The growth in urban areas of Udaipur city over more

Table 6. Change detection matrix in LULC class in between October 2001 to 2018.

		2001								
	Class	Dense forest	Open forest	Scrub-land	Agri-culture	Fallow land	Waste/ Barren/ Rocky	Built up	Water	Grand total
2018	Dense forest	**19153.5**	8722.89	6397.11	465.84	55.35	266.31	10.8	59.85	35131.65
	Open forest	33469.3	**40543**	20771.3	1540.35	162.63	1337.76	63.81	107.55	97995.7
	Scrub-land	8737.83	53297.1	**261195**	25676.8	18254.4	62154.8	282.69	98.37	429696.99
	Agri-culture	1162.08	9183.33	63807.5	**20788**	6462.45	26377.9	527.94	184.59	128493.79
	Fallow land	5.94	32.4	3759.3	427.23	**4869.81**	2441.97	91.98	26.91	11655.54
	Waste/ Barren/ Rocky	276.84	4457.16	170620	21618.9	57629.5	**181207**	2923.38	723.87	439456.65
	Built up	96.03	148.5	2902.5	1476.9	2777.13	8592.93	**3886.56**	1982.16	21862.71
	Water	21.6	15.84	433.17	223.47	1254.24	1242.72	70.2	**6193.62**	9454.86
	Grand total	62923.12	116400.22	529885.88	72217.49	91465.51	283621.39	7857.36	9376.92	**1173747.89**

than 65 years together with population density is given in Table 4.22. Udaipur city covered an area of 17.17 km^2 in 1946 with a density of 4347 persons per km^2. The expansion of urban areas doubled from 17.75 km^2 in 1951 to 35.97 km^2 in 1961, while the population density decreased from 5049 persons per km^2 to 3089 persons per km^2 during the same period of time. Similarly, the urban area further expanded from 35.97 km^2 in 1961 to 61.10 km^2 in 1971. During the 20 year period from 1971 to 1991 the expansion of the city was only marginal at 64.28 km^2 in 1991 (Bharadwaj 2014).

As the overall accuracy of the change detection results exceeded 85% recommend the result of the mentioned work clearly indicates the change in the forest cover. The main conclusion of the study which is clearly revealed is the deterioration of forest land cover which is a threat to biodiversity of Jaisamand area. The study has demonstrated the utility of multi-temporal satellite data and GIS to monitor changes in the forest cover. This is very simple, fast and effective technique to detect change in land use/ land cover of a particular region. It is very powerful tool in the monitoring and research especially in the inaccessible areas to eliminate the lot of time, money and human power. The main LULC classes identified were forest, scrubland, water and Barren/ rocky land. Other high resolution satellite imagery will be useful to do further studies on deforestation and forest monitoring.

Major anthropogenic disturbances which are the main cause for the degradation of LULC are the following :—

1. Increase in the mining production
2. Population expansion-
3. Increase in the agriculture
4. Urbanization
5. Increase in the no. of vehicles
6. Increase in the tourism influx.

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REFERENCES

Al-sharif AAA, Pradhan B (2014) Monitoring and predicting land use change in Tripoli Metropolitan City using an integrated Markov chain and cellular automata models in GIS. *Arab J Geosci* 7 : 4291—4301.

Bharadwaj GS (2014) Geo-social aspects of developments in peri-urban regions. In: The security of water, food, energy and live ability of cities. *Springer, Dordrecht*, pp 29—40.

Boisier JP, de Noblet-Ducoudré N, Pitman AJ, Cruz FT, Delire C, van den Hurk BJJ M, van der Molen MK, Müller C, Voldoire A (2012) Attributing the impacts of land-cover changes in temperate regions on surface temperature and heat fluxes to specific causes : Results from the first LUCID set of simulations. *J Geophysic Res* 117: D12116. https://doi.org/10.1029/2011JD017106.

Boori MS, Vozenilek V, Choudhary K (2014) Land Use/ Cover Change and Vulnerability Evaluation in Olomouc, Czech Republic, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume II-8, 2014 ISPRS Technical Commission VIII Symposium, Hyderabad, India.

Deka Dhanjit, SharmaPradip (2012) Analysis of changing forest cover and its impact on environment with special reference to Umtrew Basin, North East India.*The Clarion : Multidis Int Jl* (I) : 121—126.

Dewan Ashraf M, Yamaguchi (2009) Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka Metropolitan of Bangladesh during 1960–2005. *Environ Monit Assess* 150 : 237—249.

Disperati L, Gonario S,Virdis P (2015) "Assessment of land-use and land- cover changes from 1965 to 2014 in Tam Giang-Cau Hai Lagoon, Central Vietnam." *Appl Geogr* 58 : 48—64.

Eric K Forkuo, Adubofour Frimpong (2012) "Analysis of forest cover change detection". *Int J Rem Sens Appl* 2 (4) : 2012.

Giriraj A, Babar Shilpa , Reddy C. Sudhakar (2008) "Monitoring of forest cover change in Pranahita Wildlife Sanctuary, Andhra Pradesh, India using remote sensing and GIS". *J Environm Sci Technol* 1 (2) : 73—79.

Giriraj Kumar Songara, Nidhi Rai (2010) Land use and land cover change driven by green marble mining in Kherwara tehsil Udaipur (India) using remote sensing and GIS. T*he Ecoscan* 4 (1) : 103—106.

Gunaid EI, Hassan F, El Hag AMH (2013) Assessment and mapping of land use/land cover, using remote sensing and GIS techniques. *Int J Scientific Technol Res* 2 (2) : In press. http://forest.rajasthan.gov.in/content/raj/forest/en/home. html#- Government of Rajasthan, Forest Portal.https://earthexplorer. usgs.gov/- USGS Earth Explorer.

Jamal SulimanAlawamy, Siva K. Balasundram, Ahmad Husni Mohd. Hanif, Christopher Teh Boon Sung (2020) Detecting and analyzing land use and land cover changes in the region of Al-Jabal Al-Akhdar, Libya Using Time-Series Landsat Data from 1985 to 2017. *Sustainability* 2020, 12, 4490; doi:10.3390/su12114490.

Kushwaha SPS (2012) Remote sensing and GIS for forest monitoring and management. *Int Soc Environm Bot* 18 (4) : In press.

Mansur S, Rotherham ID (2010) Using TM and ETM+ data to determine land cover/land use changes in the Libyan Al-jabal Alakhdar region. *Landsc Archaeol Ecol Tradit* 8 : 132—138.

Muhammad Asim Rizwan (2011) "Forest mapping by using RS and GIS techniques". *Global J Res Engg* 11 (7) : 1—41.

Panigrahy K. Rabindra, Kale P. Manish, Dutta Upasana, Mishra Asima, Banerjee Bishwarup, Singh Sarnam (2010) "Forest cover change detection of Western Ghats of Maharashtra using satellite remote sensing based visual interpretation technique". *Curr Sci* 98 (5) : 657—664.

Pielke RA, Pitman A, Niyogi D, Mahmood R, McAlpine C, Hossain F, Goldewijk KK, Nair U, Betts R, Fall S, Reichstein M, Kabat P, de Noblet N (2011) Land use/land cover changes and climate: Modeling analysis and observational evidence. Wiley Interdisciplinary Reviews : Climate Change 2 (6) : 828— 850.

Pongratz J, Reick C, Raddatz T, Claussen M (2009) Effects of anthropogenic land cover change on the carbon cycle of the last millennium. *Global Biogeochem Cycle*s 23 : 413—417.

Sader SA, Hayes DJ, Hepinstall JA, Coan M, Soza C (2010) "Forest change monitoring of a remote biosphere reserve". *Int J Reme Sens* 0143 (1161): 1366—5901.

SanthoshBaboo S, Renuka Devi M (2010) Integrations of remote sensing and GIS to land use and land cover change detection of Coimbatore District. *Int J Computer Sci Engg* 2 (09) : 3085—3088.

Simula M, Mansur E (2011) A global challenge needing local response—a common approach to defining and measuring forest degradation can lead to unique solutions for addressing it. *Unasylva* 2011 (238) : 62.

Singh Deepti , Mc Dermid Sonali P, Cook Benjamin I, Puma Michael J, Larissa Nazarenko , Maxwell Kelley (2018) "Distinct influences of land cover and land management on seasonal climate". *Atmospheres* 123 (21) : 12,017—12,039.

Smail Robert A, Lewis David J (2009) "Forest-land conversion, ecosystem services and economic issues for policy : A review. PNW-GTR-797", US. Dept Agric For Service Pacific Northwest Res Station, pp 40.

Van der Werf GR, Morton DC, DeFries RS, Olivier JGJ, Kashbhatla PS, Jackson RB, Collatz GJ, Randerson JT (2009) CO_2 emissions from forest loss. *Nat Geosci* 2009 (2) : 737—738.