Monitoring and Temporal Study of Mining Area of Jodhpur City Using Remote Sensing and GIS

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Abstract - *Mining plays a significant role after agriculture for the development and building a country self sufficient. In recent years, remote sensing technology has emerged as a powerful tool for mapping and monitoring the environmental conditions. The use of remote sensing data in recent times has been of immense help in monitoring the changing pattern of land use-land cover. This involves situations where the spectral characteristics of the land cover type in a given location changes over time. This paper deals with a case study of mining cluster around Soorsagar, Mandore and Barli area of Jodhpur city. These quarries produced large quantity of sand stone of high quality. Continuous mining activities have severe impact on environment and health of the native peoples. Efforts have been made to evaluate changes in land cover features using temporal and multi resolution satellite images.*

Key Words: Surface Mining, Temporal Study,Remote Sensing, GIS.

1.INTRODUCTION

The purpose of this work is monitor changes in mining area and study the temporal analysis of the sandstone mines around Jodhpur city. At present sandstone mining in the city has helped in improving the living style and elevating the earning capacities of local inhabitants by providing employment to all segments of persons. It has also been a reason for the development of infrastructure facilities in and around the area. At the same time quarrying activities also affect very adversely the environment of the area. It is inevitable to clean the vegetation cover with underlying soil mantle and excavating overlying rock masses (overburden) to put a quarry in production. A large number of quarries is located on the skirt area of the city and extraction of sand stone causes problems including damage to water catchment network of Jodhpur city.

2. STUDY AREA

Jodhpur city is located at a latitude of 26º 18' North and longitude of 73º 1' East and is located in the middle of the Thar Desert tract of western Rajasthan about 250 km from the Pakistan border. Its general topography is characterized by the hills located in the North and North-west. The hill ranges start within the walled city and extends up to Mandore. Jodhpur city is located at an average altitude of 241 m above Mean Sea Level at railway station. Fort and old city being much higher at 367.83 m and between 277.21 m to 245.50 m respectively. The city has a natural drainage slope from North-North East to South-South East towards Jojari River. The location map of the study area is given in Fig.1.
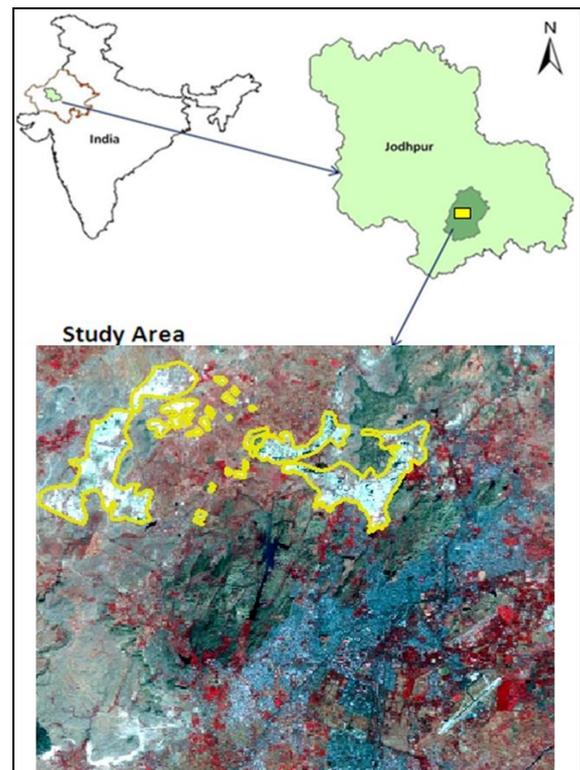

Fig.1. Jodhpur City Wards (65) on Satellite Image.

3. DATA AND RESEARCH METHODOLOGY

The Geocoded False Colour Composite(FCC) scene of LANDSAT data on scale 1:50,000 for last three decade with Survey of India (SoI) maps are used in the present study. The data that has been used for studying the municipality level spatiotemporal land use/land cover change include four historical Landsat, IRS L3 satellite images covering Jodhpur municipality for the years 1991-2012. (Table 1).

Table -1: Characteristics of Satellite Data Used

Reference year	Satellites/ Sensors	Resolution	Path/Row
1991	Landsat TM	30 m	149/42
2001	Landsat TM	30m	149/42
2008	IRS P6 LISS-III	24m	92/53
2012	Landsat TM	30m	149/42

The Area of Interest was demarcated on the satellite imagery of the study area. Various image processing techniques, classification and interpretation was performed using ERDAS Imagine. Land use/land cover classes were identified by means of visual interpretation and ground truth data using handheld GPS. Digital Elevation Model (DEM) and counter map of the study area was generated for landscape analysis and visualization of various landforms occurs around the Mining clusters (Fig.2&3). Major classes in the study area are mining area, settlement, dense forest, shrub forest, barren rocks, water bodies and Fallow Land. Using ERDAS Imagine & ArcGIS software a land use classification & change detection analysis were carried out on LANDSAT images of year 1991, 2001 and 2012. The generated land use classification was also compared with field data for better accuracy of the LU/LC features of the area. The final land cover maps produced using these procedures enabled spatiotemporal change analysis.

3. RESULTS AND DISCUSSION

3.1 Analysis of Main Quarry Land of the Study Area

There are three main mining blocks marked in Fig.4. The blocks are Fidusar - Soorsagar, Balsamand - Mandore and Keru. In Fidusar Soorsagar area the total number of plots for which leases have been sanctioned are about 3600, out of which 2500 are presently operating. In the absence of any detailed mapping the topography plan of the areas has been prepared on the basis of rough surveying using altimeter. The area is marked in the Fig. 7.5. The site specific natural parameters for the area are as follows Topography: The area is undulating and consists of small hillocks. It is surrounded by a hilly terrain. In the North and North East of the area hills between 275 - 335 M altitude and in the South of the area hills of 290 - 366 M altitude are existing. Slope of the area is gentle. The altitude of Jodhpur city is 241 M. The area under study is at a higher altitude as compared to that of Jodhpur city. The altitude of the area ranges between 260 - 300. Because of hilly terrain, there is practically no top soil except in the small valleys and depressions. There are no tube wells / wells in the quarrying area. Some of the quarries of this block lie either in the catchment area or in its very close proximity. Thus, the quarrying and disposal of the overburden have damaged the natural profile of the catchment area. A drastic effect of the quarrying activities can be observed on the canals which are in close proximity of the quarrying area and are taking the rain water to Kailana reservoir . During the field visits in the mining area, it was observed that a large area has been occupied by the abandoned mines, non operative mines and overburden dumps. Proper planning is needed to use these areas for other public utility uses.
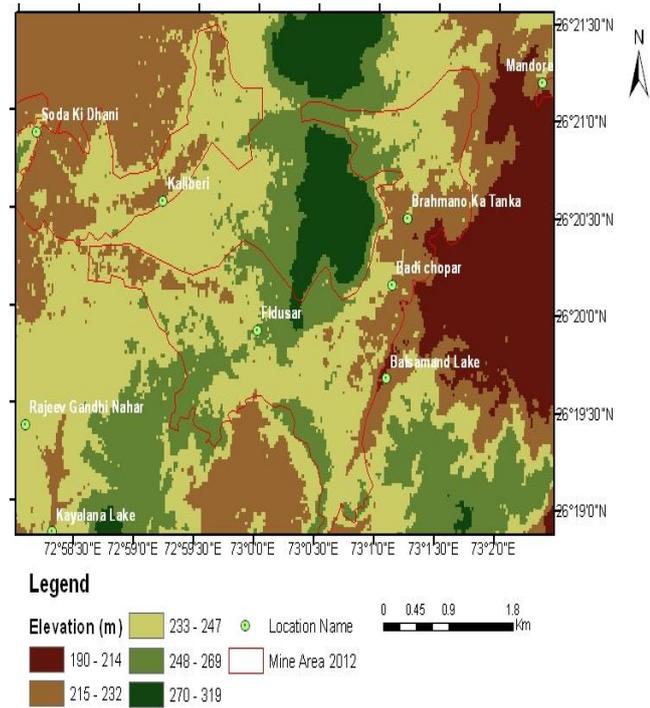

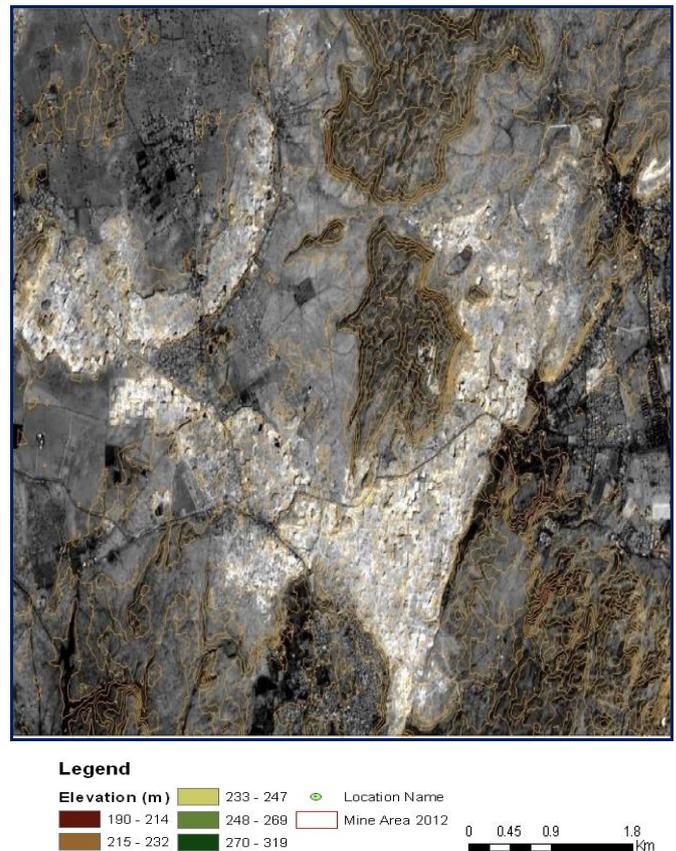**Fig. 2.** Digital Elevation Map of the Mining Area (2015)

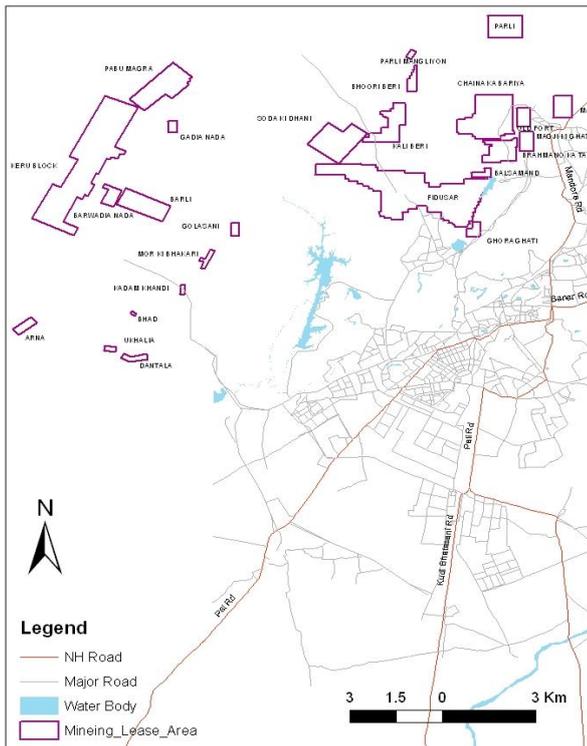**Fig. 3**. Overlay of Counter Map (15m) on Satellite Image.

Fig. 4. Overlay of Mining Lease area on Base Map of The Study Area

3.2 LU/LC Classes and Change Analysis

Based on the interpretation of satellite image and ground truth data of the mining cluster near the study area, seven land cover classes were identified. Using remote sensing and GIS techniques land cover changes around the mining area of Jodhpur city are mapped and their statistics were generated for the two decades between the years 1991 to 2012. There have been considerable land cover changes in the study region during the 21 years period as a result of surface mining activities (Fig.5). It was found that the area of sandstone quarries was 6.63 sq km (15.63%) in the year of 1991; this value has notably increased to 9.71 sq km (22.91%) in the year of 2012. The area of dense forest decreased to 2.78 sq km (6.57%) from 3.91sq km (9.21%) in 21 years period. This means that the forest area was decreased about 2.63% between the year of 1991 and 2012 (Table-2). On the other hand, in the field surveys it is seen that the change in the water area is derived from the mining activities as a result of the large mining holes filled by water. These significant results show that the study area has not affected by the urbanization yet and the most of the forests in the study area destroyed as a result of the mining activities. The statistical results of classification obtained by using RS technology verified visually in GIS environment (Fig.6). The temporal expansion of the mining area is visualize in fig.7 and field photo is given in fig.8&9. While the amount of the water bodies has been increasing in expansive stone quarries, dense and scrub forests were cut up drastically.

Table-2: LU/LC Change statistics for the Decade (1991-2012).

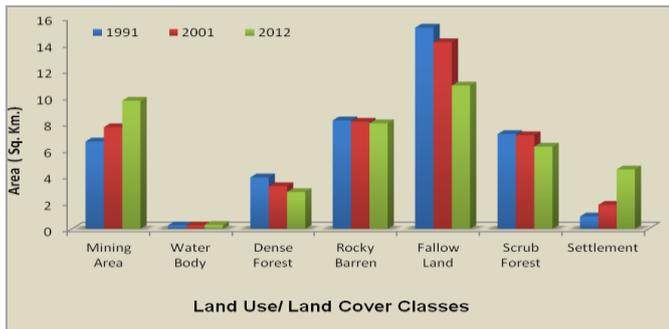| Land use/ Land cover Classes	Year 1991	Year 2001	Year 2012	1991-2012
	Area %	Area %	Area %	Change (%)
Mining Area	15.63	18.18	22.91	7.28
Water Body	0.59	0.60	0.68	0.09
Dense Forest	9.21	7.63	6.58	-2.63
Rocky Barren	19.41	19.16	18.88	-0.53
Scrub Forest	16.95	16.73	14.71	-2.24
Settlement	2.21	4.28	10.61	8.4
Fallow Land	35.98	33.40	25.63	-10.35
Total Area	100	100	100	--

Fig. 5 No. LU/LC Map of the Area. Based on the satellite Images of a) 1991, b) 2001, c) 2012.

Fig.6 Nature of relative Land use/ Land cover change 1991 to 2012.
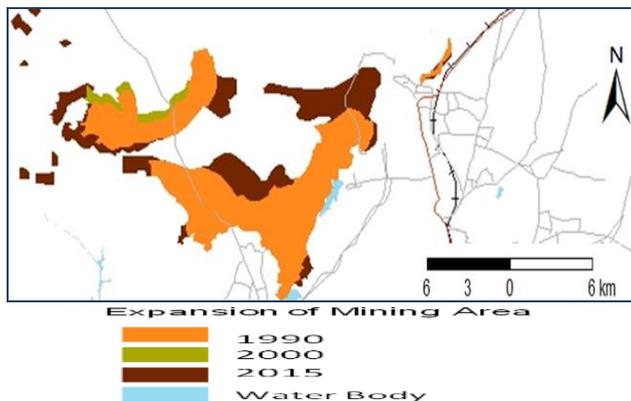

Fig.7. Growth of the Mining Area over the time.

Fig.8. Huge OB Dump in Fidusar Mining Area.

Fig.9. Impact of mining on natural Landscape near Mandore Mining Area

4. CONCLUSION

The present study will be very useful in monitoring of changes in land use pattern and temporal expension of the mining area. LU-LC changes in mining and surrounding area can be effectively mapped & monitored by remote sensing and GIS technology. Results show that LU/LC changes of major classes were significant during the period from 1991 to 2012. From the analysis of land use land cover classification of multi-temporal satellite data it is observed that there are enormous changes especially in vegetation and agricultural area. Almost scrub vegetation have been converted either into mine area and mine overburden. The water bodies has also increased due excavation of huge quantity of sandstone excavation, not because of natural water surface bodies. Mining area has also increased manifold since two decades of the study periods.

ACKNOWLEDGEMENT

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BIOGRAPHIES

Dr S.K Yadav received MSc (Geology) and PhD from JNV University, Jodhpur. Presently he is working in Defence Laboratory, Jodhpur and has experience of 18 years in the area of remote sensing and terrain analysis. His research interests include: Remote Sensing Geology, GIS & Urban Planning , Risk Analysis & Disaster Management.

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