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Land Use/Land Cover Mapping In Buffer Zone of Gotan Limestone Mines Village Borunda, Bilara, Jodhpur (Rajasthan) Using RS & GIS Tools

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Abstract

Studies on land use aspects of ecosystem play an important role in identifying sensitive issues and to take appropriate action to maintain "Ecological homeostasis" in the region. The main objective of this study is to provide a baseline status of the study area so that present land use pattern and temporal changes occurred, on the surroundings due to the project activities can be assessed. Study was carried out on the Land Use/Land Cover Mapping In Buffer Zone of Gotan Limestone Mines Village Borunda, Bilara, and Jodhpur (Rajasthan) Using RS & GIS Tools. The RESOURCESAT-I (IRS-P6) LISS IV MX image was studied with a purpose to know the status of land use and land cover variables. Land use and land cover classes along with the changes under different categories were identified from the satellite image.

Keywords: Land Use, Land Cover, Natural Vegetation, Remote Sensing and GIS.

Introduction

Land use/ Land cover (LULC) mapping and detection of change using remote sensing and GIS techniques is of paramount importance to policy makers, planners, geographers and environmentalist, in fact to everybody who cares about human sustainable development. More recent significant effects of land use include urban sprawl, soil erosion, soil and land degradation, salinization and desertification. Land use changes together with the use of fossil fuel are the major anthropogenic source of carbon dioxide, a dominant green house gas, into the atmosphere (World Bank Environment Development, 1993). The knowledge of land use and land cover is important for many planning and management activities as it is considered as an essential element for modeling and understanding the earth's systems. The term land use relates to the human activity or economic function associated with specific piece of land, while the term land cover relates to the type of feature present on the surface of the earth (Lillesand and Kiefer, 2000). During 2007-09 extensive studies were carried out by Geological Survey of India on limestone mines and cement plants in Rajasthan (www.portal.gsi).

Land damage is a major impact of an opencast mining project. Land gets damaged due to excavations made for extracting minerals or for locating waste disposal sites and other allied operations. The land-use pattern undergoes a change due to the use of the land for mining, dumping, and other mining and associated activities. Poor agricultural management due to all these reasons thus not only accelerates soil degradation and poor yield but also affect human health of the area. To study land use pattern satellite image for the 10 km radius area with existing Gotan Limestone Mines as centre were collected and interpreted. Total area under present study was 356.84 km2. For studying the temporal variations of land use and land cover, satellite image is required. So, satellite image from RESOURCESAT-I (IRS-P6) LISS IV MX was used. The present study has been taken up in order to understand the changes that have taken place in Land Use/Land Cover Mapping In Buffer Zone of Gotan Limestone Mines Village Borunda, Bilara, Jodhpur (Rajasthan) Using RS & GIS Tools. I have done this work in my Project work of P.G. Diploma in Remote Sensing and GIS. The field visit to the project site was for a very short duration of time and only for preliminary data collection.

Review of Literature

Land use and land cover patterns are important in environmental impact assessment study because land use describes the present use such as agriculture, settlement and land cover describes the material on it such as forest, vegetation, rocks or building. Land change puts an impact on the environment of the area (Jerzy, 1983). A report by Pembina Institute for Appropriate Development, (2004) discussed the CDM status & CDM methodology approval, market in various countries. As in India, it has significant potential for CDM-related project activities in the areas of energy, coal, industry, renewable, transport, and municipal solid waste. As the world's sixth largest emitter of CO_2, India's needs include energy efficient technologies to reduce GHG emissions, and to overcome the financial constraints associated with the adoption of cleaner technologies. New EIA Notification dated 14th September 2006 (2006),Ministry of Environment and Forest, GoI, New Delhi, issued the Notification for Process of the Environmental Clearance for New/expansion project .The Central Government hereby directs that on and from the date of its publication the required construction of new projects or activities or the expansion or modernization of existing projects or activities listed in the Schedule to this notification entailing capacity addition with change in process and or technology shall be undertaken in any part of India only after the prior environmental clearance from the Central Government or as the case may be, by the State Level Environment Impact Assessment Authority, duly constituted by the Central Government under sub-section (3) of section 3 of the said Act, in accordance with the procedure specified. Mining project being site specific project will also have to obtain separate site clear from the Environment as specified in the EIA notification (Singh, 2008).

Land use/ land cover mapping and detection of changes may not provide the ultimate explanation for all problems related to land use/ land cover changes but it serves as a base to understand the patterns and possible causes and consequences of land use/ land cover changes in the area (Abbas, Muazu and Ukoje, 2010). Herald, 2011 Forest department for made it clear that clearness for several mines operation at around wildlife sanctuaries would be cancelled once the panel comes cut with proper marking of coo-sensitive areas (English report). The present status of land use/ land cover of Kanpur city is evaluated by visual interpretation of satellite data (Kumar, 2011). Land change is the primary modifier of the landscape, which leads to an impact on socioeconomic, biological, climatic, and hydrologic systems (Sohl and Sohl, 2012). Land use in general reflects the activities of human being on land thereby changing the land cover. The conversion of agricultural lands to non agricultural uses is almost inevitable and irreversible. So, comprehensive information on the spatial distribution of agricultural land use and pattern of their change is prerequisite for planning, utilization and management of the land resources. Such information thus permits a better understanding of the land utilization aspects on cropping pattern, grazing lands, wastelands, surface water bodies, settlements and communication network, which are vital for overall development and planning (Brar, 2013). Land use and land cover change, is one of the main driving forces of Global Environmental Changes and central to the sustainable development debate (Jaiswal and Verma, 2013). Land use/ land cover classes along with the changes under different categories can be identified from the satellite imagery (Sharma, Rishi, Ahluwalia and Lata, 2014). The temporal maps for different periods depicted the changes in LULC. Still agriculture is the most dominant category under LULC (Saini, J., 2016). The cement plant development would not be on the cost of intensive cropland (Jiterwal, S. 2017).

Study Area

Limestone Mine (ML No. 133/92 & ML Area 100 Ha). Near Village Borunda, Tehsil Bilara, District Jodhpur (Rajasthan). The lease area is situated about 2.25 km away from village Borunda in North-West direction. The lease area is approx. 79 km away from Jodhpur and is well connected by tar road. There is regular private bus service from Jodhpur which is well known & well connected place by Rail & Bus services. The details about the study area are given below in Table 1.

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Table No: 1

S. No.	Particulars	Details	
A.	**Location**		
	Village	Borunda	
	Tehsil	Bilara	
	District	Jodhpur	
	State	Rajasthan	
	Latitude	26º26' 27.5" – 26º27' N	
	Longitude	73º49' 12.9" – 73º49' 57.4" E	
	Toposheet No.	45 F/15	
B.	**Lease Area Details**		
	Mining Lease Area	100.00 Ha	Govt. Waste Land: 5 Ha Private Land: 95 Ha (Barren land – 80 Ha., Agricultural land – 15 Ha.)
	Proposed Area for plantation	37.40 ha.(Including backfilled area)	
	Topography	Flat	
	General ground level	320 mRL	
	Elevation Range in the area	320 mRL- 324 mRL	
	Water Table	230 mRL (90 mbgl) – 240 mRL (80 mbgl)	
C.	**Details of Environmental Setting**		
	Ecological Sensitive Areas (National Park, Wild Life Sanctuary, Biosphere Reserve, eserve/Protected Forest etc.) within 10 km radius	None with the 10 km radius of the study area	
	Nearest Village	Borunda (2.25 km in NW direction)	
	Nearest City	Jodhpur (approx. 79 km away from the mine site)	
	Nearest Railway Station	Kharia Khangar Railway Station (23 km in NW)	
	Nearest National Highway	NH – 112 (approx. 31 km in SW)	
	Nearest Airport	Jodhpur (approx. 79 km away from the mine site)	

Land Details

The mining lease area is 100 ha, which is already in possession of the lessee. There is no forest land in the lease area. There is no habitation in the lease area; hence no R & R plan is applicable. The details of land are given in table 2.

Table No. 2 Land Details

Forest Land	Govt. Waste Land	Private Land		Total Area (ha)
		Barren land	Agricultural land	
Nil	20 ha.	62 ha.	18 ha.	100.00 ha

Physiography

The leasehold area is generally flat with slight slope towards south. Elevation Range is 302 MRL to 325 MRL. The general ground level of the area is 313 MRL. No seasonal nallah is flowing through the lease area.

Drainage Pattern

The depth of the water table in the area is about 233 MRL (80 mbgl) – 223 MRL (90 mbgl). No perennial nallah or river is found in the study area. Jojri river flows at around 9.4 km in NW direction and Dukliyan Nadi flows at around 10 km in SSE direction.

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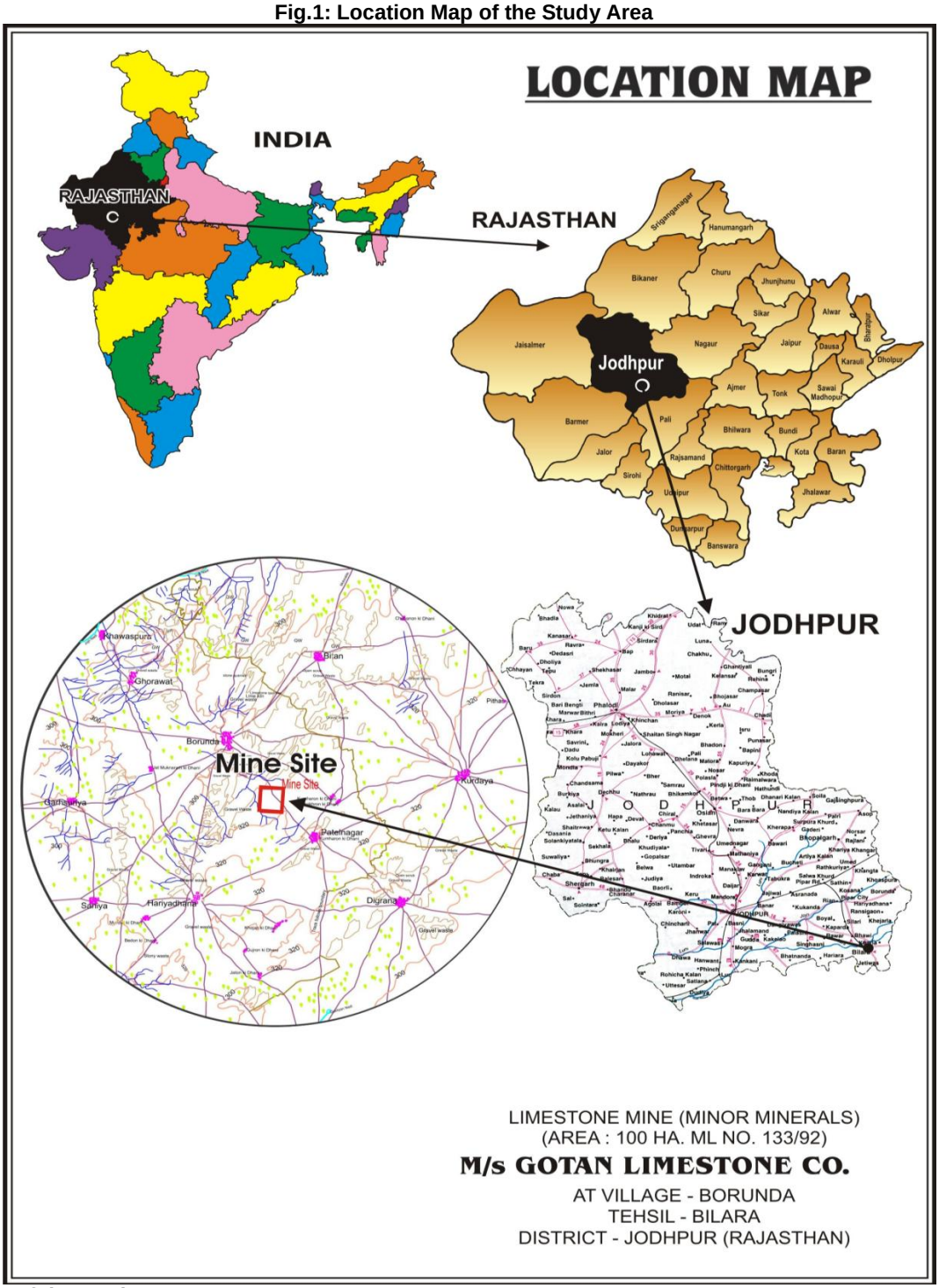
Fig.1: Location Map of the Study Area



Objective of the Study

1. Land Use/ Land Cover mapping of the study area:
2. Identify the Land Use/Land Cover map preparation process
3. Shape the projects to suit local environment;

Data Base and Methodology

Satellite Data - IRS P6 LISS IV MX

Current vintage data of Indian Remote Sensing Satellite IRS P6 LISS IV MX digital FCC (False Color Composite) has been used for preparation of Land use/ Land cover thematic map of study area. Satellite image has been procured from National Remote Sensing Centre, Hyderabad.

Technical Details about IRS P6 Satellite:

1. Satellite Image - IRS P6 LISS IV MX
2. Satellite Data Source - NRSC, Hyderabad

Survey of India Topomaps

Survey of India (SOI) maps of 1:50,000 scales have been used for georeferencing of satellite

images, digitization of cultural features and creation of masks.

Google Earth Software

We refer the Google Earth Software also in doubtful cases and for verification purpose.

Methodology and Analysis

Steps 1: Processing of Raw Satellite Data

Land use / Land cover map preparation, Base map creation, geometric and radiometric correction of raw satellite images has been proposed using Erdas Imagine 9.1 software. The methodology used for present Land use / Land cover study area is explained in following headings

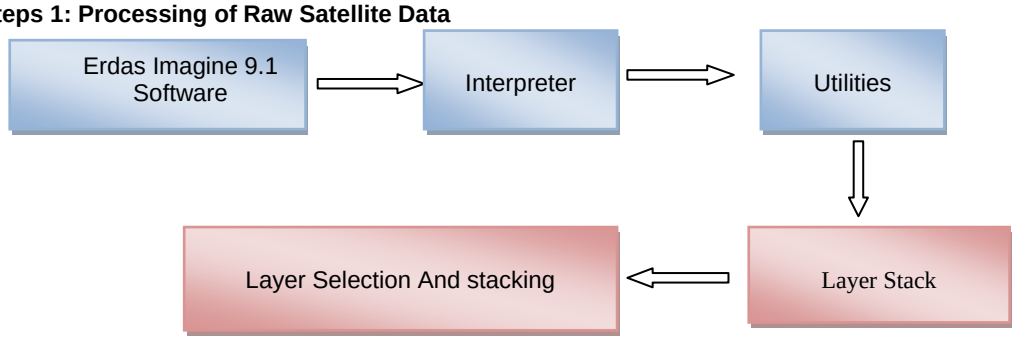
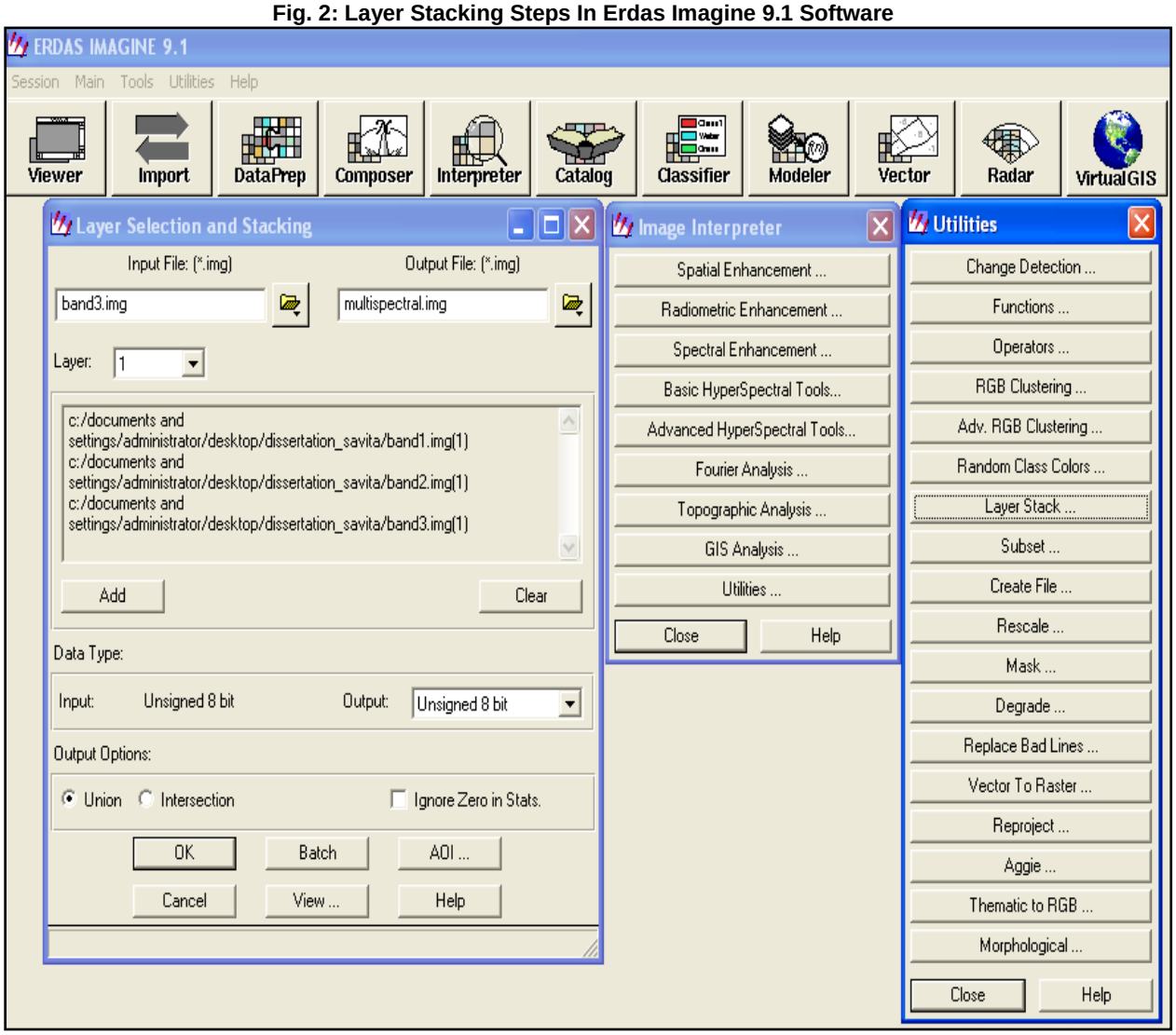


Fig. 2: Layer Stacking Steps In Erdas Imagine 9.1 Software



Step 2: Georefrencing of Satellite Images

Survey of India Toposheet has registered in Geographic lat/long. Satellite image has been georeferenced by using registered. SOI toposheet as a reference map taking suitable Ground Control Points (GCP) points like intersection point of railway, Road network, landmarks and permanent feature.

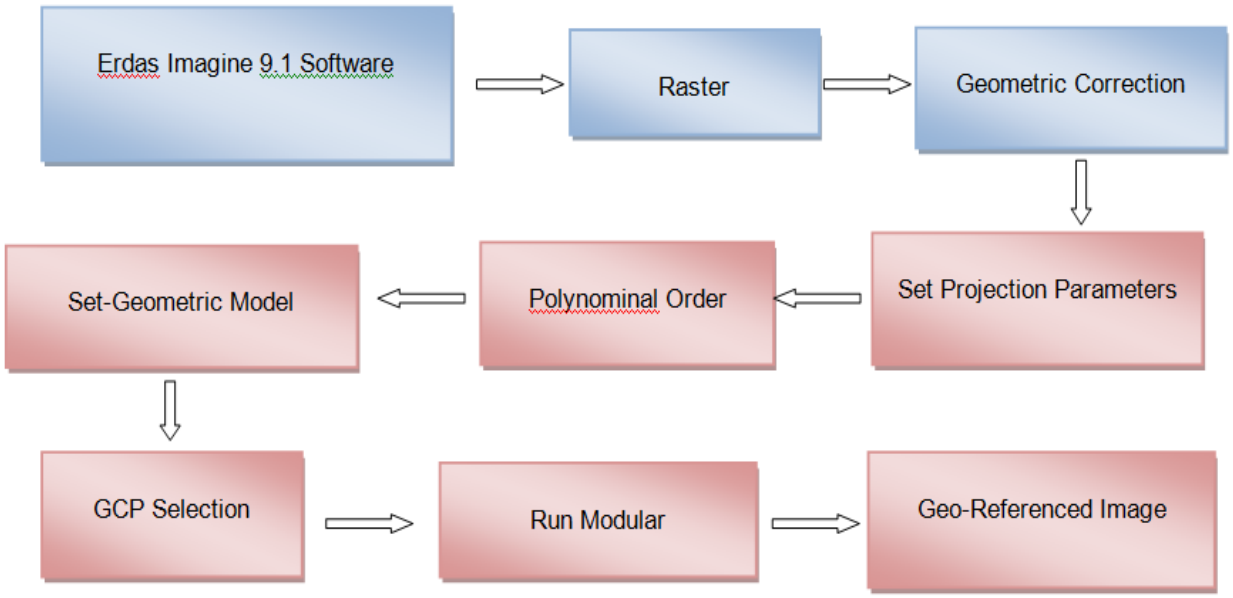
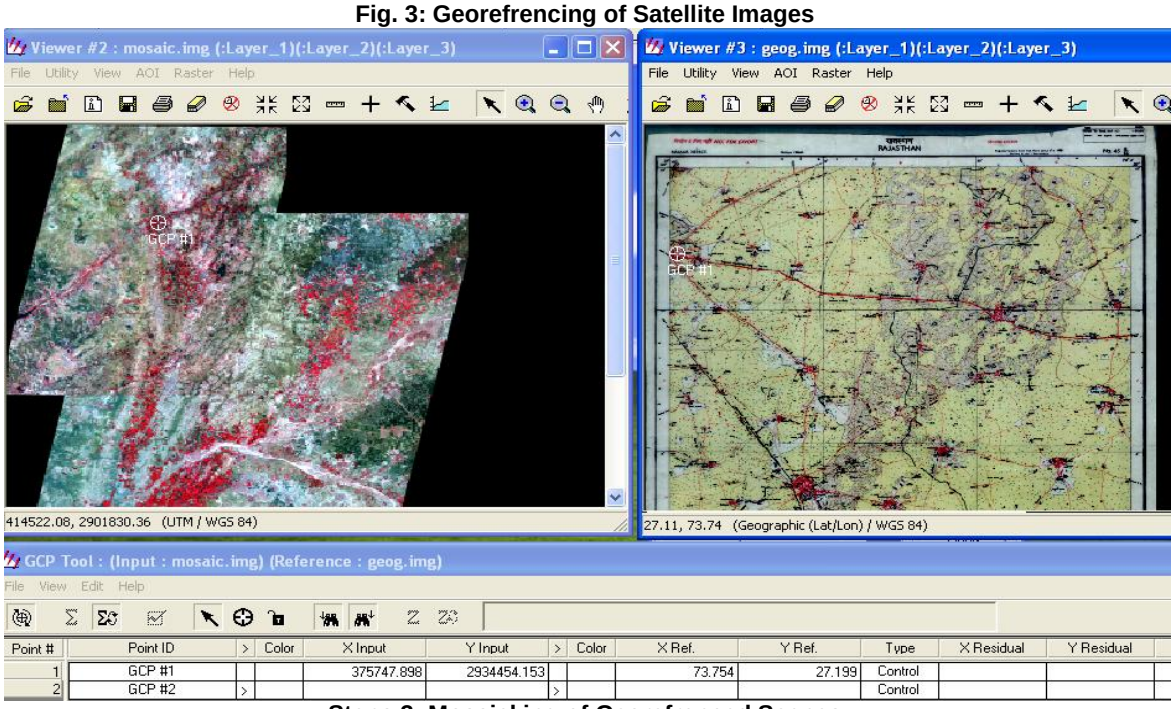


Fig. 3: Georefrencing of Satellite Images



Steps 3: Mosaicking of Georefrenced Scenes

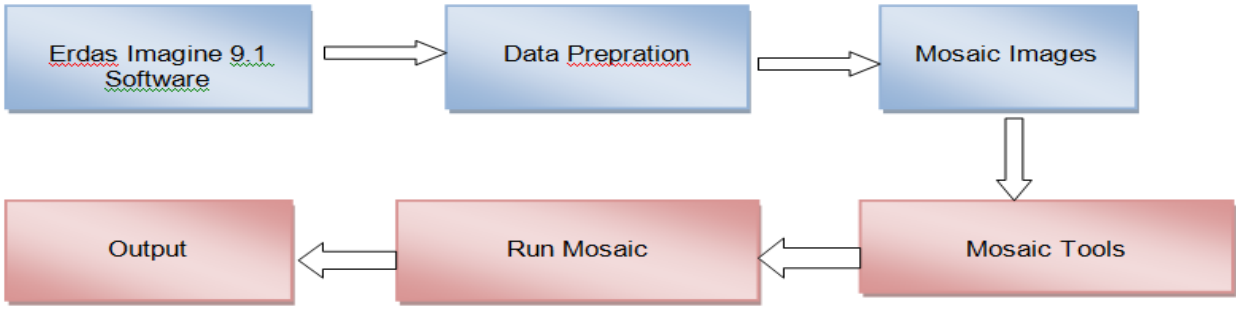
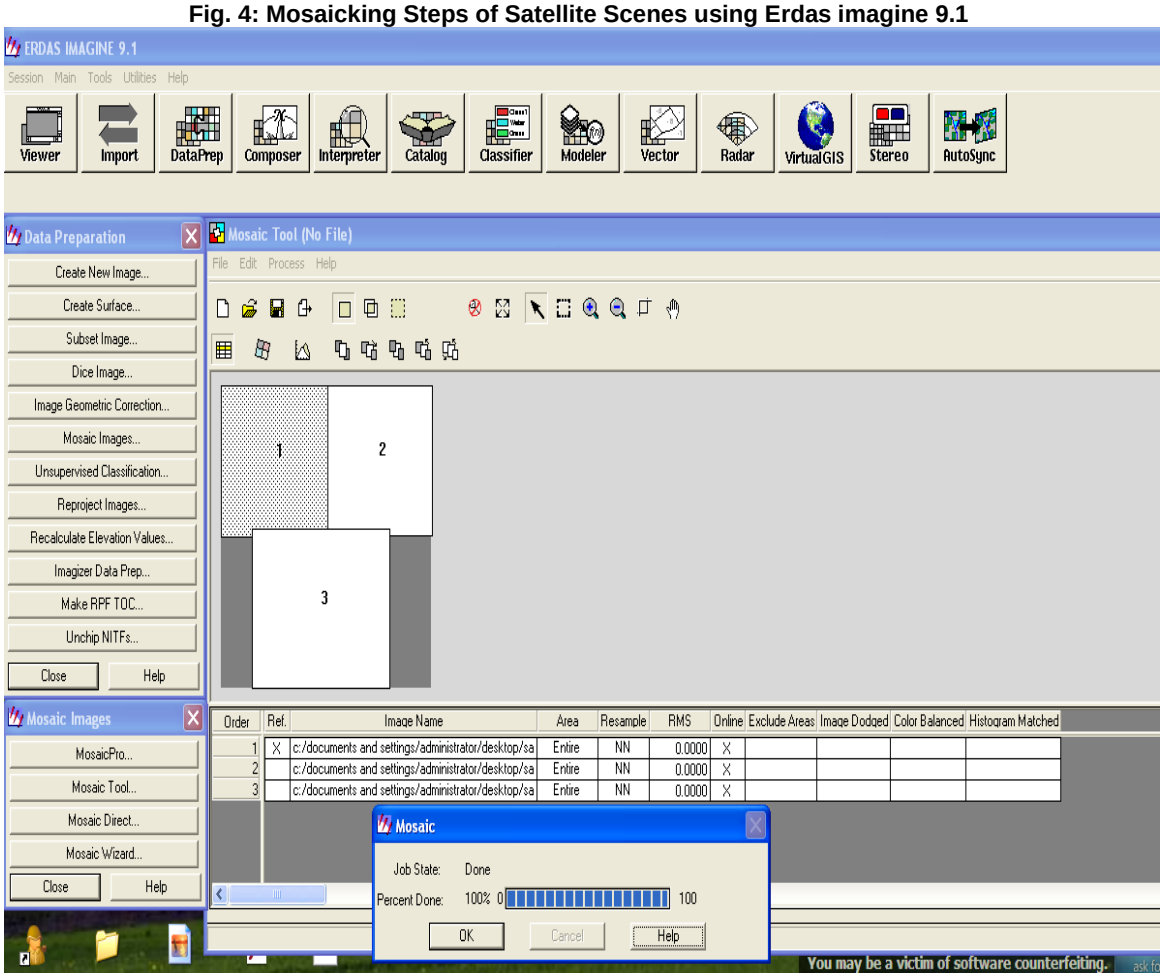
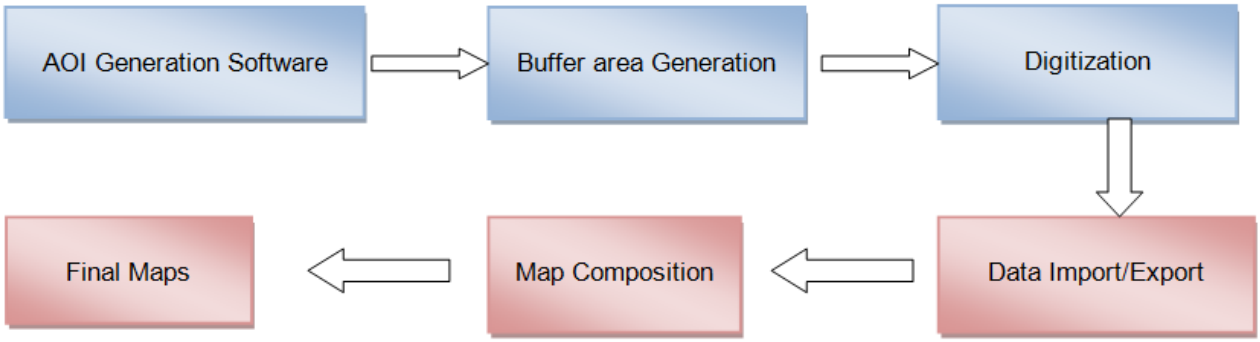


Fig. 4: Mosaicking Steps of Satellite Scenes using Erdas imagine 9.1



Steps 4: Base Map preparation Using ArcGis 9.2 and Autocad-2007 Software



Base map has been prepared using Survey of India Toposheet as a reference map on 1:50,000 scale. In base layer linear and point feature like road, rail, canal, village location and plant site have been created in vector data format. After Geo-Referencing of toposheet on 1:50,000 scale we digitized the entire area with the help of Autocad-2007 and ArcGIS 9.2 software.

Base Map contain following layers.

1. Plant Boundary
2. Buffer Zone Boundary
3. Contour
4. Village Roads
5. Water Bodies , River & Drainage
6. Settlement
7. Open Scrub
8. Gravel Waste
9. Agriculture Land

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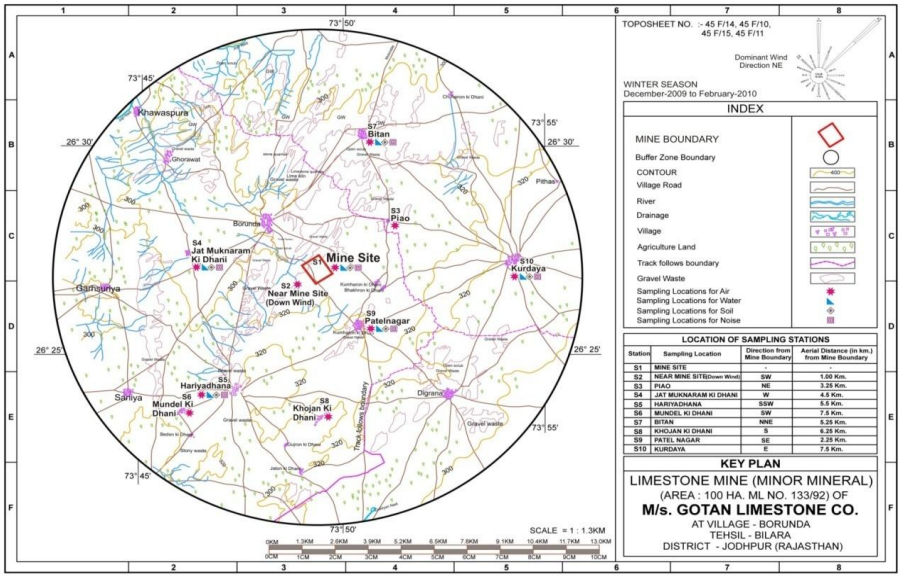
Fig. 5: Base Map of the Study Area



Buffer Area Mask Generation

After Georefrencing of the survey of India (1:50000 scale) Toposheet we superimposed the core area GPS coordinates on Georefrenced Toposheet and create the core area boundary in .SHP format using ArcGis 9.2 Software. With the help of Arc-GIS 9.2 Software we make the 10 km radious buffer from the plant boundary and mask Georefrenced Satellite Image using Erdas Imagine 9.1 Software.

Procurement of Toposheet & Satellite Image

⇩

Georefrencing of Toposheet

⇩

Superimposed the GPS Coordinate on Toposheet

⇩

Core area Aoi Creation in .shp format

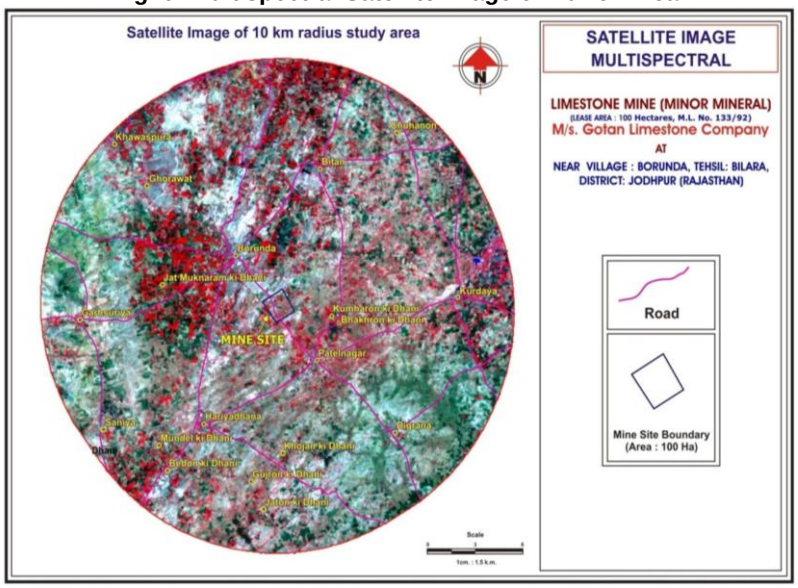
⇩

Buffer creation of 10 km Radious using ArcGis 9.1

⇩

Subset of Satellite Image from Buffer area .Shp File

Fig. 6: Multispectral Satellite Image of Buffer Area



Enhancement of Satellite Image

Satellite data is composed of substantial noise and haze errors due to various environmental factors, Which affect the amount of reflectance

(information) that can be deciphered Since mapping of satellite images is based on spectral signatures, it is necessary to normalize the redundant values into near true values.This process of deriving true reflectance values is known as normalization. This will enhance the interpretability of the satellite image thereby Facilitating better identification of land features viewed on satellite imagery. Histogram equalization and radiometric correction has been used for satellite image enhancement.

Interpretation of Remote Sensing Data

Satellites images are composed of array of grid, each grid have a numeric value that is known as digital number. Smallest unit of this grid is known as a pixel that captures reflectance of ground features represent in terms of digital number, which represent a specific land features. Using image classification technique, the satellite data is converted into thematic information map based on the user's knowledge about the ground area. Hybrid technique has been used i.e. visual interpretation and digital image processing for identification of different land use and vegetation cover classes based on spectral signature of geographic feature. Spectral signature represents various land use classes. Image interpretation keys are developed based on image characteristics like color, tone, size, shape, texture, pattern, shadow, association etc, which enables interpretation of satellite images for ground feature. Training sites are then assigned based on their spectral signature and interpretation elements. Using image classification algorithm land use map is then generated. Aerial photographs as well as imagery, obtained by remote sensing using aircraft or spacecraft as platforms, have applicability in various fields. By studying the qualitative as well as quantitative aspects of images recorded by various sensor systems, like aerial photographs (black-and-white, black-and-white infrared, colour and colour infrared), multiband photographs, satellite data (both pictorial and digital) including thermal and radar imagery, an interpreter well experienced in his field can derive lot of information.

1. Image interpretation is defined as the act of examining images to identify objects and judge their significance. An interpreter studies remotely sensed data and attempts through logical process to detect, identify, measure and evaluate the significance of environmental and cultural objects, patterns and spatial relationships. It is an information extraction process.
2. Anyone who looks at a photograph or imagery in order to recognize an image is an interpreter. A soil scientist, a geologist or a hydro geologist, a forester or a planner, trained in image interpretation can recognize the vertical view presented by the ground objects on an aerial photograph or a satellite image

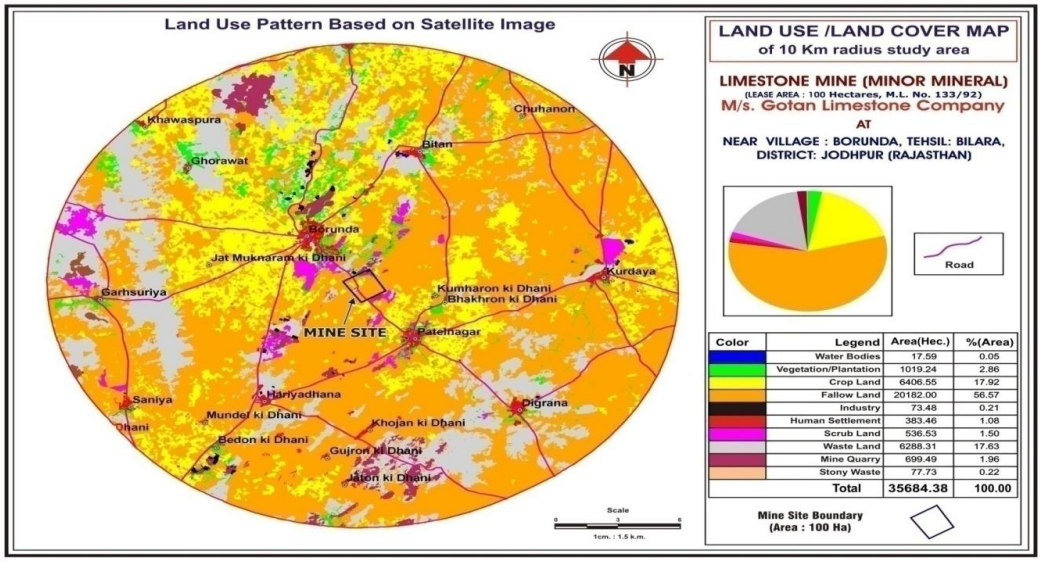
Land Use / Land Cover Maps Pattern of Buffer Area

A hybrid technique has been used i.e. visual interpretation and digital image processing to generate output Land use / Land cover map of 10 km study area on 1:50,000 scale. Statistical data observed and results obtained from satellite image are given below. Result shows that the study area is dominated by fallow land with 69.12 % of the total area in the 10 km radius.

Table 3: Land Use Pattern of the Study Area Based on Satellite Image (10 km radius)

S. No.	Class Name	Area (in hec.)	% Area
1.	Water Bodies	17.50	0.05
2.	Vegetation/Plantation	1019.24	2.86
3.	Crop Land	6406.55	17.92
4.	Fallow Land	20182.00	56.57
5.	Industry	73.48	0.21
6.	Human settlement	383.46	1.08
7.	Scrub land	536.53	1.50
8.	Waste Land	6288.31	17.63
9.	Mine Quarry	699.49	1.96
10.	Stony Waste	77.73	0.22
	Total	**35684.38**	**100**

Figure 7: Land use Land Cover Map of Buffer Area



Conclusions

The total lease area is 100.00 ha. The lease area is having 5.0 ha. of Govt. waste land; 80.0 ha. of private barren land and 15.0 hectare private agricultural land. Mining activity will also be done in the agricultural land. No Gauchar Land or Grazing land is falling within the Core Zone.

At the conceptual stage, the total mined out area will be 97.0 hectare out of which 34.40 hectare will be backfilled and reclaimed by plantation and remaining 62.60 hectare will be converted into water reservoir. Therefore, in the core zone the land use will change, but no adverse effect is envisaged.

In context with the study area, 50.78% land is under cultivation. There will be no adverse impact on agricultural land of study area due to mining activities. Proper resources/ assistance will be provided to the farmers to develop their agricultural land. The following practices shall be carried out to increase the productivity of the study area:

1. Awareness for new methodologies of the agricultural practices viz. mixed farming, crop rotation and agricultural cropping pattern suitable for the lease area.
2. Providing seeds, manure and fertilizers from different sources.
3. Rainwater harvesting practices shall be encouraged which will lead to ground water recharge and ultimately increased productivity in the study area.
4. No major impact on soil of the study area is envisaged due to mining activities.
5. There will be no outside discharge from mining lease area.
6. There is no toxic element present in the mineral which may contaminate the soil.

Precise quantitative information could be extracted about existing land use / land cover in context to spatial dimension. Remote Sensing data provides real time information pertaining to aspects of Land Use / Land cover.

Study on land use and land cover mapping using remote sensing and GIS techniques. When the results from remote sensing and GIS were compared with the ground reality they were found quite reliable. The results were found near to the reality. Remote Sensing is very useful for the view of the study area.

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