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LAND USE LAND COVER CHANGE DETECTION USING GEOSPATIAL TECHNOLOGIES-A CASE STUDY FROM RAMAGUNDAM

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Abstract: Land use/ land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to monitor and detect the changes to maintain a sustainable environment. In this project an attempt has been made to study the changes in land use and land cover patterns. This project examines the use of Geographic Information System (GIS) and Remote Sensing in mapping Land Use Land Cover change detection in study area between 2012 and 2013, so as to detect the changes that has taken place in this status between these periods. Subsequently, an attempt was made at projecting the observed land use land cover in the 2-years. In achieving this, Land Consumption Rate and Land Absorption Coefficient were introduced to aid in the quantitative assessment of the change. Suitable change detection techniques were developed for the study area by taking into account its physical and cultural conditions, there by optimising use of information in the land cover maps. The result of the work shows a rapid growth in built-up, land between 2012 and 2013. Suggestions were therefore made at the end of the work on ways to use the information as contained therein optimally.

1. GENERAL:

The land use/land cover pattern of a region is an outcome of natural and socio– economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use / land 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 and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on land use land cover change thus providing an accurate evaluation of the spread and health of the world's forest, grassland, and agricultural resources has become an important priority.

Viewing the Earth from space is now crucial to the understanding of the influence of man's activities on his natural resource base over time. In situations of rapid and often unrecorded land use change, observations of the earth from space provide objective information of human utilization of the landscape. Over the past years, data from Earth sensing satellites has become vital in mapping the Earth's features and infrastructures, managing natural resources and studying environmental change.

Remote Sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analyses of Earth - system function, patterning, and change at local, regional and global scales over time; such data also provide

an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Wilkie and Finn, 1996).
Therefore, attempt will be made in this study to map out the status of land use land cover of Hyderabad District between 2005 and 2008 with a view to detecting the land consumption rate and the changes that has taken place in this status particularly in the built-up land so as to predict possible changes that might take place in this status in the next 14 years using both Geographic Information System and Remote Sensing data.

2. STUDY OBJECTIVES

The following specific objectives will be pursued in order to achieve the aim above.

- To create a land use land cover classification scheme
- To determine the trend, nature, rate, location and magnitude of land use land cover change.
- To forecast the future pattern of land use land cover in the area.
- To develop land use/ land cover details of the Core Zone (Mine lease area) and the buffer zone (10km radius from the Mine lease area boundary) using latest possible satellite imageries.
- To evaluate the socio – economic implications of predicted change.

3. PROJECT DESCRIPTION

Physiography & Drainage:

a) Core zone Physiography:

The Core zone area is 2070.10 Ha. This is a plain terrain and gently slopes towards northeast. The topographic elevation varies from 140 m. to 180 m. above mean sea level. The area is covered by Sandy clay soils. In this area north and north western part is covered by RG - OC III Project up to a depth of 140 m and western portion is covered by OB dumps of the existing project to the height of 240 m. above MSL..

4. RESULTS AND DISCUSSION

A) PRE PROCESSING OF DATA

The Digital Image Processing has been performed using ERDAS Imagine software tools and Garmin handled GPS has been used for Ground truthing.

The IRS R2 Liss IV Multispectral Imageries Kharif and Rabi seasons have been geometrically corrected with respect to Survey of India Toposheets. To carry out the geo-referencing, ground control points (GCPs) were identified on the maps and raw satellite data. The coefficients for two co-ordinate transformation equations were computed based on polynomial regression between GCPs on map and satellite data. Alternate GCPs were generated till the Root Mean Square (RMS) error was less than 0.5 pixels and then both the images were co-registered.

This IRS R2 Liss IV Multispectral satellite data of Kharif and Rabi season has been used for the Land Use Land Cover Analysis of Buffer Zone. The satellite imageries were analyzed digitally by the method of supervised classification with necessary Ground truthing using the reference map as well as GPS instrument.

IRS PV Cartosat-1 Pan F data (of Core Zone) is geo-referenced data supplied by NRSC, Hyderabad. This For better spatial resolution of multi-spectral, the satellite datasets - IRS Resourcesat 2 Liss IV and IRS PV Cartosat-1 Pan F have been merged for Core Zone to achieve better spatial resolution.

The hybrid method of Digital Interpretation and visual interpretation has been used to classify the Core Zone to achieve accuracy levels.

The coordinates of the boundary were collected using the GPS for geo-referencing the boundary, during Ground truthing phase.

The topography of the buffer zone has been studied using the Survey of India Toposheets considering the elevations and the drainage pattern including drainage orders.

B) TOPOGRAPHY

i) Source of Information

Survey of India Toposheets 56N/5, 56N/6, 56N/9 and 56N/10 SOI has been used for the study of the topography. In topography map of buffer zone has been shown elevation and drainage pattern including drainage order in Pic 3.1.

ii) Study Results

The 10km buffer zone from the core zone boundary i.e. mine lease area of Ramagundam Open Cast-I Expansion (Phase-II) Project is mostly pediment area, the elevation contour values ranges between 140m–540m from amsl. There is hilly terrain only in the Southern part of the buffer zone. The mine has the elevation contour values within the range of 140-180m from amsl.

South-West area of the buffer zone covered with reserve forests namely Begumpet, Ramgir and kamanpalli Reserve Forests. Bokkala Vagu, Jallaram Vagu and Godavari River are passing through the buffer zone. The buffer zone is covered with 1-5th order streams. Industrial Area of Ramagundam Open Cast-I Expansion (Phase-II) Project contains NTPC, RTPS and FCI. NTPC Reservoir also covered in this buffer zone. Godavarikhani, Ramagundam urban Settlements covered this buffer zone

C) PREPARING SPATIAL DATA

The step-by-step procedure for preparing the spatial data for the entire study area is discussed below:

Step I: Satellite data was processed using image processing software

Step II: Generation of thematic maps such as land use / land cover, hydro geomorphology, groundwater prospect map and soil map.

Step III: Generation of topographical maps showing physical characteristics of the study area. The topographical maps extracted from SOI toposheets are drainage, physiography and basemap.

Step IV: Generation of maps derived from hydro geomorphology map and land use map.

Satellite Data Processing

In this study, the Remote Sensing data is used in the digital mode and is obtained by LISS III and PAN of Indian Remote Sensing (IRS - ID). More details of IRS-ID and its sensor characteristics are discussed by Anji Reddy (2001).

Map of 1:50,000 scale obtained from SOI covering the entire study area is used to extract the Ground Control Points (GCPs) and to demarcate the boundary of study area. This information is then used for image registration of LISS III and PAN digitally using EASI/PACE software.

D) HARDCOPY GENERATION

In order to derive spatial thematic data, a hardcopy of satellite image is generated through the following steps:

i) Acquisition of satellite data from National Remote Sensing Centre (NRSC), Balanagar, Hyderabad and toposheets from Survey of India (SOI) Hyderabad.
ii) Geo-coding and geo-referencing of LISS III and PAN digital data by extracting the Ground Control Points (GCPs) from SOI toposheets.
iii) Digital image enhancement and application of correction models for making the digital data free from errors and distortions both radiometry and geometry of the satellite data.
iv) Fusion of PAN and LISS III for merged product preparation of a mosaic (Plate 3.1), which shows the continuous imagery of two study areas.
v) A satellite hard copy of this fused data is generated for subsequent analysis.
vi) Preparation of Land use / Land cover map of sites 1 and 2 using visual interpretation technique.
vii) Preparation of cartographic output of visual interpretation for making the data layer ready for scanning for further GIS analysis.
viii) Scanning of cartographic output using A0 colour Abacus scanner, digitization of this hard copy using AUTOCAD software and editing the digitized data compatible to ARC/INFO GIS software.
ix) GIS data manipulation and analysis, linking the spatial data file and attribute data file for the creation of topology.
x) GIS output in the form of land use/land cover map showing various land use/land cover patterns of the study area.

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E) LAND USE / LAND COVER CLASSIF ICATION OF OR BUFFER ZONE

Digital image processing was carried out to delineate various land use / land cover categories in 10km buffer Zone viz. built up area, crop areas, forests, scrubs, land with or without scrub, water bodies by assigning necessary training sets, which were identified based on tone, texture, size, shape pattern and location information. Necessary care has been taken to identify proper land use class, where there is conflict between signatures of various classes. The interpreted map was verified on ground at limited points and final land use / land cover map was prepared.

(i) Various Land Use Classes Identified:

The buffer zone can be broadly identified into forest areas, built-up areas, agriculture areas and other land with or without Scrub. The definitions of various land use classes are given below. Forest Blank and Forest Plantation are additional classes shown in the classification compared to the classes followed by Forest Survey of India (FSI).

(ii) Forest Cover:

All the areas declared as reserve forest areas are shown in this class. The forests can be classified based on density into following classes:

Very Dense Forest:	Forests with tree canopy coverage above 70%
Moderate Dense Forest:	Forests with tree canopy coverage between 40%-70%
Open Forest:	Forests with tree canopy coverage between 10%-40%
Scrub Forest:	Forests with tree canopy coverage between 1%- 10%.
Forest Blanks:	Forests with tree canopy coverage less than 0%. Forest encroachments and illegal agriculture also will be shown in this class.
Plantations:	The plantations raised with in the reserve forest boundaries are shown in these classes.

(iii) **Agriculture Area:**

Single Crop Land:	The areas where farmers practice cultivation for single season (Kharif) in a year.
Double Crop Land:	The areas where farmers practice cultivation for two seasons (Kharif & Rabi) in a year.
Fallow Land:	The areas not cultivated in current year/ years.
Plantations:	The private areas with horticulture/ other plantations

(iv) Waste Lands:

Areas with/ without Scrub: Generally waste lands-non agriculture, non forest areas covered with or without scrubs.

Barren lands:	Land without any usage and without scrubs and sometimes they are rocky exposed areas.
Built-up Area:	The habitations are villages/ colonies/ Industries will be shown in this class.
Mining Areas:	The areas, where the mining activity is being carried out/ has been done are shown in this class.
Industrial Area:	The industrial Establishments will be shown in this class.
Water Bodies:	The oceans, rivers, streams, lakes, tanks, reservoirs, canals etc will be identified in this class.

(v) Land Use Land Cover Details of Buffer Zone

The image of the study area around 10 Km. from mine site (Core zone boundary) as captured by satellite is presented in figure 1.2 and 1.3. The Land use land cover in this study area is depicted in figure 2.1. Total 9.75% of the buffer zone is covered in Reserve Forest area under various density categories and 53.08% of the area is under cultivation.

(vi) Land Use Land Cover Study of Core Mine Area

The Satellite data of the core zone of 923.88 Ha has been presented in fig 1.4, 1.5, and 1.6 (IRS R2 Liss IV, Cartosat Pan F and Cartosat Pan F + IRS R2 Liss IV Merged data respectively). The IRS R2 Liss IV and Cartosat Pan merged data has been interpreted to delineate various land use classes in core zone.

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The hybrid method of digital and visual interpretation procedures was followed for Core mine area on the merged data of Liss IV and Pan Datasets for identifying various classes.

5. CHANGE DETECTION:

The land use studies for Core and Buffer zones of Ramagundam Open Cast-I Expansion (Phase-II) Project comparative statement of land use land cover studies of 2010-11 and 2012-13 are given below.

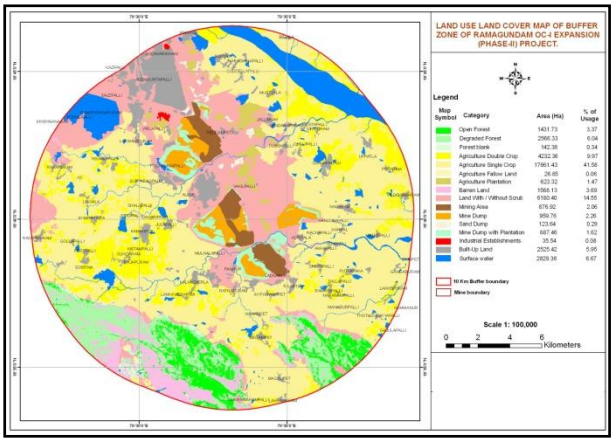

Figure 1.1 Land Use/ Land Cover pattern map of the Core zone

Tab: 1.1 Table showing land use comparative area statement of Buffer zone

Land Use Land Cover Class	**2013**		**2012**	
	Area in ha	**Area in%**	**Area in ha**	**Area in%**
Open forest	1431.73	3.37	414.22	0.98
Degraded forest	2566.33	6.04	4714.39	11.1
Forest blank	142.38	0.34	661.14	1.56
Agriculture - Double Crop	4232.36	9.97	6613.6	15.57
Agriculture - Single Crop	17661.43	41.58	16802.55	39.56
Agriculture - Fallow Land	26.85	0.06	988.42	2.33
Agriculture - Plantation	623.32	1.47	16.17	0.04
Barren land	1568.13	3.69	23.57	0.06
Land With/ Without Scrub	6180.40	14.55	5398.52	12.71
Mine area	876.92	2.06	739.93	1.74
Mine Dump	959.76	2.26	1343.93	3.16
Dump with plantation	687.46	1.62	0	0
Sand dump	123.64	0.29	0	0
Industry	35.54	0.08	115.79	0.27
Built Up Land	2525.42	5.95	2295.27	5.40
Water body	2829.36	6.67	2343.53	5.52
Total Area	**42471.03**	**100**	**42471.03**	**100**

The Land use / Land cover categories of Agriculture plantation, Barren land, Coal Dump are not classified in previous study. Mine pit, Dump with plantation, road, water body, Built up Land has been increased in Current year Core study. OB Dump and land with/without scrub are decreased in current study.

The Land use / Land cover categories of Dump with plantation and Sand dump are not observed in the previous study Buffer zone, these categories are classified in the current study. Open forest, single crop and plantation, barren land, mine area, water body are increased. In current buffer area forest blank, fallow land, mine dump, degraded forests are decreased in current study.

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