THE STUDY OF LAND USE / LAND COVER CHANGES AROUND SINGRAULI COAL FIELDS, INDIA USING REMOTE SENSING

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Abstract: In the present study an attempt has been made to study the land use and land cover changes around Singaruli Coalfields over a period of two decades. The study is based on the visual interpretation of geo-coded false colour composite (FCC) IRS-1A (Indian Remote Sensing) LISS II satellite imagery on 1:50,000 scale and Survey of India Toposheet number 63L/12 published in 1970. From the results obtained significant changes in the land use and land cover have been detected. For example forest cover has declined from 36 percent in 1970 to 26 percent in 1991. Similarly cultivated area too has shown a declining trend from 53 percent in 1970 to 49 percent in 1991. Rapid expansion of mining activity and growth of township are primarily responsible for these changes.

Introduction

Land use is the way in which, and the purposes for which, human beings employ the land and its resources: for example, farming, mining, or lumbering. Land cover describes the physical state of the land surface: as in cropland, mountains, or forests. The term land cover originally referred to the kind and state of vegetation (such as forest or grass cover), but it has broadened in subsequent usage to include human structures such as buildings or pavement and other aspects of the natural environment, such as soil type, biodiversity, and surface and groundwater. Land use information forms an important part of decision making at international, national and state levels. At national level land use information is an important element forming policies regarding economic, demographic and environmental issues. International requirements for land use data also focus upon many of today's major concerns considered at their broadest level. Remote sensing technique has emerged as a powerful tool to study landuse and land cover changes. It not only provides reliable and accurate baseline information for land use mapping but also generalized delineation of land use classification for large area and spatial distribution of land use categories is easily possible through satellite imageries. The relative advantage of remote sensing over conventional methods is that not only is the synoptic view of the area under study available but also change detections are easily deciphered.

Owing to its inherent advantages an attempt has been to made to study the land-use and land cover changes in the area surrounding Singrauli Coalfields covered under Survey of India toposheet 63L/12 and detect land-use land cover changes between 1969-70 and 1991.

Materials and Methods

For the present study remotely sensed data and other collateral data including Survey of India toposheet have been used. The remotely sensed data is obtained from IRS 1A LISS II false colour composite bands 2,3,4, row 132, path 042, resolution 36 meters on

1;50000 scale of February1991 other data include Survey of India toposheet number 63L/12 on 1;50,000 scale, Anderson's Land Use/Land Cover classification and NRSA (National Remote Sensing Agency, Hyderabad) Land use/Land cover classification for the delineation of land use/land cover mapping. The entire study is based on the visual and digital interpretation. The visual interpretation is based on the basis various elements including shape, size, tone, texture, pattern and association. The land Use Land Cover Classification has been done digitally using Unsupervised Classification using Erdas Imagine and Arc GIS 9.1 softwares and various thematic maps have been prepared. After the preparation of various image overlays these have been compared with the land use maps delineated from the Survey of India toposheet for change detection

Study Area

Location and Extent: The study area lies partly in Sidhi district of Madhya Pradesh and Mirzapur district of Uttar Pradesh. It extends between latitude 24°00′ N to 24°15′ N and longitude 82°30′ E to 82°45′ E. It is covered by the Survey of India (SOI) topographical sheet numbered 63L/12. It is delimited by the district boundary of Sihawal (Madhya Pradesh) in the south-west and southern part. It is bounded by Sonbhadra and Mirzapur district (Uttar Pradesh) in the eastern and northern part respectively

Geology: The study area occupies the junctional region between the east-west trending Damodar-Koel-Tatapani graben and the NW-SE trending rift zone of the Son-Mahanadi valley.The northern limit of the Singrauli basin is defined by a prominent east-west trending fault, along which the Gondwana rocks about against gneisses, schists, quartzites and phyllites of Precambrian age. Along the eastern boundary of the coalfield Talchir sediments rest unconformably on the Precambrian rocks. Towards west, the Gondwana sediments are juxtaposed against the Proterozoic Bijawar Group of rocks.(Raja Rao, 1983). The area immediately north of G.B. Pant Sagar reservoir is formed of lowlying hills of granite gneiss, granite and migmatite of Dudhi Group which are separated from hills of phyllite, schist and quartzite of Bijawar super Group on northern side by a E-W trending fault (Dudhi Tectonic Lineament). On the western side of G.B. Pant Sagar reservoir, coal-bearing sandstone, grit, conglomerate and shale of Gondwana Super Group are exposed.

Physiography and Relief: Topography of the study area is variable with altitude varying from 243 to 640 meter above mean sea level (MSL). Seven major landform units based on variation in relief, slope, drainage, texture and crest types are recognised in the study area.(Fig.-1). These include (1) structural hills, (2) structural plateau (undissected/dissected), (3) denudational hills, (4) residual hillocks, (5) colluvial footslopes, (6) low-lying flats (both pediplains and peniplains) and (7) badland.Structural hills occupy the northern part of the area and are represented by a series of east-west trending strike ridges formed by

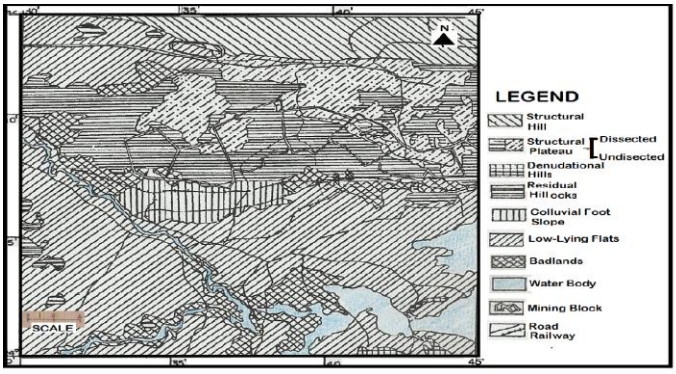

Figure 1: Physiography and Relief of the Study Area
Source: Journal of the Indian Society of Remote Sensing, Vol. 22, No. 1, 1994

resistant Precambrian rocks. The structural plateaux are made up of coal-bearing Gondwanas. Low-lying flats characterised by a gently-undulating topography with general slope towards south-east in the central part of the areas are the only landform unit where most of the agricultural activities have been noticed. Most of the badland topography is found over unconsolidated colluvial deposits.

Drainage

The study area is traversed by a number of streams and nalas which are mostly seasonal and flow in their full capacity rainy season. The four main dendritic perennial streams and nalas are Mayar River, Kachan Nala, Matwani River, Baliya Nala. Matwani River and Baliya Nala terminate into Govind Ballabh Panth Sagar Reservoir. These are the main source of surface water. Most of the tributaries and nalas are dry by the end of December / January to February. So, these river usually contain very small quantities of water during summer when temperature rises up. They do not provide much recharge to the aquifer present, and most of the water is lost through evapotranspiration.

Climate

The average annual maximum and minimum temperature for the district as a whole are 37°C and 20°C respectively. The climate prevailing in the area can be divided into three distinct seasons viz., dry summer (March/April to June), rainy season (July to September) winter season (October to February/March). The average annual rainfall is about 1000 mm. The overall climatic condition of the area is tropical to semi-arid.

Soil

Soil in the study area are derived from sandstone, granite, shist, gneiss, quartzite, phyllites and shales. The undulating topography has given rise to different grades of soil at different elevation. It varies loamy sand to clay. Extensive pocket of alluvium soil mainly exist in plain areas . Colour vary from red to yellow. Red and brown forest soil indicate development of Archean and Dharwarian basement cover extensive areas.

Vegetation

The seasonal rainfall and nature of soils provide for a variety of vegetation ranging from grasses and thorny trees to deciduous trees of commercial significance like teak, sal, balbu etc. The tropical dry deciduous forests are distributed in the region both in small patches and in considerable stretches. The depth of soil and water table play an important role in the distribution of species. The deciduous forest is mostly confined to the region occurring both on hill slopes and plateaus and also in river valleys. Considerable acreage has been maintained under reserve category while those in the slopes over 25o are classed as protected forest as their further exploitation may accentuate soil erosion in the area.

Land Use, Land Cover Changes between 1969-70 and 1991

On the basis of the analysis of the 1969-70 Survey of India toposheet of the study area and the IRS LISS II data of 1991 following changes are recognized in the study area:

1. **Built-up Land:** Area under total built-up land which includes rural settlement, urban settlement, thermal power plants and coat dump yards was 26.24 sq km during 1970 which has increased to 64.02 sq km by 1991. Built-up land which constituted 3.26 per cent of the total area during 1970 increased to 8.06 per cent during 1991(Fig-2).The rural settlements in the area show a negative trend from 2.94 per cent in 1970 to 2.30 per cent in 1991. In contrast, urban settlements have shown a positive trend from 0.31 per cent in 1970 to 4.35 per cent in 1991. Out of total 34.55 sq km covered by urban settlement, NCL township, NTPC township and other marketing centres comprises 17.02, 13.50 and 4.03 sq km respectively. The area under thermal power plants has increased from 0.10 sq km during 1970 to 10.47 sq km in 1991. It is evident from the analysis that urbanization got impetus in this area from the year 1986 due to coal mining and power industry. Industrial townships and thermal power plants have mainly developed on wasteland and agricultural land.

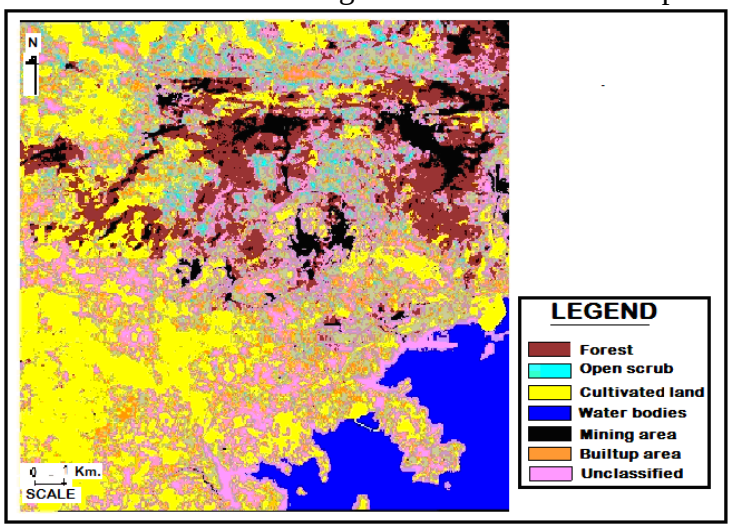

Figure- 2 :Land Use/Land Cover Based on IRS 1A LISS II Satellite Image, 1991

2. Forest: The forest area has shown a declining trend from 1970 to 1991. As per analysis, the area of forest cover was 296.41 sq km (36.85% of the total area) during 1975 as compared to 222.75 sq km (27.60% of the total area) in the year 1986 registering a loss of 73.66 sq km. over a period of eleven years. It further depleted in 1991, showing net loss of 82.71 sq km over the year 1975.(Figs-3A,B) Thus, the total natural forest including plantation under social forestry available as on 28th October, 1991 was 213.70 sq km which represents 26.89 per cent of the total area. It is estimated that out of 82.71 sq km, 43.64 sq km of forest land has been utilised for coal mining and related activities and 39.07 sq km of loss in forest cover over a period of about 17 years may be due to human pressure on forest for firewood as well as grazing of cattle in the forested area. In all three categories of forests can be visualized in the study area. (a) Open Scrub identified by whitish

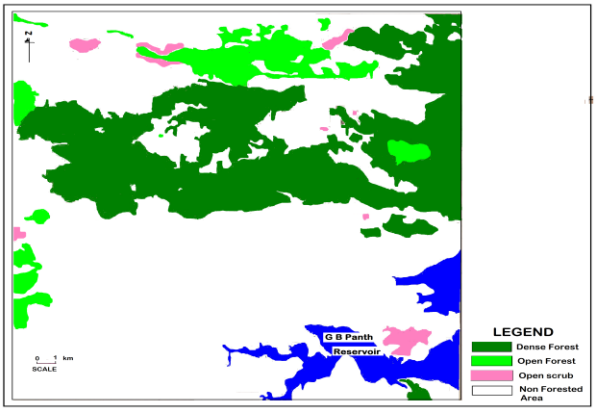

Figure- 3A Extent of Forest Cover Based on Toposheet 63L/12, 1969-70

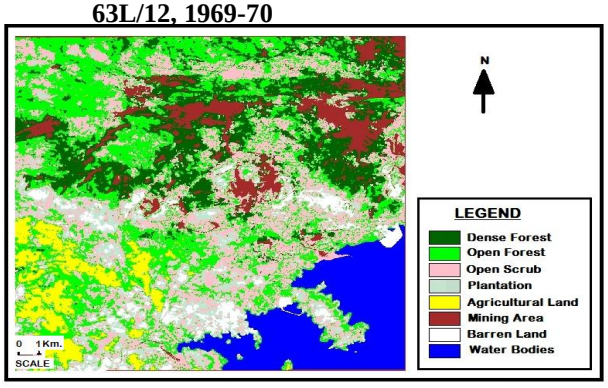

Figure- 3B: Extent of Forest Cover Based on IRS 1A LISS II Image, 1991

to light grey tones in the imagery, located mainly in the south-east portion of the region with minor patches in west , north-eastern region. Total area under this category is 9474.80 hectare. (b) Open Mixed forest identified by light to dark mixed tone of green and grey in satellite imagery, Most of this forest type is located in the middle and northern portion accounting for 6794.7 hectare area. (c) Dense forest identified due to their smooth dark (in reddish brown) tonal characteristics in imagery, found mainly in higher elevations in north western and north eastern regions. Area under this category of forests is 11409.2 hectare.

3.**Agricultural Land:** Before the industrial development based on thermal power generation and coal mines exploitation around the GBP Sagar agriculture was the main occupation of the working population in this region. During 1970 about 53 per cent of the total area was under cultivation. However, analysis of 1991 data indicates that only 49.40 per cent !and is under cultivation thereby showing a net loss of 35 sq km area.(Fig-2) This reduction in agricultural land is due to development of infrastructure and residential complexes of mining industry as well as thermal power plants. Fig-4 shows the agricultural zones in the study area. These are categorized into good, moderate and poor categories. Land under intensive cultivation can be marked mostly along the both sides of Kachan River and Mayar River as well as in the northern region of G.B. Pant Sagar Reservoir dominated by the Matwani River and Baiyal River. Another patch of intensely cultivated land is found in the north-west in valley of the Bijul River. River Bijul with its tributaries Bukuru , Silhor etc. along with Kachan , Mayar and Matwani has deposited fertile soil by bringing sediment from Vindhyan Upland. Land under good cultivation area amounts of 8455.85 hectare. Land under moderate cultivation is seen basically surrounding areas of good cultivation. Besides some land under moderate cultivation is seen in degraded forest area. Total area under this category is 6281.86 hectare. Poorly cultivated areas are observed in shallow buried pediment zones, forested and stony area of Vindhayan Upland. In these regions degree of concentration of agricultural land depends on availability of irrigation. Poorly cultivated areas in the study area are located North of Kachan River , middle of Bijul River, north part of Dudhichua Protected Forest and middle part of the hilly area. The total area under this category is 8539.37 hectares.

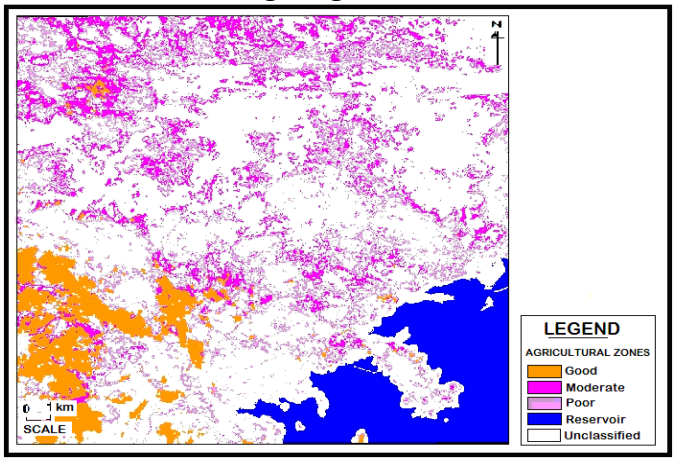

Figure- 3 :Agricultural Zones Based on IRS 1A LISS II Satellite Image, 1991

4. **Mining Area:** Total coal mining area covering mostly forest land. This rapid increase in the mining area is due to higher coal production as well as stripping of overburden materials. Besides the coal mining, some stone quarries are also under operation in the northern part of the coalfield on metamorphic near Jhingurdah. The area covered by stone quarries was 0.72 sq km during 1991. Study reveals that NCL has taken lot of efforts in

greening the mined out area by putting plantation on overburden dumps. Plantation on overburden dump has been increased substantially to 5.22 sq km during 1991 (Fig-3)

5. **Wasteland:** There has been a substantial increase in wasteland area as manifested in the satellite data of 1991 due to deforestation. These lands have been utilised for establishing the Super Thermal Power Plants, townships as well as other infrastructures related to mining as seen on 1991 data. It is evident from the toposheet and satellite data analysis that the area covered by wasteland during 1970was 44.51 sq km (5.53% of the total area) which has increased to 69.77sq km (8.78% of the total area) during 1991. By 1991, area under wastelands has comperatively decreased due to development of townships and other infrastructures on it. The fly ash generated from the thermal power plants are disposed through pipelines in the ash ponds concentrated along the periphery of the reservoir. The area of fly ash ponds was 2.47 sq km in 1991. This increase of 3.28 sq km area of ash pond mostly on agricultural land is due to increase in fly ash generated on account of higher power generation from Super Thermal Power Station.

Conclusion: The above study based on satellite data has well brought out the significance of the utility of Remote Sensing in Land Use Land Cover Study. Significant changes have been detected in the land use pattern in the study area. Owing to increased mining activity there has been a rapid depletion of forest. Expansion of mining activity has also led to an expansion of settlements mainly developed for the mine workers. A serious repercussion is the increased rock-waste resulting directly from the mining and related dumping activities.

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