INTRODUCTION

Mining is one of the most important activities in the state of Jharkhand, which has been separated out from Bihar in 2000. This activity causes deforestation, which encompasses permanent destruction of indigenous forests and woodlands to provide land for agricultural purposes, residential and industrial sites, roads, etc., harvesting the trees for building materials or fuel wood etc. The changes in the land cover particularly the tropical deforestation have attracted worldwide attention because of their potential effects due to increase in soil erosion, run-off and carbon dioxide level. The loss of forest cover in India between 1990 and 2000 was 380.89 km^2 per annum between 1991 and 1999 (FAO 2000).

With the impending threat of climate change, vegetation mapping is now being attached highest priority world over. Less than a century ago, vegetation maps were largely unknown but by today, these maps are quite common. Indeed, much energy is now being spent on preparing vegetation maps, and great is the need for more and better maps. Global database provide broad vegetation classification viz. forest, grassland, shrub lands, tundra, desert, marsh/swamps and cultivated areas. Regional mapping allows stratification based on bioclimatic classification of vegetation, which serves the nation-wide mapping needs. Macro level mapping incorporates physiognomic - floristic approach and subdivides bioclimatic types into different communities. Micro level stratification is based on association present in the community and provides most homogeneous mapping units based on species composition and other structural characteristics of vegetation. The information becomes more presentable and comprehensive when represented in the form of vegetation maps.

Ecosystem disturbance is an event or series of events that alters the relationship of organisms and their habitat in time and space. Ecosystem disturbance caused due to mining is an evitable fall out of industrialization and modern civilization. Forest ecosystems have important functions from an ecological perspective and provide services that are essential to maintain the life-support system on a local and global scale (Rao and Pant, 2001). The rate and the intensity of land use and land cover change are very high in developing countries because of various human activities. Mining of coal both surface and subsurface causes enormous damage to the flora, fauna, hydrological relations and soil biological properties of the systems. Destruction of forests during mining operation is invariably accompanied by an extensive damage and loss to the system. The overburden of coal mines when dumped in unmined areas creates mine spoils which ultimately affects the surrounding vegetation. Mining operations, which involve minerals extraction from the earth’s crust tends to, make a notable impact on the environment, landscape and biological communities of the earth (Down and Stocks, 1997 and Bell et al., 2001). Unscientific mining of minerals poses a serious threat to the environment, resulting in reduction of forest cover, erosion

ABSTRACT

The aim of the present investigation is to study the alarming decline in forest cover in a coal mining area of Ramgarh district of Jharkhand by using Remote Sensing and GIS. The analysis results that have taken place due to rampant coal mining are incorporated in this paper. The satellite images of IRS 1C-LISS III data of year 1996 and 2004 have been used for mapping land use and land cover in the area with special emphasis to delineate forest cover and all coal mining areas, old as well as active mining areas. Integration of remote sensing data with other spatial/non spatial data is carried out using ARC/INFO software package. A useful classification technique is adopted for land cover/land-use change analysis in relation to elevation, slope, aspect and bio-climatic classes. Change detection for forest cover between 1981 and 2004 has been done. Digital terrain model (DTM) of the study area has been developed to see the gravity of condition more clearly by taking into account of undulating terrain and its slope, aspect etc. Based on the trend of land use and land cover changes detected in this study show that in the present study area forest cover has decreased drastically due to active coal mining.

KEY WORDS

Coal Mining
Forest
Land use/land cover
Change detection

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of soil at a greater scale, pollution of air, water and land and reduction in biodiversity (UNESCO, 1985). The problems of waste rock dumps become devastating to the landscape around mining areas (Goretti, 1998).

Generating an environmental database in regional context to understand deforestation in spatial and temporal domain is difficult task by conventional methods. Today, Remote Sensing data, which is synoptic, repetitive and multi temporal in nature has efficiently filled this gap. Kindred with Geographical Information System (GIS) technique has a distinct advantage over conventional methods/approaches to map and monitor the evolution of degraded areas. It has become a versatile tool for assessing and monitoring environmental impacts as a result of natural and man made activities. It provides an excellent overview regarding the status of mining areas and impact on mining activities. Earlier works have demonstrated its potential in various facets of mining activities.

The developments in remote sensing technology have indicated that if it is judiciously combined with ground-based studies, it is possible to carry out detailed forest inventories and monitoring of natural vegetation cover at various scales (Tucker et al., 1984; Botkin et al., 1984). The analogue representation of remote sensing data of a pictorial nature is used for visual interpretation. Earlier works have demonstrated its potential in various facets of mining activity, viz., land use change detection in mining area (Ghosh and Ghosh, 1991; Prakash and Gupta, 1998), environmental impact of Mining (Ghosh, 1989; SAC 1990; Rathore and Wright, 1993; Chatterjee et al., 1994). Remote Sensing and GIS together have potential to provide comprehensive information on various facts of forests management in India. It can be said that remote sensing and GIS are twins of advanced technologies. Thus, it is undisputed that GIS is complementary to remote sensing technology and as well as a tool for spatial representation of information obtained from remotely sensed data which are essential as management input.

Study area

The Study area (Fig. 1) is located in Ramgarh district of Jharkhand covering Patratu, Bhurkunda and Simratann. The study area comprising of 347.12 sq. km in the Survey of India topographical sheet No. 73 E/6 on a scale of 1:50000 is situated in Ramgarh district of Jharkhand. It lies between longitude 85°15′ to 85°25′ and latitude 23°35′ to 23°45′. The general climate of the area is tropical with maximum annual temperature between 37.7°C to 44.3°C and minimum temperature between 3°C to 14°C. The area receives normal rainfall between 1102 mm to 1472 mm with significant seasonal variation. The area is drained by Damodar river with Nalkari river as its main tributary. Patratu is the main industrial town and is well known for coal mining activity and thermal power. Patratu is well connected by road and rail network. Coal mining areas are located mainly in the vicinity of Damodar river. Forest covers are mainly in the hilly terrains of the study area. Most of the forests are of deciduous type. Some are also of evergreen type. Agricultural lands are located in the plain area i.e. in the central part of the study area. Some agricultural lands are also near forest boundary.

MATERIALS AND METHODS

Remote sensing and GIS based techniques for deforestation estimation in the Patratu region include data preprocessing, interpretation and change analysis. IRS 1C LISS-III data (Fig. 2) of same season of year 1996 and 2004 were used to evaluate the changes. For year 1981 Landsat TM satellite data was used. Survey of India Toposheet on 1:50000 scale and Forest Survey of India (FSI) reports were also used as collateral data. Satellite data provided by NRSA was radiometrically and geometrically (orthorectification with UTM/WGS 84 projection) corrected. Datasets were with sub pixel level accuracy. Field work was carried out in October 2005. Detailed ground truth was carried out on 1:50,000 scale using Toposheet, base maps, Global Positioning System (GPS) and on-site investigation.

A uniform classification scheme was used for mapping. For assessing the impact on natural resources, the classification scheme was restricted to (1) Forest (not impacted, highly degraded, medium degraded, less degraded), (2) Agricultural Land, (3) Active Mines, (4) Water body and (5) Agricultural Land. The Degradation on the forest was assessed by preparing Land use / Land Cover map of the study area using temporal satellite data. Local enhancement (data scaling and histogram equalization) was carried out on the temporal scenes for better interpretation. Normalized Difference Vegetation Index (NDVI) is one of the band ratio (Rouse et al., 1973) that show high values for vegetation parameters such as green leaf biomass, green leaf area, percentage green cover and leaf area index (LAI) and hence is of considerable value for vegetation discrimination \[ NDVI = \frac{(IR - Red)}{(IR + Red)}. \] It has helped to depict dense vegetation and fragmented patched vegetation.
The low NDVI values helped to detect the mining areas. The NDVI values were lower in the open mining areas than in the already reclaimed areas, even when both areas had the same type of vegetation cover. The NDVI images allowed identification of cover changes related to mining.

On screen visual interpretation was carried out for land use/land cover map at 1:50000 scale (Fig. 3). The red areas represent forest areas over hilly terrain over northern and southern part of the area. A large reservoir can be seen in the lower portion of the image. The coal mine areas in the central portion have characteristics of denudated land with dominance of scrub vegetation (greenish tone) with elongated water bodies in old dormant coal mines. Thermal power plant and associated industries (bright white with smoke) can be located in the vicinity of the Reservoir. Perennial Damodar River traverse the area flowing from west to east. Agricultural land have sporadic occurrence and generally surrounded by scrub or barren lands.

The interpreted layer was used for the change detection by rectifying the changed polygon by overlaying it on the image of the 1996 and 2004. For all images the scale was kept constant. This technique was found more efficient and convenient while mapping the changes. Tonal contrast between eroded areas, agricultural fields and forest cover, aided the identification of the disturbed area on the satellite data. Alarming rate of conversion of well stocked forest to barren land was noticed.

The results show that the land use in the area is governed by mining activity and its concomitant effect on land. The land cover dominates by urban residential and industrial build up lands corresponds to mining operations and related industries whereas forests dominates over the hilly terrain reflecting the natural climatic setting of the region. The various categories of land use and land cover observed in the study area have been classified into six major groups, viz., built-up land, agricultural land, forestland, wasteland, water bodies, and others (Table 1). Built up land occupies 28.43 sq. km area with Patratu as the main urban and industrial town.
Nearly 33% of the area is used for agriculture of which plantation occupies the maximum area (18%) followed by crop land (8.28%) and fallow land (6.8%). Total forest area is 68.01 sq. km (19.59%); most of them are located on the hill ranges. Wasteland occupies an area of 81.76 sq. km (23.55%) and mainly consists of dense (48.35 sq. km) and open scrub (31.2 sq. km) and barren land (2.21 sq. km) (figure 4). River Damodar is the only perennial river draining the area. Coal mining area constitutes 7.58% (26.33 sq. km) of the total study area and is mainly located in the vicinity of Damodar River. Large part of area classified under mining area have mining dump which form large heaps of dumping materials attaining height of about 30-50m.

The land use / land cover distribution during the year 1981, 1996 and 2004 was assessed. Change in coal mining area over the years (Fig. 5) and change in Forest area were calculated. The forest area which was 90.49 sq. km in 1981 (26.06%) came down to 76.46 sq. km in 1996 (22.03%) and further reduced to 68.01 sq. km. (19.59%) by the year 2004. Thus, apparent decrease in forest cover is 15.50 % during the 1981-1996 and 11.05 % during 1996-2004 (Fig. 6).

It has been observed that major loss of forest areas occur in the vicinity of coal mining areas. Total destruction of forest cover has been noted in the certain coalmines. Also the forest cover reduced due to agriculture extension into forest areas and due to clearing of tree due to fuel wood required of local inhabitants coupled with reduced regeneration of vegetation due to environmental pollution.

Similarly, the coal mining area, which was 10.16 sq. km in 1981 (2.92 %) increased to 20.08 sq. km in 1996 (5.78 %) and further spread over to 26.33 sq. km. (7.58 %) by the year 2004. Thus, apparent increase in the spread of mining activity area is 97.63 % during the 1981-1996 and 31.13 % during 1996-2004. The spread of coal mining activity leads to total destruction of forest cover within the mine area and also leads conversion of surrounding agricultural lands into wastelands dominated by open and dense scrub. Large bodies of stagnant water accumulated in the depression areas of mine due to accumulation of surface and ground water over a period of time indicating a changing geo-hydrological regime with possible threat of ground water contamination in potential aquifer passing through the area or located at lower stratigraphic level.

The application of satellite remote sensing data in this study provided useful information about the trend of deforestation in the mining landscape. Satellite images proved to be a good data source with useful temporal resolution. The spatial complexity and spectral heterogeneity of the surface mine area made the application of the satellite data somewhat difficult. There is a sharp decrease in forest area by 24.82 percent and phenomenal increase in coal mining area by 159.15 percent during the year 1981 to 2004. The increase in coal mining activity has direct impact on the forest cover when coal-mining activity enters into the domain of forest cover.

The present change analysis can be useful to find out the change in different land use/land cover pattern in mine affected areas and it will be also helpful to delineate the vegetation areas under risk due to mining activities. The findings of the study could be quite useful while formulating the Management Plan for the district.

REFERENCES

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APPLICATION FORM
NATIONAL ENVIRONMENTALISTS ASSOCIATION (N.E.A.)

To,
The Secretary,
National Environmentalists Association,
D-13, H.H.Colony,
Ranchi - 834002, Jharkhand, India

Sir,
I wish to become an Annual / Life member and Fellow* of the association and will abide by the rules and regulations of the association.

Name _________________________________________________________________________________________________
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Official Address ___________________________________________________________________________________________
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E-mail ___________________________________________ Ph. No. __________________________ (R) __________________________ (O)
Date of Birth ______________________________________ Mobile No. ___________________________________________
Qualification _____________________________________________________________________________________________
Field of specialization & research __________________________________________________________________________
Extension work (if done) __________________________________________________________________________________
__________________________________________________________________________________________________________

Please find enclosed a D/D of Rs…………………………………. No. …………….......…… Dated …………………. as an Annual / Life membership fee.

*Attach Bio-data and some recent publications along with the application form when applying for the Fellowship of the association.

Correspondance for membership and/or Fellowship should be done on the following address:

SECRETARY,
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D-13, H.H.Colony,
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