ASSESSMENT OF IMPACT OF OPENCAST MINE ON SURROUNDING FOREST: A CASE STUDY FROM KEONJHAR DISTRICT OF ODISHA, INDIA

Patra Himansu Sekhar* and Sethy Kabir Mohan
Department of Geography, Utkal University, Bhubaneswar, Odisha (INDIA)

Recieved January 10, 2014 Accepte d June 19, 2014

ABSTRACT

Mining as an industrial activity, disturb the surrounding natural environment. Surface mining in particular involves the clearing of large tracts of forest and agricultural land, resulting in serious land and forest degradation. Forests are the greatest victims of developmental activities like mining, which can be gauged from the depletion of the forests in various mine belts. Large scale of unplanned and unscientific open cast mining in various mineral belt of Odisha has been observed during last decade having serious implications on the surrounding forest. Remote sensing technology can be effectively used as a valuable asset in assessing the impact of mining activity on the surrounding forest. The present study was undertaken to analyze the impact of iron mine on the surrounding forest in Keonjhar district of Odisha, India by interpreting temporal remote sensing data and using Geographic Information System (GIS). The results find out significant reduction in dense forest area along with increase in open and degraded category forest during the study period. This study concludes that degradation of forest is one of the major externalities of open cast mining which is yet to be addressed properly and their needs a thorough attention to this issue in upcoming days. The study also highlights the utility of this technology in monitoring the impact of large-scale mining and other extensive forms of resource exploitation such as deforestation in developing countries.

Key Words: Iron mining, Remote sensing, GIS, Degradation, LULC, Deforestation

INTRODUCTION

For economic growth of a country mineral resource plays an important role. Minerals and metals have played a crucial role in the development and continuation of human civilization. After agriculture it is the second largest industry at all scales and regions and has played a vital role in the development of civilization from ancient times. However Mining, like any other industrial activity tends to leave a strong negative impact on the environment unless it is meticulously planned and carefully executed. It is a well established fact that mining is an environmentally destructive activity. The state of Odisha is bestowed with abundant mineral resources which are found to be deposited under the large tract of forest mostly located in Keonjhar, Sundergada, Mayurbhanja, Koraput and Kalahandi district. After 2000, the government of Odisha tried to turn around the state economy by using its vast mineral deposits.

For this, the state government leased out a large part of its mineral resources, whose exploration is found to directly affect the forest. Data of Directorate of mines, Government of Odisha, shows that till date more than 600 mines (both operating and non-operating) covering diversified minerals has been leased out in different part of state. The environmental impact of open cast mining is many and diverse. Increase in mining activities is damaging to 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. Modern open pit mining techniques utilize heavy equipment. As a result, dramatic changes in the land cover take place in a very short period of time, affecting the neighbouring habitat both ecologically and hydrologically. Mining and quarrying has destroyed large tracts of forest land in all the states of India. According to ministry of mines (2008), Government of India, the

*Author for correspondence
A vast amount of cultivable and forested land is permanently rendered useless because of the pits and dumped overburden. Mining in forest zones, is a major factor of degradation. Environmental degradation that has threatened the survival of all life forms on the surface of the earth. The problem of waste rock dumps during mining become devastating to the landscape. As a result, natural plant communities get disturbed thus, making the environment unsuitable for growth of plants. A detailed assessment of the impact of the existing mining on surrounding forest is essential for regulatory point of view. Location of the mines at inaccessible location is a major challenge to assess the impact. Remote sensing technology affords a viable means of analyzing the changing land use pattern at mine sites located at inaccessible place. The information generated from this technology provides reliable data which can be used for environmental compliance and evidence during litigation. With the advent of space borne remote sensing techniques it has become possible to get a synoptic coverage of a larger area, at cost effective and repetitive manner which is extremely useful.

AIMS AND OBJECTIVES
To analyze the process of human-induced deforestation that took place at the iron ore mined area of Keonjhar district of Orissa, India by using Remote Sensing and Geographic Information System.

METHODOLOGY
Study area
The study area is located between 21°37'09"-21°40'02"N and 85°29'20" - 85°31'30"E, near to Suakati town in Keonjhar district of Odisha (Fig. 1). A major iron deposit of state namely Gandhmardan hill is located at the centre of study area, having a estimated reserves of 350 million tonne of iron ore. The existing iron ore mine at this hill is one of the oldest mines of Odisha. The iron ore mining started in Gandhamardan hill range by Odisha Mining Corporation (OMC), a State Government owned agency in 1965 and presently it has two open cast iron mines namely Gandhamardan A and B covering around 2200 hectare. Similarly two private owned mines are also operating at Putulpani (Talajagar) and at Urumunda village respectively covering a total area of 182.1932 hectares. The core mining area as well as the surrounding area (buffer) shows a good forest cover.

Fig. 1 : The location of study area
The forest cover of the study area can be classified into pure sal forest, mixed forest, degraded forest, extensive plantation and open forest. Reserve forest like Nayagarh R.F, Gandhamardhan R.F, Raiguda R.F, Kumundi R.F, Khejurmundi R.F, Suakati R.F, Sanaghagara R.F and Siddhamatha R.F are found to be located within 10 km of the mines area which shows the ecological richness of the area.

Remote sensing and its usefulness in mining impact assessment

To understand the consequences of human actions and natural phenomena on the environment there are needed data acquired in real-time that are the basis of modelling various environmental impacts. Remote sensing and GIS techniques are quite useful in identifying the degraded areas cause by mining activity. These are important tools for studying the pattern of landscape dynamics. The changes of land cover are invariably associated with mining of natural resources. Remotely sensed data is one of the best source of information that can show the location of all areas that have been deforested or degraded or still healthy. The satellite data provides a permanent and authentic record of the land-use patterns of a particular area at any given time, which can be re-used for verification and re-assessment. This can be very useful in assessment of impact of mines. As most of the mines are located at in-accessible and hostile terrain, remote sensing can be effectively used to collect information about the impact of the mining. It has tremendous application in rapid spatial and temporal monitoring as well as assessment of tropical forest resources and hence in formulation of concrete policy frameworks for their sustainable management.

Area of Interest (AOI) comprising the study area was selected and extracted from the satellite image. Suitable image enhancements were then applied on the extracted area of interest. IRS P-6 LISS III data offers spatial resolution of 23.5m with the swath width of 141 kms. The data was collected in two visible bands namely green (0.52-0.59 µ), red (0.62-0.68 µ), infrared (0.77-0.86 µ) along with new feature SWIR band (1.55-1.70 µ) with orbital receptivity period of 24 days. The shapes, sizes and colours of several geomorphic features are visible in the IRS data.

The standard FCC was generated by assigning blue, green and red colours to visible green, visible red and near infrared bands respectively. Image processing and rectification was done in ERDAS IMAGINE 8.4 software and spatial data was created in Arc GIS-9.1 software. A visual interpretation followed by supervised classification was adopted to classify the forest cover features. Mask of mine area within 10 kms radius was superimposed on the final output to generate area statistics for forest land categories. Classification accuracy estimation was done on the supervised classified image for further rectification. Then comparison of forest land category status was made between the three map to know the degree of change. Land use land cover statistics is used to compute percentage change, trend and rate of LU/LC change between 1990, 2000 and 2012. Table 1 shows area and percent of forest land cover and change during these periods. Percentage of change occurred was computed by comparing the initial and final forest area coverage according to the following formula:

\[
\text{Percent forest land change} = \frac{\text{Present forest land area} - \text{Previous forest land area}}{\text{Previous forest land area}} \times 100
\]

where area is extent of each forest land type. Positive values suggest an increase whereas negative values imply a decrease in extent.

RESULTS AND DISCUSSION

In the present study, satellite imagery of 1990, 2000 and 2012 was compared. This comparative study has provided insights regarding the changes in land use pattern especially in the forest land during these years. The results of land use / land cover assessment were based on visual interpretation from satellite data. The land coming under forest refers to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses within the notified forest boundaries. Forest was classified into three categories on the basis of crown density viz; dense, open and degraded. After observation of percent change analysis, it was found that maximum deforestation occurred in the vicinity of iron ore mining areas.
The dense forests exhibit crown density of more than 40%. Periodic analysis of dense forest shows that it covered an area of 5255.18 Ha (16.70 % of the total area) during 1990, 3123.67 ha (9.93 % of the total area) during 2000 and 1527.51 ha (4.85 % of total area) during 2012. Dense forest shows a decrease of 40.56 % in area during 1990 to 2000 while this decreased by 51.09% between 2000-2012. It has been found out that most of the iron ore mining activities are taking place in the vicinity of dense forests because most of the iron resources are located with the hilly terrain covered with forest. Therefore, decrease in the area of dense forests is attributed to the removal of trees to initiate iron mining activities and development of mining infrastructure. Open forest exhibit crown density in between 40% to 10%. It is easily identified on FCC image by its light red - pinkish colour, smooth - medium texture, contiguous to non contiguous pattern with irregular outline. Open forest covered an area of 3567.89 ha (11.34 % of total study area) in 1990, 5673.44 ha (18.03 %) in 2000 and 7430.88 Ha (23.62%) in 2012. Open forests exhibit overall increasing pattern by 59.01 % during 1990 to 2000 and 30.97% during 2000 to 2012. Similarly area under forest plantation category was found at 256.24 ha (.81% of total area) during 1990, which was reduced to 202 ha (0.64%) in 2000 and 179.17 (0.56%) during 2012. The land coming under land with shrub was 2707.24 Ha (8.60%) in 1990, 3808.63 (12.10%) during 2000 and 5810.32 (18.47%) during 2012. The growth percentage was +40.68% during 1990-2000 and +52.55% between 2000-2012 (Table 1 and Fig.2).

Table 1: The percentage of changes occurred in forest land at various year

<table>
<thead>
<tr>
<th>Category of land</th>
<th>Status of LULC in (Ha) 1990</th>
<th>Status of LULC in (Ha) 2000</th>
<th>Status of LULC in (Ha) 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense forest</td>
<td>5255.18 (16.70%)</td>
<td>3123.67 (9.93%)</td>
<td>1527.51 (4.85%)</td>
</tr>
<tr>
<td>Open forest</td>
<td>3567.89 (11.34%)</td>
<td>5673.44 (18.03%)</td>
<td>7430.88 (23.62%)</td>
</tr>
<tr>
<td>Forest plantation</td>
<td>256.24 (.81%)</td>
<td>202.54 (0.64%)</td>
<td>179.17 (0.56%)</td>
</tr>
<tr>
<td>Land with shrub</td>
<td>2707.24 (8.60%)</td>
<td>3808.63 (12.10%)</td>
<td>5810.32 (18.47%)</td>
</tr>
<tr>
<td>Total land area in the 10 km radius in Ha</td>
<td>31456.08</td>
<td>31456.08</td>
<td>31456.08</td>
</tr>
</tbody>
</table>

Fig. 2: Year wise forest land changes occurred at study area
It has been found out that forest land located near to the mining lease area such as upper Jagar, Kumundi, lower Jagar village has been largely converted to open forest and land with shrub. It may be occurred due to increase in anthropogenic activity like mining, road, development of settlement, setting and expansion of villages, dumping of overburdens on forest land and increase demand for fuel wood. This also indicates that the mining authority has failed to check the falling of trees in and around the lease area at. Rapid conversion of dense forest in to open category is quite alarming from ecological and economical point of view. It will create problem for habitation of wild animal resulting in more human-wild life conflict in upcoming days.13-15

CONCLUSION

The study found out that deforestation due to mining and allied activity coupled with development of new settlement is leading to rapid degradation of forests in the study area. Indiscriminate mining has disastrous effect leading to deforestation, destroying good soil ingredients and loss of wildlife. Study at coal mining affected area also district that rapid growth of mining activities can be attributed as one of the reasons for decrease and degradation of land.14 Similarly it has found out significant alternation of land use pattern occurred surrounding mining area at Keonjhar district of Odisha, India. Scientific approach during mining activities has to be adopted in order to minimize the impact on forest resources. Mining activity will continue to expand in upcoming days, as a number of mineral based industries are going to setup in Odisha. Periodic mapping and monitoring the level of degradation at mining affected area plays an important role in formulating strategies for reclamation during post-mining period. Now a day, it has also become compulsory to use the remote sensing techniques for regular monitoring of these environmental hazards in-and-around the mining areas. At this background, the present study is an attempt to find out the adverse effects of mining and associated activities on forest land through RS and GIS technology. It has found out that Remote sensing technology can play a major role in carrying out the environmental studies and the subsequent impact assessment especially for open cast mines, which are of dynamic nature.

REFERENCES

3. Majumder B., Land use and land cover change detection study at Sukinda valley using remote sensing and GIS, Thesis submitted before Department of Mining Engineering, NIT, Rourkela, 1-20, (2011).
7. Kumar Mohit et al., Application of remote sensing and GIS techniques in understanding changes in Mangrove cover in parts of Indus delta around Kori creek, Gujarat, India, J. Environ. Res. Develop., 7(1A), 504-511 (2012).


