REMOTE SENSING MAPPING FOR ASSESSING LAND UNIT CHANGES OF MINING ENVIRONMENT: A CASE STUDY FROM MAGNESITE MINES, SALEM

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Abstract

Mining and mineral exploration is essential for the economic and industrial development of a country and that too it is necessary for developing country like India. However, such mining activity disturbing the ecology, forestry, geology geomorphological and hydrological environment. The most important aspects of environmental assessment are to identify extent and nature of changes consequent upon the commissioning of a mining activity. Remote Sensing is one of the effective tools to monitor the environmental changes caused by mining activity. An attempt has been made to illustrate the role of Remote Sensing technique in mapping and monitoring the geomorphology and land use / land cover changes over a period of time through a case study carried out from magnesite mining area in Chalk hills, Salem.

Introduction

Mining has a major role to play in the economic development of any country and more so with respect to the developing countries. At the same time, it creates a lot of environmental impact on land, water and air systems. The environmental damage include morphological changes, land subsidence, change of land use and land cover, degradation of natural vegetation, thermal pollution, pollution of surface and subsurface water, air pollution and impact on flora and fauna and the human habitats. The recent flooding and catastrophe event in Bihar coal mine is a major threat to human by mining activity. Such type of incident has warning us to take preventative measures immediately to avoid the accidents in future. In this circumstance, we cannot simply stop the mining activities, on the other hand, through proper mapping and monitoring, one can develop a mining management model to protect the environment. In the past few decades, optical remote sensing techniques have involved a crucial role in mapping the mining area and monitor their impact on environment. Thermal remote sensing facilitates to map and monitor the temperature anomalies resulting from coal mine fires. In the present context, the magnesite mine in Chalk hills of Salem is analyzed through satellite data (Fig.1). The area was studied by number of workers including hydrogeomorphological and environmental assessment study (Anbazhagan and Saranathan 1991, Chandarasekaran et.al 1991). Geomorphologically, the Chalk hill area is forming small hillocks with undulating terrain and surrounded by shallow and buried pediments. This is the largest and important deposit of magnesite in India occurs in Salem district, Tamil Nadu. The deposits occur in a series of low hillocks known as “Chalk Hills” which are situated about 6.4 km north of Salem town. The estimated reserve is about 43.35 million tones. Since 1900 onwards, the magnesite deposit has been exploited by number of firms. The deposit in the chalk hills being exploited by a number of companies like TANMAG, Dalmia Magnesite, Burn & Co. and other private agencies. From 1901 to 1972, the manual method of mining had been adopted, and 1972 onwards, semi-mechanized mining method was used. The mining activities have changed the morphology and land use / land cover in and around the chalk hills to some extent. For mapping the changes on environment, a remote sensing based study carried out in this area.
Remote sensing techniques have been widely used in terms of environmental studies like wasteland mapping, desertification, coastal erosion, geomorphological changes, water logging and salinity assessment, impact of mining on environmental changes etc (Rabindranath 1987, Dhar and Rao Toleti 1988). Depending on the spectral and spatial resolution, the minor and major land use land cover categories can be interpreted from satellite data. It can be used to map active and abounded mines, if they are spectrally different. Garg et.al 1988 mapped and monitored the environmental changes in Kudremukh iron ore mining area by using Landsat satellite data. Further, Gupta and Singh (1988) adopted the temporal Landsat satellite data for delineating the environmental impact around metalliferous mine in conjunction with in-situ spectral studies. Subsidence of ground surface, land degradation, removal of vegetation, pollution of water resources, geomorphological changes, deforestation and elimination of drainage are readily mappable and monitored through high resolution remote sensing data. Further example, with the help of synoptic view, the polluted surface water body can be identified by its dispersion and tonal variation of pollution. The turbidity of water can be seen in light tonal contrast in satellite data when compared to clear water body. Satellite data can also be widely used for monitoring the air pollution in the mining area. The aerial extent and direction of the movement of air pollution can easily decipher through satellite data. Rajendra Singh and Singh (1988) have used the photogrammetric technique successfully for monitoring mining environment.
Geology and Geomorphology

The magnesite mining area falls in hard compact crystalline terrain in northern Tamil Nadu, India and comes under Archaean formation. Charnockites, fissile hornblende biotite gneiss, ultra basic complex and magnetite quartzite are important rock types in this area. The geomorphological evolution of this area is mainly controlled by fluviol, erosion, denudation, and structure. The various litho units present such as: structural hill (SH), residual hill (RH), shallow pediment (SP) and buried pediment (BP) are demarcated on the map (Fig. 2). The charnockites forming the high-elevated structural hilly terrain in the northeastern boundary called 'Shevaroy' hill. The western and southern part of the shallow pediment area is covered by gneissic terrain. Buried pediment and part of bajada zones are important fluviol landforms present in the foot hills of Shevaroy hill and these are well brought out in satellite imagery and demarcated. The magnetite quartzite stands as structural ridges near Kajamalai in the southwest of Salem town. The ultra basic complex does stand out as structural features in some portion, representing a undulating topography. The magnesite deposit occurs as a network of veins, lenses and stringers, within two detached main belts of ultra basic rocks, dunites and peridotites, covering an area about 21 sq.km (Krishnaswamy 1979).

Land Use/Land Cover Mapping

Remote Sensing plays a major role in mapping of various natural resources like mineral explorations, ground water explorations, forest mapping, land use / land cover mapping etc. The synoptic view of large area, multi-spectral nature and repetitive coverage of satellite imagery is favorable for mapping and monitoring the mining and its impact on environment. Preparation of land use / land cover information and monitoring the dynamic changes over a period of time is important for environmental management in mining areas. In Chalk hill area, the magnesite deposit is being extracted since hundred years. This mining activity has considerably changed the land cover pattern. Further, it may influence on deforestation, wildlife habitat, erosion and groundwater level depletion in the surrounding environment. For the present study, Landsat Thematic mapper (TM), IRS 1A and 1C satellite data on FCC mode were used for different periods. The main objective of the study is to understand the mining activities for different periods and its impact on various land unit and land cover pattern for more than a decade. The land use / land cover map for the year 1986 was visually interpreted using Landsat TM FCC imagery. Similarly, IRS 1A and 1C satellite data were used for presenting pictorial representation of the mining environment in the year 1989 and 1996 respectively (Fig. 3 and 4). From the satellite data, the agriculture land, forest and scrublands were clearly demarcated and these areas occupied by mining/mined out area and mining waste. In False Colour Composite imagery, the mining area has shown in pure white tonal contrast with irregular shape and whereas the mining waste has shown in bluish white tonal variation. Scrubland has identified through light yellowish color. The area covered by different land cover categories is shown in the following Fig. 5 & 6.

Result and Discussion

Mining activity, though a must for economic development, it leads to severe environmental degradation if suitable corrective steps are not taken in time. The magnesite mine at Chalk hill is open cast mining. Open cast mining has more impact on environment than underground mining. The present investigation demonstrates that the change of land unit and land cover in the surrounding mining area with help of three different period of satellite data. The environmental changes on land unit and land cover as a result of mining activity have been brought out for the year 1986, 1989 and 1996.
Fig. 3 Land Use Map
In the year 1986, out of 38.77 acres of agricultural land, (shallow pediment area), about 29.07 acres occupied by mining activity and 9.70 acres covered by mining waste. Similarly, 388.08 acre of forest land mainly coming under bajada zone was changed into forest blank (10.20), mining activity (300.37) and mining waste (77.50). In the same year, out of 1563.36 acre of undulating upland (scrub land), mining area and mine waste occupied by about 940.01 and 423.35 acre respectively. The change of agriculture, forest and scrubland by mining activity in the year 1989 and 1996 is represented in the Table 1.

Table 1 Mining activities under different Land Unit and Land Cover in different Period

<table>
<thead>
<tr>
<th>S. No</th>
<th>Land cover categories</th>
<th>Land unit</th>
<th>1986</th>
<th>1989</th>
<th>1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mining in Agriculture land</td>
<td>Shallow pediment</td>
<td>29.07</td>
<td>86.18</td>
<td>372.14</td>
</tr>
<tr>
<td>2</td>
<td>Mining waste in Agriculture land</td>
<td>Shallow pediment</td>
<td>9.70</td>
<td>37.07</td>
<td>74.13</td>
</tr>
<tr>
<td>3</td>
<td>Changes in forest plantation</td>
<td>---</td>
<td>---</td>
<td>80.31</td>
<td>290.34</td>
</tr>
<tr>
<td>4</td>
<td>Blank in forest land</td>
<td>Bajada zone</td>
<td>10.20</td>
<td>339.77</td>
<td>580.69</td>
</tr>
<tr>
<td>5</td>
<td>Degraded in forest land</td>
<td>Bajada zone</td>
<td>---</td>
<td>61.75</td>
<td>1170.37</td>
</tr>
<tr>
<td>6</td>
<td>Mining in forest land</td>
<td>Bajada zone</td>
<td>300.37</td>
<td>407.77</td>
<td>494.70</td>
</tr>
<tr>
<td>7</td>
<td>Mining waste in forest land</td>
<td>Bajada zone</td>
<td>77.51</td>
<td>49.43</td>
<td>172.97</td>
</tr>
<tr>
<td>8</td>
<td>Mining in scrub land</td>
<td>Upland</td>
<td>910.01</td>
<td>1675.77</td>
<td>2506.56</td>
</tr>
<tr>
<td>9</td>
<td>Mining waste in scrub land</td>
<td>Upland</td>
<td>423.35</td>
<td>501.41</td>
<td>803.16</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1790.21</td>
<td>3239.71</td>
<td>5411.56</td>
</tr>
</tbody>
</table>
In the year 1989, the agriculture land was occupied by mining area, which is two times more when compared to 1986. Once again the forest area occupied by mining environment was doubled within three years. The mining activity in the scrub land is also almost doubled in the year 1989. In the year 1996, the agriculture land, forest and scrub land occupied by mining activity of 446.27, 1365.23 and 3309.72 acre respectively.

The scrubland was the major land cover changed by mining activities and followed by the reserved forest area. In the forest, around 580 and 117 acres of land were converted into forest blank and degraded forest respectively. Further, about 290 acres of plantation was changed into mining activities. The land cover changes slows down in the year ranges between 1989 and 1996 when compared to the year ranges between 1986 and 1996.

Conclusion

Analysis of satellite data of different periods is very useful for assessing land unit and land use / land cover changes due to mining activity. The same information can be further utilized for development of better management plan. The impact of mining activities on Reserved Forest land itself is comes under 1365.23 acre. The spillover from the mining waste in the surrounding mining areas may have been polluted the surface and ground water. However, it needs further detail study.

References


