Abstract

Coal mining activities lead to geoenvironmental degradation in and around the coal mining area. An understanding of the behavior of environmental pollutants is required to minimize the environmental impacts of mining. An integrated approach of remote sensing techniques, geochemical investigations and geostatistical analysis on a geographic information system (GIS) platform, can provide additional valuable information on geoenvironmental degradation in the area. Such an integrated approach was adopted in the present study to assess the geoenvironmental degradation in Makum coalfield (MCF) in terms of mining induced land use/land cover changes, water and soil contamination.

Survey of India (SOI) Topographical Maps for the year 1954 and satellite images for the years 1976, 1988, 2001 and 2003 were used for analyzing time sequential land use/land cover changes in MCF influenced by the mining and other related activities. The study revealed a significant decrease (59.83%) in dense forest cover and a growth in tea gardens (70.56 %) contrary to the decrease in agricultural land (17.73 %) in the study area during the period 1954 to 2003. The area occupied by open cast mine showed a significant change from 6.80 ha in 1954 to 544.44 ha in the year 2003. The land use/land cover conversion matrix of MCF, generated using post classification change detection technique, was analyzed to assess the change in the areal extent of eleven land use/land cover classes occurred during the period 1988 to 2001. The analysis revealed that during 1988 to 2001, dense forest was converted to degraded forest (6891.06 ha.), tea garden (16.54 ha.), agricultural land (60.50 ha.), zhum cultivation (23.0 ha) and coal dumping areas (1.88 ha). During the same period, 1110.06 ha of degraded forest land were converted to tea gardens and 76.0 ha of dense forest and 132.42 ha of degraded forest were converted to open cast mines. The land use/land cover conversion matrix was further used to develop a land use/land cover conversion model that depicted the rate of land use/land cover conversion in MCF.

Water, soil and sediment pollution in MCF were investigated with the help of geochemical analysis. The water quality assessment revealed that mine water in MCF was significantly polluted with TDS (51.11- 632.4 ppm), Ca (52.49 – 423 ppm), Mg (918 – 4334 ppm) and phenol (0.28 – 3.0 ppm). Very low pH levels were observed in Sipijan (2.45 ± 0.64) and Hamukjan (3.65 ± 1.20) streams. Arsenic (As) was traced (0.01 -0.06 ppm) in mine water of MCF. Tirap mine water sample contained the maximum amount of Cr (0.104 ppm), Cu (0.053 ppm), Fe (267 ppm), Mn (2.0 ppm) and Ni (2.0 ppm) amongst all the mine water samples. Significant concentrations of Pb (0.048 – 0.83 ppm) and Zn (0.014-0.793 ppm) were also observed in mine water of MCF.

Chemical analysis of the soil of MCF was carried out to find out the heavy mineral concentration. Significant concentrations of Al (040 – 72.380mg/kg), As (0.01- 2.46 mg/kg), Cr (0.05 - 4.44 mg/kg), Fe (6.71 – 157.11 mg/kg), Hg (0.04 - 3.12 mg/kg) and Ni (0.08 – 6.04 mg/kg) were observed in Makum soil. It can be inferred that mining activities have greatly influenced the soil heavy metals concentrations in Makum soil. The sediment analysis revealed that the stream sediments were enriched with various heavy metals. Highly toxic heavy metals, like As (0.11- 5.32 mg/kg) and Hg (0.29-4.6 mg/kg) were observed in the stream sediments of MCF. The significant amount of heavy metals in the stream sediments of MCF revealed the alarming level of contamination of the sediments by the mining related activities.

Geostatistical modeling of Makum soil data set was carried out to understand the spatial variation of heavy metal content in the soil. Prediction maps were generated for analyzing the spatial variation of heavy metals in and around the MCF and then to identify the areas significantly affected by heavy metal pollution.

This present study shows that synergistic use of remote sensing, geochemical and geostatistical analysis tools on a GIS platform is useful for the assessment of geoenvironmental degradation in a polluted area.