2.1

IMPACT OF MINING ACTIVITIES AND SUPER THERMAL POWER STATIONS ON ENVIRONMENT

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INTRODUCTION

Mining and power generation are among the most important developmental activities after agriculture. The mining of mineral resources (whether by open-cast or underground methods) and thermal power generation have severe environmental implications, if proper planning and management strategies are not adopted. Magnitude of these impacts depends, to a large extent, on the existing environmental conditions and socio-economic status of the people. Monitoring of such areas at periodic intervals is required to take remedial measures for environmental conservation.

Satellite remote sensing has emerged as a powerful tool for inventorying and monitoring of natural resources and is gradually finding its use in monitoring ecological conditions at a macro scale. Now-a-day, the remote sensing based methodology for quick assessment and periodic monitoring of the impact of developmental activities like mining and thermal power stations on the environment is also gaining increasing importance.

OBJECTIVES

- Mapping and monitoring of the impact of mining and thermal power generation on forests and other land uses in the environs of thermal power complexes and mining sites at a scale of 1:50,000 using temporal satellite data,
- Mapping and monitoring the areas adversely affected by mining and power generation, and
- Exploring the possibility of detecting pollution of major rivers passing through the project sites.

STUDY AREA

Kudremukh (iron ore), Dehradun-Mussoorie (limestone mine belt) and Korba as well as Talcher (thermal power stations)

METHODOLOGY

Land sat MSS, Land sat TM and IRS-1A LISS-II sensors, Multidate data, False Colour Composites (FCCs) and Computer Compatible Tapes (CCTs) were used for visual and digital analyses. Base maps were prepared using Survey of India (SOI) topographical maps on 1:50,000 scale. In addition, collateral data such as meteorological, air and water quality, and literature were also used. In the case of digital analysis, various techniques were evaluated for their efficacy in detecting environmental changes, viz. image differencing, orthogonal transformations, image ratio and classification comparison, etc.

RESULTS/ OUTPUTS

Maps prepared for deciphering the environmental impact of mining and power generation included: (i) Land-cover maps for the period 1972-75, 1985 and 1988-89, (ii) Environmental change maps for all the project sites, (iii) Map of the area affected by fly ash deposition in the case of thermal power plants, (iv) Map showing active and abandoned mines, and (v) River course change map due to mining activities.

For Kudremukh Iron Ore mining area, image differencing was found as a more appropriate method, though in Talcher, orthogonal transformation (Principal Component Analysis, Kauth-Thomas Transformation) yielded better results. However, classification comparison method was not so useful due to overlapping signatures between different classes. It was observed that in Kudremukh, the forest area decreased by 10.8 % during 1973 to 1989, while grasslands increased by 2.8 % during the same period. The Bhadra River is highly polluted mainly due to tailing spill over and runoff during the rainy season. In Dehradun, forest area has decreased by 2.8 sq. km during 1972 to 1988. Some of the river courses have shown variations due to mining wastes and the debris brought by landslides. There is some regeneration of vegetation around the abandoned mines. In Korba, forest area has decreased by 25.2 % mainly near coal mines and due to lease given to power plants. Actual mining area has increased from 0.40 sq. km to 8.84 sq. km. Deposition of fly ash and coal dust have affected about 844.90 sq. km area as per December 1988 imagery. The Hasdo River is getting more and more polluted mainly due to the turbid waters of ash pond on the Ahiran River. In Talcher, due to mining activities and thermal power generation, forest area has decreased by 34 % during the period 1975 to 1989. The area under fly ash deposition has increased from 25 sq. km in 1979 to 117 sq. km in 1987. The Brahmani River is highly polluted as effluents of Talcher Thermal Power Station (TTPS) and other industries are getting into its water through Nandira Jhor, which is a biologically dead stream.

2.2

REMOTE SENSING APPLICATION IN MONITORING ENVIRONMENTAL IMPACT OF MINES IN JHARIA RANIGANJ COAL BELT, INDIA

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INTRODUCTION

Mining activity, wherein the land is used temporarily for the exploitation of mineral wealth, is one of the major causes for the degradation of environment, and it becomes more serious if it is open cast mining. Coal mining takes a huge toll on the ecology and its operations cause more severe impact on environment due to dumping of solid waste, coal from mines, dumping of mill tailings, generated from mineral beneficiation plants, and indiscriminate disposal of waste materials from coal washeries and smelter plants. In India, considering the present and expected demand of energy, and the increasing cost of liquid fuel, more and more exploitation of coal, particularly from areas like Jharia Raniganj coal belt, is envisaged by way of highly mechanized open cast and underground mining operations. Satellite based remote sensing has emerged as an excellent tool for pre-survey, planning and monitoring of mining activity and for finding its impact on land, water and air. In addition, its ability to sense beyond visible region of electromagnetic spectrum, such as sensing in thermal region, can delineate zone of coal mining fire and spread of plumes (smoke) from power plants and discharge of hot effluents in water stream.

OBJECTIVES

- Assessing the impact of long-term mining on the environment and land use in the study area, and
- Establishing the applicability of remote sensing technique in monitoring impacts due to coal mining and related operations.

STUDY AREA

Jharia-Raniganj coal belt of India. The Jharia coal belt is located at latitude North 23° 37' to 23° 50' and longitude East 86° 8' to 86° 30') in Dhanbad district of Bihar (480 sq. km), while the Raniganj coal belt is located at latitude North 23° 30' to 23° 55' and longitude East 86° 40' to 87° 25' and is spread over six districts, viz. Burdwan, Birbhum, Purulia and Bankura of West Bengal state and Dhanbad and Santhal Paragana districts of Jharkhand state (600 sq. km).

METHODOLOGY

Changes in land use/land cover since 1925 for three time periods i.e. 1925-27, 1973-75 and 1988-89 were studied using photoproducts and digital data of various satellites, including LANDSAT MSS, TM, IRS-1A LISS-I and LISS-II SPOT PAN and multispectral data besides black and white aerial photos on 1:50,000 scale and Survey of India (SoI) toposheets as collateral data. Such data was used to register the image and was further validated by the field observations.

RESULTS/ OUTPUTS

It was observed that due to coal mining operations, the environmental conditions of Jharia coal belt have degraded and in the Raniganj coal belt, the conditions are fast deteriorating since the nationalization of mining industry.

Jharia Coal Field : In the Jharia coal belt, land-use change statistics showed that the degradation of environment was at an alarming stage as: (i) nearly 60% of total land area has been damaged due to subsidence, fire, mining voids, and dumping of waste materials and conditions are further deteriorating at a fast rate with increasing mining operations, (ii) forest cover in the region has almost disappeared, the scrub vegetation is showing stunted growth, and area is covered by falling rock and coal dust, indicating environmental degradation to such an extent that it has become difficult even for the plants to survive, (iii) growth of settlement within the study area has taken the shape of a slum and needs to be rehabilitated in an organized manner on upland region, (iv) Damodar river, the only major source of water in the area, has been polluted to the extent that its the treatment has become a must before supplying for domestic use. Similarly, water in the existing ponds/tanks has also become unfit for drinking and pisciculture. However, local people use pond water for bathing and irrigation purposes, (v) shallow and deep borewells form the major sources of drinking water in the region, and (vi) civil infrastructure facilities are overloaded and are in dilapidated conditions.

Raniganj Coal Field: In the Raniganj coal belt, though presently, the environmental conditions are not so alarming, but if immediate attention is not paid, these will reach a critical point. The environmental conditions have been enumerated as: (i) the total landscape is dominated mainly by scrub and fallow land, with only 2-3% of area under forest, (ii) built-up land has grown by about one and a half times that of the area occupied in 1975, i.e. at an annual growth rate of 6%, (iii) degradation of land has taken place mainly due to subsidence, fire and dumping of waste materials. Development of cracks and subsidence causing damage to surface settlements is not an uncommon phenomenon in this region. Therefore, old abandoned mines, both open cast and underground, have created a sense of fear in the minds of local inhabitants, and (iv) pumping of huge amount of water from various horizons of mine has caused lowering of local groundwater level.

It is evident that 50% of the total area of Jharia coal field is derelict, whereas it is only 10% of the total area in Raniganj coal field.

STUDY ON IMPACT OF INDUSTRIALIZATION IN URBAN AND RURAL ENVIRONMENT IN MADRAS METROPOLITAN AREA

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INTRODUCTION

Madras, the fourth largest metropolitan city of India, according to the 1981 Census, had 4.28 million people in its urban agglomeration (531 sq. km), which included 3.27 million people living in the Madras City (172 sq. km). The Madras Metropolitan Area (MMA) extends over 1,167 sq. km, including Madras urban agglomeration and a large number of villages. The Madras urban agglomeration experienced an annual population growth rate of 3.04% during 1971-81. Expansion of the manufacturing sector is a major reason behind the rapid population growth in Madras during the past four decades. As the city grew in importance, growth occurred along its radial roads and railway lines, assimilating the existing small independent settlements in the process. Infillings between the radial developments also followed.

OBJECTIVES

Identifying locations of major industries and direction of urban expansion in the Madras Metropolitan Area (MMA) along with the delineation of major land uses with emphasis on industrial activities

STUDY AREA

Madras Metropolitan Area (MMA), located in south India.

METHODOLOGY

Study was based on LANDSAT TM, SPOT (MLA), IRS-1A (LISS-II) data products and aerial photographs. Satellite data products were used to generate land-use maps and were obtained as computer out-puts for the study area. Two sets of maps were obtained for 1986 and 1988, showing identified built-up areas, industrial locations and other uses. Visual interpretations of FCCs of 1986 and 1988 were also used for the preparation of land-use maps, while aerial photographs were used for the preparation of land-use maps of 1976 Manali and Guindy industrial areas. Madras seacoast, which is subjected to erosion and accretion, was analysed with the help of LANDSAT FCC 1986 and topographical map of 1969. Visual interpretation of the satellite imagery was done to identify broad categories of land uses in the metropolitan context.

RESULTS/ OUTPUTS

As land-uses were seen to be mixed in nature, exhibiting heterogeneity in character, much of the detailed land-use information required for planning studies could not be made. However, the maps were produced showing certain basic information like alignment of roads, canals, location of important landmarks, major water bodies, continuous tracks of forest areas, agricultural lands, etc.

Land-use maps of Madras Metropolitan Area (MMA), prepared based on the field studies conducted in 1974, were compared with land use maps prepared by adopting visual interpretation techniques on satellite images of 1986 and 1988 and changes were detected. This showed expansion of urban limits within the MMA, which had taken place, mainly along the transport corridors.

The coast near the Ennore creek was subjected to accretion. Erosion in Tiruvottiyur-Royapuram stretch was seen for a long stretch in the north of the harbour. Marine is a zone of accretion. The zone lying south of the Adyar estuary is characterized by erosion.

Direction and extent of urban expansion within the Madras Metropolitan Area (MMA) could have been studied, provided satellite products over a longer period, say one or two decades, were made available. Since the data products available were pertaining to the years 1986 and 1988, the two reference periods being placed closely, changes occurring in urban features could not come out clearly. Getting cloud-free satellite data for Madras Metropolitan Area (MMA) was a serious problem. Since Madras happens to be on the seacoast, it is subjected to the influences of monsoon variations. High-resolution satellite images may help in generating better quality outputs. Digital processing of satellite data in VAX 11/780 system had to rely much on data inputs provided, based on the ground truth details. Spectral characteristics of various materials, when used as the main basis for extracting information about land-use developments, faced many problems. Difficulties were also experienced in differentiating sandy areas from buildings with asbestos roofs or agricultural lands from new residential areas with buildings surrounded by trees. In the visual analysis, pattern of development is recognized as an important input for land use identification. Unfortunately, it could not be built into the computer programme used to identify the land uses.

2.4

CHANGES IN LAND USE BECAUSE OF URBAN SPREAD AND INDUSTRIALIZATION IN AHMEDABAD - VAPI REGION

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INTRODUCTION

Gujarat, due to its various topographic, soil and climatic regimes, boasts of immense variety in its floral and faunal wealth. The expansive estuaries and the gulfs support a variety of animal and plant forms. Unfortunately, all these ecosystems, are under great stress and facing ecological disaster due to disproportional growth of industry in the state. Discovery of oil and establishment of its refining facilities, industrial congestion in the Bombay zone, electrification of broad-gauge railway line between Bombay and Ahmedabad, widening and excellent maintenance of National Highway No.8 have all contributed to the gigantic industrial growth between Ahmedabad and Vapi region in the Gujarat state.

The total number of all sizes of industries in Gujarat stood at around 80,000 as on 31 March 1988. About 90% of these industrial units exist in Ahmedabad-Vapi region. The spread of industrialization, followed by urbanization has encroached the most fertile alluvial soils of Gujarat. These activities have further resulted into a variety of problems like deforestation, followed by soil erosion (enhancing the process of ravine formation along the rivers and nalas), waterlogging, salinization of soils, air pollution and water pollution.

OBJECTIVES

To assess the impact of massive industrialization followed by urbanization in the Vapi-Ahmedabad region, on the land use pattern and its subsequent influence on various ecosystems of the region.

STUDY AREA

Ahmedabad-Vapi region, i.e. 20,000 sq. km on either side of the National Highway No. 8 and Ahmedabad-Bombay railway line.

METHODOLOGY

Ten land-use classes were delineated for preparing land-use maps for two time- frames. Interpretation keys were developed by taking extensive field visits and detailed ground truthing.

RESULTS / OUTPUTS

The land-use classification figures indicated that nearly 75% of the total study area was covered by agricultural land. Due to industrialization, followed by urbanization, this fertile land was encroached to the tune of 441.61 sq. km from 1975- to 1986-88. Population increased by 68% during the study period in this region. Disproportional growth of population has put tremendous pressure on various natural resources, resulting in the degradation of almost all ecosystems of the region. In totality, considerable increase in salinity-affected areas (28.09 sq. km), urban area (441.61 sq. km), blanks (172.28 sq. km), ravines (122.03 sq. km), and area occupied by villages (69.33 sq. km) was seen. At the same time, decline was observed in forest land (67.76 sq. km), mudflats (67.56 sq. km), orchards (371.67 sq. km) and agricultural land (354.48 sq. km). This showed degrading pattern in almost every ecosystem, whereas no improvement or maintenance pattern was observed in any ecosystem under consideration. Marked increase in these areas was observed at Aliabet, where Narmada meets the sea and similarly at the mouth of Mahi River. At Aliabet, disappearance of forests gave rise to saline areas, whereas at the mouth of Mahi River, mudflats were converted into saline areas. This degradation has been attributed to biotic interference by man, who has cleared tree growth occurring in this area, to meet his fuel wood requirements. Increase in industrialization has mainly taken place in 12 major cities/towns, viz. Ahmedabad, Nadiad, Anand, Baroda, Bharuch, Ankleswar, Kosamba, Surat, Bardoli, Navsari, Valsad and Vapi. This industrialization has encroached the most fertile agricultural land. This essentially means that 37,900 ha area was converted into uncultivable land forever, resulting in the total loss of vegetation growing in these areas. In addition, this has put additional pressure on the adjoining vegetated areas, further degrading them ecologically. Area occupied by this class during 1975 was 33.062 sq. km, which increased to 205.341 sq. km during 1986. The increase of 172.279 sq. km area was mainly due to decrease in the forest area in Dharampur and Vyara forests, orchards converting into blanks near Navsari and at places, blanks appeared in the agricultural land as well. These blanks were mainly around Ahmedabad, Kheda, Anand, Baroda and Bharuch. A majority of these areas was observed at the periphery of forestland and in orchard areas. Area under ravines increased from the year 1975 to 1986 along with almost all the rivers, namely Sabarmati, Khari, Meshna, Vatrak, Mahi, Narmada, Tapi, Par and Daman Ganga. The increase of 122 sq. km during a span of 11 years was due to the loss of tree growth along river blanks, which may be due to increase in population and clearance of tree growth by the people to meet their energy needs.

In the study area, forests occupy hardly 415 sq. km (2.80%), which is subjected to tremendous pressure from people as well as cattle and from 1975 to 1986, there was a decrease of 67.76 sq. km in its area which indicates that the social forestry programmes did not prove effective and needed more efforts to stabilize as well as to increase area under forests. Area decreased under mudflats by 67.56 sq. km from 1975 to 1986 and this decrease was due to conversion of mudflat areas into saline areas and at places into forests, where *Prosopis juliflora* occupied mudflats at Mahi mouth and Aliabet. Area under orchards in the Kheda and Bulsar district decreased to the extent of 371 sq. km. Orchards were converted mainly into agricultural land and at places into blanks. Agricultural land (about 510 sq. km) was lost under urban and villages spread and some portions of agricultural land became barren.

ENVIRONMENTAL IMPACT OF IRON ORE MINING IN GOA THROUGH REMOTE SENSING

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INTRODUCTION

Remote sensing, particularly satellite remote sensing, due to its capability for repetitive digital multispectral imaging of large areas at low cost, plays an important role in environmental impact assessment. This may be successfully applied prior to mining, monitoring the distribution and changes in the areas of different activities during mining and the evaluation of restoration success and landscape quality after mining. The important environmental problems associated with mining in Goa are lessening of forest cover, deterioration of agricultural fields and soil degradation, siltation of streams and depletion of groundwater.

OBJECTIVES

To assess the impact of open cast iron ore mining in Goa on land and water regimes with the aid of remote sensing data analysis.

STUDY AREA

Goa

METHODOLOGY

Land-use/land-cover maps for six toposheets covering study area were prepared using temporal satellite data sets, including MSS 1981, 1984, TM 1986, 1987, SPOT 1989 and IRS 1989. In addition, aerial photographs of 1973 and 1978 covering the major mine blocks were also used in land-use/land-cover map preparation. Three windows were considered for aerial measurement of various land-use/land-cover categories, due to the incomplete coverage of aerial photographs. The first window measuring 992 sq. km encompassed five mine blocks and the temporal data considered included the satellite remote sensing data ranging from 1981 to 1989.

Windows 2 and 3 corresponded to the Bicholim and Pale mine blocks, respectively. For temporal analysis, aerial photograph of 1978 and satellite images of 1981, 1984, 1987 and 1989 were used in the case of window 2 and in the case of window 3, aerial photographs of 1973, 1978 and satellite images of 1981, 1984, 1987 and 1989 were considered.

The digital analysis was carried out for select sub-scenes 1024 x 1024 size, representing various mine blocks. The digital techniques employed were supervised classification using maximum likelihood method, Normalized Difference Vegetation Index (NDVI), Tasseled Cap Transformation Brightness and Greenness Index and Band ratioing.

Supervised classification techniques had helped in bringing out eight land-use/land-cover categories. In addition, built-up area was easily recognized in SPOT and TM images and with some difficulty, in IRS 1A image and not at all in the case of MSS. With the help of overlaying techniques, TM and SPOT classified images were co-registered to bring out temporal changes. However, this exercise was not extended to IRS and MSS, but MSS 1981 and 1989 data could be easily co-registered and the temporal changes for the eight-year duration were clearly brought out.

The NDVI images were generated using MSS, TM, IRS and SPOT data. However, temporal analysis was attempted only in the case of 1981 and 1989 MSS data, as these belonged to the same sensor. Techniques for normalizing temporal data sets were employed only for data sets of the same sensor and not for the multi-sensor temporal data sets. For this purpose, normalization techniques based on mean and standard deviation were used and the normalized data sets were subjected to NDVI and image differencing.

Normalization of MSS 1981 and MSS 1989 data was carried out using mean and standard deviation method. Using this normalized data, NDVI images were generated and map showing vegetation density change information was obtained through image differencing. This map had five classes of which two correlated to the degradation of vegetation and the other two related to newly cultivated or afforested regions, while one class showed no change in vegetation.

For Tasseled Cap Transformation, the co-efficients used were taken from the available published literature for LANDSAT MSS and TM. For IRS, co-efficients worked out by the scientists of Space Applications Centre (SAC), Ahmedabad, were adopted. Using these co-efficients, brightness and greenness of images did not reveal much of the ground information, as it looked noisy. The greenness of image showed different vigours of natural and cultivated vegetation.

To analyze siltation of streams around the mines, TM, SPOT and IRS data were considered because of their better spatial resolution. Optimum band ratio image pertaining to water bodies alone was generated. To carry out quantitative analysis, soil, groundwater, surface water and pit water samples were collected for two seasons, viz. April 1990 and December 1990. Major elements, viz. Na, Mg, Al, Si, P, K, Ca, etc. and trace elements, viz. Pb, Ni, Cr, Co, and Zn were analyzed for soil samples. Groundwater samples were analyzed for pH, conductivity, turbidity, depth of water column, COD, alkalinity, hardness, Na, Ca, Mg, K, Pb, Zn, Ni, Co and Cr. Surface water samples were analyzed for Pb, Ni, Cr, Co, Zn, Na, Ca, Mg, K, Fe and Mn. Physical parameters such as pH, conductivity, turbidity and TSS value were determined for pit water samples. The data for chemical and physical parameters for all the samples were statistically analyzed using factor, cluster, discriminate, canonical correlation analyses and regression analysis.

RESULTS / OUTPUTS

The land-use/land-cover units demarcated were: mine zone (pit, open area, tailing pond); agricultural zone (standing crop, fallow land); surface water body (river, lake, mudflat), vegetation (dense, moderate, sparse, open scrub/barren land) and built-up land beach sand. The temporal data analysis for the first window indicated a significant increase in the spread of mining and built-up land categories at the cost of vegetation and agricultural zones during the past eight years, from 1981 to 1989. A comparison between 2nd and 3rd blocks revealed that the rate of increase of mine area was more pronounced in the Pale block,while the rate of increase of built-up land was quite significant in the Bicholim block. However, thick vegetation had declined marginally in both the cases. The spread of moderate vegetation had marginally improved in the Bicholim block while there was a significant loss of moderate vegetation in the Pale block. Agricultural zone and sparse vegetation registered a decrease in both the blocks, while open scrub/barren land had increased.

The classes in the increasing order of their chlorophyll content as shown by NDVI image, were surface water/marshy land, mine and related area, open scrub/barren land/fallow land, built-up area, moderate vegetation, dense vegetation and standing crops. Various band ratio combinations were tried and found that Band 1/Band 3 or SPOT and Band 1/Band 4 of TM and IRS gave encouraging results. Three qualitative levels were identified in the classified map for the study area, namely shallow water, deep water and turbid water. Because of the spatial resolution of the data used and narrow width of the streams, more detailed work could not be attempted.

Oxygen isotope studies carried out for the pit water and well water samples of the Pale-Surla-Velge area indicated that the mine pit water and the groundwater in the wells were not hydrologically connected. This is in conformity with the findings of Central Ground Water Board (CGWB). However, some local effects were reported from the Bicholim block. Hence, the effect of pumping of mine pit water on the well water was localized and marginal. Leopold Matrix method was carried out to quantify different environment parameters. A 10 x 14 matrix was established considering different project actions and parameters. It was seen that among the project actions, surface excavations, surface transport, pumping of mine pit water and solid waste disposal had highest contribution for the environmental change. Among environmental parameters, soils, landforms, groundwater, surface water and flora were affected more due to mining activities.

From the discriminant analysis of soil samples, it was seen that there was a fairly large variation in chemical components from mining to non-mining area. R-mode factor analysis of soil chemical data suggested the dominance of clay minerals derived from the overburdens nearer to the mining area. The distribution of Fe and Mn in agricultural soil as generally high in near mining area. The Pb, Cr and Ni content in soil was high in the active mining area as well as near highway, which was revealed from the factor score maps. Also observed from the factor score maps of water samples was the moderate dominance of Pb-Ni content in the wells nearer to active mine area and highway. From the canonical correlation analysis of soil samples, it was seen that Fe-Al-Si coming from overburden dumps were dominated in the East-West and North-East direction. From the statistical analysis of groundwater, the area was divided into 6 groundwater zones during pre-monsoon period, viz. (i) dominance of coastal water, (ii) high turbidity zone, (iii) vehicular exhaust, (iv) high depth of water column, (v) high hardness zone, and (vi) estuarine intrusion. Out of these 6 zones, three zones viz. zones ii, iii, and iv could be correlated to the mining activity. From the discriminant analysis of ground water and pit water, 15% similarities in composition were reported.

Detailed information collected from 20 working mines in a required format was used to create a relational database. The entire data were stored in 4 files, as (i) general information; (ii) physiographic data; (iii) geology and mining data; and (iv) environmental data. This database, if intersected properly with GIS, can be effectively used for the environmental management planning of mines. Mine leases map of Goa were digitized .On these leases maps, information like areas under active mining and maps with other detailed information were prepared. GIS techniques were used to overlay temporal land-use/land-cover raster maps and bring out readily change detection maps. This exercise was carried out for two mine blocks. Change detection maps showed quantitative decrease affected in the vegetation and agricultural zones due to the expansion of mining and built-up lands.

Temporal analysis of visually interpreted land-use/land-cover maps, based on aerial photographs of 1973, 1978 and satellite images of 1981, 1984, 1987 and 1989, revealed the increase in the spread of mining area and built-up land at the expense of vegetation cover over the past sixteen years. Supervised classification helped to get information related to land-use/land-cover features. NDVI and Greenness Index images also provided land-use/land-cover information, however based on vegetation vigour. Resultant image generated through NDVI differencing based on MSS 1981 and 1989 images, brought out the changes in vegetation density over a large area. It could be appreciated from this image, that more areas showing maximum depletion in vegetation cover were seen in the vicinity of mining areas.

Band ratioing of TM, IRS 1& 4 and SPOT 1 &3 helped in identifying three different zones in the Mandovi River, viz. deep water, shallow water and turbid water. However, it did not show the siltation zones close to the processing plants on the bank of the Mandovi River. This could be due to the fact that these siltation zones were very small, localized and isolated. Further, because of the rapid flow of the river, the dispersion of silt was quite fast and dilution took place quickly.

2.6

REMOTE SENSING STUDIES ON ENVIRONMENTAL IMPACT OF MINING BAUXITE & CHROMITE IN EAST COAST AREA

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INTRODUCTION

Environment, howsoever vast it may be in quantity, is a non-renewable and non-replenishable resource. Multifaceted and multiple drawls lead to impoverishment of the plethoric storehouse in the environment. The Eastern Ghats have witnessed a number of mineral epochs. The deposits of chromites, graphite, kyanite, mica, manganese, gem stones and bauxite are genetically related to the Eastern Ghats. As usual, the Eastern Ghats constitute a high level of bauxite deposits. The dissected plateau with low sloping plains on top of some of the higher peaks serves as suitable loci for bauxite formation. The Panchpatmali and the Gandhamardan constitute the largest bauxite deposits of Asia. The mining operations in the area cause an adverse impact on the site and surroundings.

OBJECTIVES

To assess the environmental impact of bauxite and chromate mining in the Eastern Ghats

STUDY AREA

Eastern Ghats, particularly, Panchpatmali plateau, Gandhamardan bauxite deposit and Sukinda chromites belt. The Panchpatmali plateau is located between latitudes 18° and 18°55′ North and longitudes 82°57′ and 83°30′ East and is featured in Survey of India (SOI) toposheets No. 65 J/13 and 65 N/1. Gandhamardan bauxite deposit in Gandhamardan plateau is the second largest deposit in the country. It lies between 20°50′ - 20°55′ North and 80°53′30″-82°45′ East. Sukinda chromites belt comes under Survey of India (SOI) toposheets nos. 73 G/12, 16 and 73 H/9 and 13 having latitude 20°57′-21°5′ North and longitude 85°40′-85°35′ East.

METHODOLOGY

The data about meteorology, soil, vegetation, socio-economic status, land-use/land-cover, other literature and maps, etc. were collected from various organizations/institutions. Water samples were collected from the selected sites during summer, monsoon, post-monsoon and winter seasons. Air and dust sampling was taken up by NALCO in the mining area. Besides, studies on the noise level, vibration and blasting were undertaken at the sites. Detailed data collection on various plant species was also undertaken.

The study is based on the satellite data of IRS-IA FCC of October and December, 1989, Landsat MSS imagery of bands 5 & 7 of October 1975 at 1:250,000 scale, Thematic Mapper FCC of October 1975 at 1:50,000 scale, and IRS-IA FCC transparency of October 1985 and December 1991. These data were interpreted visually for generation of various thematic maps at 1:50,000 scale. These included geological map, geomorphological map, geohydrological map and land-use map. An interpretation key was prepared for the purpose of land-use mapping. These maps were verified on the ground for necessary correction and modification.

RESULTS/ OUTPUTS

The study has indicated the danger of water pollution in the Panchpatmali plateau, which includes surface run-off and groundwater contamination. It was observed that in view of the higher altitude of the windy and open plateau, the repercussions of the noise may not be very seriously affecting the villages at the hill base. In mines, care has been taken to use the overburden in reclamation process. Therefore, these was nil or minimum impact during dry season while loading and unloading and transportation to the reclamation point. There are more than 47 springs around the plateau. Owing to their water saturated for longer periods, this water in course of time will be affected by certain chemical reactions and would be contaminated. Mining operations in the Gandhamardan bauxite deposit have been taken over by Bharat Aluminum Company (BALCO) which has formulated action plans of the management of environment on various themes. Mining operations would proceed in phase taking 2-3 ha at a time. Due to afforestation, adverse impact on the forest growth would be minimized. Land after mining will be backfilled with overburden systematically, sequentially graded, compacted and finally topped with subsoil and soil. In Sukinda chromites belt, although environmental parameters of air, water and noise were found within the tolerance limits at present, these would surely lead to worsening the situation. The Damsal nala is the main target of water pollution by way of sporadic and unsystematic dumping of overburden on the banks and discharging of the effluent directly from the dewatering process in the mines. Conversion process of chromites into hexavalent component posses a threatening situation for human beings.

2.7

IMPACT OF INDUSTRIALIZATION ON ENVIRONMENT IN INDORE-DEWAS-UJJAIN REGION OF MADHYA PRADESH

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INTRODUCTION

Undoubtedly, the industrial areas and associated urban complexes are important for economic development, but are also dangerous for environment. In the absence of proper planning and policy, such areas adversely affect both natural and human activities. Therefore, the planning is necessary for monitoring the growth of urban and industrial areas. To this, a lot of inputs are required, for which scientific and systematic studies are needed.

OBJECTIVES

To establish a methodology for identifying the impact of industrialization and urbanization on environment which could be applied to other comparable areas facing similar type of problems related to environmental degradation.

STUDY AREA

Indore-Dewas-Ujjain region, which lies on the Malwa plateau of the Central India and covers approximately 6,400 sq. km Geographically, it is located between 22° 15' to 23° 40' East latitude and 75° 15' to 76°50' North longitude.

METHODOLOGY

Both remote sensing as well as collateral data were used. The remotely sensed data included Landsat MSS FCC of 157-44 Path- Row dated 2-3-1973 and Landsat TM FCC of 146-44, Path Row dated 29-10-1987 and 2-2-1988. The SPOT FCC of Path-Row 207-305 dated 7-11-1988 and 208-305 Path-Rows as well as 207-305 Path-Rows and 208-305 Path-Rows dated 24-1-1989.Besides Landsat TM CCT of 157-44 Path-Rows dated 2-3-1973 and 146-44 Path-Rows dated 29-10-1987 and 146-44 Path-Row of 2-2-1988 were used followed by ground truth and field verification.

Collateral data included Survey of India (SoI) topo sheets on 1:50,000 and 1:250,000 scales and forest atlas of National Atlas and Thematic Mapping Organization (NATMO).

To detect the temporal changes in land-use/land-cover and environmental status, the data of 1973 and 1988 were compared. Similarly, data of 1988 to 1989 were also compared for more information. Accordingly, total 33 maps were prepared and parallel to these themes, wasteland mapping was also done.

RESULTS / OUTPUTS

Various changes were noticed with the help of temporal data. For example, a sudden increase in the built-up area was quite prominent as change was observed from 67.47 sq. km to 88.55 sq. km during 1973 to 1988. The rate of urbanization was much faster from 1988 to 1989. Deforestation was observed more in early 1970s. Area of closed forests was reduced from 271.8 sq. km to 175.95 sq. km, while that of degraded forests increased from 51.2 sq. km to 122.69 sq. km during1973 to 1988. Mining activities in the urban peripheral areas have grown very fast and occupied 0.3 sq. km to 2.1 sq. km area. The total area of water bodies had decreased because of siltation, sedimentation and lowering of water table and had come down to 50.00 sq. km from 55.65 sq. km, while it should have increased because of rising demand for water.

The wasteland mapping indicated an increase in the upland area from 417 sq. km to 582 sq. km and gullied/ravenous land from 59.3 sq. km to 70 sq. km. It was remarkable to notice that wasteland area was decreasing in the past two-three years, because of the advancement in agricultural technology, application of huge machines and improved hybrid seeds available to convert the "Padat Bhumi" into a good agricultural land.

An attempt was made to assess the effects of air pollution on plant foliage and surface water bodies. It was observed in the field that there is some permanent plant foliage in the southern and southeastern parts of the study area. But, these phenomena could not be picked up by visual and/or digital analysis of the satellite data

2.8

STUDY ON ENVIRONMENTAL IMPACT OF IRON ORE MINING IN BAILADILLA, BASTAR DISTRICT, MADHYA PRADESH THROUGH REMOTE SENSING

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INTRODUCTION

Satellite remote sensing can play an important role in understanding the impact of mining, as it has the capability for repetitive digital multispectral imaging of large areas at low cost. Remote sensing can contribute to environmental impact assessment (EIA) prior to mining, monitoring the distribution and change in the area of different activities during mining and evaluation of restoration success and landscape quality after mining.

OBJECTIVES

To study the dynamic changes occurring in the terrain conditions, land-use/land-cover pattern and surface drainage pollution due to open cast iron ore mining in Bailadilla using remote sensing techniques and thus develop a methodology to effectively monitor these changes.

STUDY AREA

Area located at 18°30′ and 19° North and 81° and 81°30′ East and falling in Survey of India (SOI) toposheet Nos. 65 F/1, 2, 5 and 6. It is the south central part of Bastar district in Chattisgarh, covering a geographical area of 3,000 sq. km.

METHODOLOGY

The forest cover maps of Bailadilla ridge were prepared using LANDSAT MSS of 1984 and LANDSAT TM of 1986 imageries for undertaking temporal analysis of these data and to assess the changes in the extent of closed forest category as well as the area of degraded forest. To appreciate the direct impact of mining on land-use/land-cover patterns, and also the temporal change before and after the commencement of the mining activity, the maps were prepared for the region encompassing 2.5 km and 5 km radius area around Kirandul mine (deposit 14 & 11 C) and Bacheli mine (deposit 5) using the aerial photographs of December, 1966-January, 1967 and the satellite data of LANDSAT MSS of 1984, LANDSAT TM of 1986 and IRS of 1989.

Band ratioing techniques involving SPOT of 1988 Band 1 and Band 3 were used to highlight only the mine-related areas. Band ratioing, followed by Density Slicing that helped in identifying different working, and non-working iron ore deposits and also the fine ore dump, stock pile and abandoned tailing dam. This was found useful to accurately evaluate the spread of mine-related activities in the region. Temporal analysis of first set of satellite data have limitations due to leaf shedding of trees and crop harvesting during this period. Hence, there was a need of considering the second data set for temporal analysis, covering the entire study area of 3000 sq. km.

RESULTS / OUTPUTS

Significant increase in the extent of agricultural land and marginal increases in the case of mine-related area, built-up land, open forest, degraded forest, forest blank and forest plantation were revealed during the period 1984 to 1989. There was a marked decline in the spread of closed forest, open land with or without scrub registered a minor decrease and within 2.5 km radius in Kirandul mine area. Agricultural land was observed between 1966 and 1989, closed forest and forest blank declined significantly between 1966 and 1989, resulting in the increase of open/degraded forest mine area, built-up land and others. Agricultural land had gone up appreciably, indicating that shifting cultivation had contributed along with mining activity to the diminution of closed forest within the 5 km radius in Bacheli mine. Closed forest reduced significantly mainly due to the mining activities and related forest degradation within 5 km radius in Bacheli mine area. There was a slight increase in agricultural land between 1966 and 1989, but closed forest declined significantly. From this, it is evident that the influence of Bacheli mine activity extended well beyond 2.5 km radius. It was observed that land use/land cover transformations around Kirandul and Bacheli mines have taken place during the initial years of mining, as large changes during 1984 to 1989 have not been noticed. Numerous locations were demarcated on LANDSAT TM and SPOT imagery as potential destabilized slopes and erosional areas. These were identified on the basis of their bright grey colour on the slopes and escarpments of the hills. Destabilization occurred mostly in contour levels between 900 and 1,000 metres. Open forest remained without much changes. Information provided by satellite data for the identification of destabilized slopes was limited due to the isolated occurrence of these features.

As a result of wet screening and washing of ore, the discharges from the plant contain higher amounts of suspended solids. This and slimes generated from fine ore dumps and rain washings cause turbidity in the Kirandul and Bacheli Nala flows. The water analysis revealed that the water with effluents from Kirandul and Bacheli Nalas had moderately high values of TDS, and turbidity; however, this effluent water could be considered as pollutant-free as far as raw water standard is concerned.

Both visual and digital analyses of satellite data helped in the identification and delineation of drainage, fine ore dumps stockpiles, tailing dams and screening plants. These maps were found useful in understanding the impact of mining on surface water. Satellite imagery also helped in identifying Kirandul Nala carrying iron rich suspended solids appearing darker on the imagery. However, the narrow width of the stream and vegetation along this created hindrance in picking up the stream throughout its length on satellite imagery. Scale of imagery and coarser resolution of satellite data imposed limitations on the identification and delineation of surface water regimes with suspended solids.

Supervised classification techniques helped to bring out 6 land use/land cover categories, viz. (i) closed forest, (ii) open forest, (iii) degraded forest, (iv) mine and related area, (v) crop land, and (vi) upland with scrub. Temporal analysis of supervised classification land use/land cover images of LANDSAT TM of 1986 and SPOT of 1988 was carried out. This analysis revealed a decrease in closed and open forest area accompanied by the increase in the spread of degraded forest and mine area.

Normalized Difference Vegetation Index (NDVI) images showed different classes such as mining area, fallow land and upland with scrub, degraded forest, open forest and closed forest in the increasing order of Vegetation Index. Cropland did not appear as a separate class, as it got mixed up with open forest. Tasseled Cap Transformation Greenness indices were computed for IRS data based on the co-efficient provided by Space Applications Centre (SAC), Ahmedabad. This process helped to classify 4 categories based on vegetation vigour, viz. (i) non vegetated area, (ii) degraded forest, (iii) open forest, and (iv) closed forest. Cropland got mixed with the open forest.

ENVIRONMENTAL IMPACT OF COASTAL WETLANDS OF VEDARANYAM

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INTRODUCTION

The coastal wetlands of Vedaranyam, particularly wetlands in Serttalaikadu and Mullippallam creek, play an important role; hence, studying environmental impact of these wetlands is of great importance.

OBJECTIVES

- To understand the status of environment of the wetlands in the Vedaranyam area by using remote sensing techniques,
- To make inventory of mangrove vegetation,
- To study the ecological status of forest in the coastal zone,
- To map the wetlands of Vedaranyam coast with special emphasis on erosion as well as deposition trends, and
- To study the impact of salt industries in the area.

STUDY AREA

Coastal Wetlands of Vedaranyam

METHODOLOGY

Remotely sensed aerial 1 satellite data products were used. The aerial remote sensing data included Black & White Photographs, while satellite remote sensing data included False Colour Composites (FCCs) and Computer Compatible Tapes (CCTs) of Thematic Mapper (TM) and SPOT satellites. The ancillary data such as rainfall, temperature, humidity, crops grown, agricultural practices followed, forest types, flora, fauna and statistics on population, fish production, industries, livestock and the details about drainage and other irrigation projects in the study area were collected from the various state and central government departments. The data were interpreted and analyzed and various wetland categories were determined. The Survey of India (SOI) topographic sheets were used to prepare base maps for superimposing the remotely sensed data for temporal studies.

A wetland morphology map of the study area was prepared by visual interpretation of the 1:40,000 aerial photographs pertaining to the year 1976-1977. Another wetland morphology map for the year 1986 was also prepared using TM FCC of 1:250,000 scale to study the overall sceneries of the Vedaranyam area in the Cauvery delta.

To compare the latest land-use changes one more land-use map for the year 1989 was prepared from the SPOT FCC. Digital analysis was carried out using TM CCT for the year 1989 by VAX 11/780 computer system. This kind of analysis was found more useful to bring out the additional information as compared to the visual interpretation. A change detection map was prepared for the periods 1976 and 1989 and the changes were studied integrating remote sensing and other ancillary field data responsible for the environmental impact on coastal wetlands of Vedaranyam.

RESULTS / OUTPUTS

About 40% of the mangrove forests have been reduced due to indiscriminate cutting of woods for fuel and other human activities like fishing. Nearly 32% of the area of salt pan hadincreased at the expense of mangrove forest to a great extent. The mudflats area was reduced by about 11 % due to their conversion into salt pans. In the Muthupet and Point Calimere area, about 66 % of the dense marsh vegetation was degraded to open marsh vegetation due to human activities. The salt-affected land had been increased by about 4.5-times to that of the area in 1976. The shorelines have accreted in four places and eroded in one place on both Eastern and Southern coasts of the study area, and the fish production had reduced by about 18 % due to deficiency of nutrients, resulting in destruction of mangroves, expansion of salt pans and drying of lagoons in the study area.

2.10

ENVIRONMENTAL IMPACT ASSESSMENT OF DHANBAD DISTRICT WITH PARTICULAR REFERENCE TO FOREST AND SOIL COVER THROUGH REMOTE SENSING IMAGE

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INTRODUCTION

Environment is the sum of all conditions encompassing the domain of living (biotic) and nonliving (a biotic) species that affect the existence and development and define a natural harmonious setting between land, water, air, flora and fauna in an area. Ecological balance of a region depends on optimum interaction between them in the region and any interactive activities beyond sustainable limit shall adversely affect the delicate balance amongst these macro elements of the system. Such degradations are also caused by the excessive consumption of natural resources and many a times result in irreversible damages too. Such impacts are observed more with increasing urbanization and industrialization. However, if such activities continue unchecked ,these will have disastrous impacts on environment, endangering the human-life and other forms of flora and fauna in the region.

Identification potentially damaging activities must be made and mitigated for the sustained growth and development of a region and this whole process comes under the realm of Environmental Impact Assessment (EIA) and management. For assessing the environmental impact in a region, the aspects required to be studied are geology, geomorphology, land use, soil, surface water, groundwater, micro-meteorology, air quality status, noise status, aquatic ecology, terrestrial ecology and socio-economic conditions. In the present study, primarily six parameters related with land surfaces have been studied using remote sensing data that basically provide synoptic view of land surfaces to degrading activities.

OBJECTIVES

- To prepare spatial distribution of natural features i.e. land-cover features and land-use map of the region showing land, water, soil and vegetation and their changing status with time, suitably with advance earth surface imaging technique such as remote sensing and Geographic Information System (GIS), and
- To delineate changes using repetitive mapping that provides the environment in a time span.

STUDY AREA

Dhanbad district of Jharkhand state

METHODOLOGY

Environmental Impact Assessment (EIA) of Dhanbad district was carried out since 1994, i.e. since when the Survey of India (SoI) toposheets of the district are available at 1:50,000 scale by mapping the changing status of various land-cover and land-use class identified and mapped on False Colour Composite (FCC) images viz. mining operational areas, waste dumps, forests, settlement or built-up lands, agricultural lands and water bodies on the basis of standard photo interpretation keys were developed. The study has been made for three periods, viz., 1974-75, 1989-90 and 1996-97. In addition, vegetation status map was prepared for the period 2002. However, the status of 1974-75 was mainly based on SoI topo sheets and from LANDSAT FCC imagery of coarse resolution, 80 m due to non-availability of high resolution remote sensing imagery during these years. For two other periods, viz. for 1989-90 and 1996-97, high resolution IRS IC & ID data as mentioned above were used. So for these years, 2^{nd} level land-use/land- cover classification was attempted.

RESULTS/OUTPUTS

The changing status of forest cover including sub-categories, viz. open forest (degraded forest) and scrub land (undulating upland) have been studied and mapped. The mining operations and the ancillary industries, including related settlement have changed the status of forest cover in the district. Also, the effort of agencies has not resulted in restoring or preserving the status of vegetation cover. Dense forests had reduced from 9% to 6% in 1989-90, to 3.6% in 1996-97 and finally to 4% of the total area in 2002. Thus, forest coverage was reduced to half since 1974. However, the status of open forest had changed from 6% to 11% in 1989-90, to 7.6% in 1996-97 and then again gone upto 12% in the year 2002. But, the undulating upland had decreased from 73% to 62% in 1989-90 and then to 31.6% in 1996-97 and to 43% in 2002.

The Dhanbad district is a typical case of serious environmental degradation due to continuous, unplanned and haphazard coal mining and presence of ancillary industries in the region for the past several decades. Increase in industrial activities had caused influx of people from illiterate and various labour classes. This was the only district where labour class outnumbered the agriculture class. Such people try to live with meager infrastructural facilities and as a result, settlement had grown with little attention to civic amenities. The ever-increasing population had also put pressure badly on land and natural resources. Forest cover in and around Topchanchi, Tundi and Gobindpur areas of the district had either degraded or even disappeared at some places.

Air was polluted due to smoke coming out of coke oven plant, diesel-driven vehicles, and burning of coal in pan and *bhattas*. Water was polluted due to effluents from coal washeries, industrial plants, etc. Noise pollution was being caused by the movements of heavy vehicles, mining operations and other factories. Severe erosion of soil was also observed as a result of removal of vegetation cover and dredging of land for industrial purpose which had caused silting of nearby lakes, river beds, nalas, and johads.

2.11

IMPACT OF URBANIZATION AND INDUSTRIALIZATION ON ENVIRONMENT- A CASE OF SELECTED INDIAN CITIES USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYATEM

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INTRODUCTION

It is well realized globally that the only way to ensure a safer and prosperous future is to deal with environment and development issues together in a balanced manner. In developing countries including India, the cities often become waste baskets in which amount of refuse grows all the time. Cities along with particular kind of commercial, industrial enterprise and upper-income groups sporting high consumption life-styles, generate huge wastes and cause pollution. The issue, which is to be taken into account, is not only of sustainable cities but also of sustainable patterns of production and consumption. The goal of industrial development should be to provide goods and services for human welfare. The industrialization in a country has brought many problems related to the environmental degradation. The unplanned industrial growth is likely to further complicate the complex problem of pollution. Thus, there is a need to strike a balance between advantage and disadvantage of an industrial project on a pollution parameter scale by applying cost benefits analysis.

To study all such problems, particularly of Indian cities and come out with appropriate solutions the use of remote sensing and Geographic Information System (GIS) seems quite significant.

OBJECTIVES

- To understand the links between environment and development in order to make economically efficient, socially equitable and environmentally sound development choices,
- To study the status of efforts being made nationally and internationally in the environmental protection field, and
- To apply remote sensing and GIS tools to understand the problems and impact of urbanization and industrialization on the environment of selected Indian cities.

STUDY AREA

The study covered global environmental concerns in the context of rapid urbanization and industrialization, with a focus on Indian environmental problems vis-a-vis developmental efforts.

METHODOLOGY

The study was based on literature and secondary sources to get information on of the research problem.

RESULTS/OUTPUTS

With the rapid process of urbanization in India, there has been an excessive growth and rush of people from rural to urban areas, thereby resulting in the overcrowding of cities. The rapid industrialization and urbanization has increased the environmental pollutant load. All these pose a serious problem to human health as well as environmental concerns. The socio-economic surveys in large cities have revealed inadequacy of basic amenities of life and the physical environment of slums and squatter settlements is worse with regards to water, drainage, latrines, and other vital necessities of life. Lack of adequate space for recreational and leisure activities is yet another dimension of poor living conditions persisting on a wider scale. Not only has congestion become chronic and acute, but also the very absence of life's basic amenities has created an unhealthy environment responsible for high morbidity and mortality, impairing the efficiency and productivity of the humans.

Due to rapid industrialization and extensive growth of metropolitan cities , the Indian cities have literally expanded into the surrounding country sides, revealing significant changes in morphology and social and economic life of people on one hand and environmental degradation on the other. The pressure of population and increasing industrial activities is leading to fast depletion of natural resources and resulting problems like lowering of water table, water salinity, waterlogging, unplanned sewerage system, land degradation, air and noise pollution and so on. All these are creating serious environmental concerns. Hence, the development must respect environment and those processes that pollute or degrade the environment should be banned.

It has been focused that modern tools like remote sensing and GIS provide ample opportunity to study the natural resources in a quicker and better way and help in finding rational solutions for their conservation and upkeep. These tools also prove quite helpful in studying the impact of developments like industrialization and urbanization and their impact on environment.

ENVIRONMENTAL IMPACT ASSESSMENT OF ZAAWAR GROUP OF MINES USING MULTI-DATE SATELLITE IMAGERY

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INTRODUCTION

Most of the development projects until a decade back, did not emphasize on the need of protecting the environment and maintaining the ecological balance. Hindustan Zinc Limited (HZL) started taking cognizance of environmental issues since 1985. Though there are several provisions under MMRD Act, 1956(Amended 1987), and Environmental (Protection) Act, 1986 regarding protection and restoration of environment, very little has been done in this regard until recently. No systematic evaluation has been carried out to assess the impact of mining on the nature and socio-economic system of the people working in and around the mines. Environmental Impact Assessment (EIA) has never been attempted for the entire mining belt of Zaawar as a whole. Most of the studies done have restricted to single lease-hold areas and limited to a few kilometre area. Hind Zawar lead-zinc belt located at 44 km south of Udaipur is an ancient base metal mining centre in India. HZL has 5 blocks under its lease conversing 51 sq. km area. The important mines, namely Mochia, Balaria and Zaawar Mala fall in block 1. An area of 370 sq. km extending from 3 to 6 km from the leasehold was chosen for the quantitative assessment of the impact on physical and social environment.

OBJECTIVES

- To gather information on the nature and extent of mining in the Zaawar area over a period of 28 years, viz. 1969-1997,
- To assess the impact of mining on natural environment – land, forest, agriculture, air, water, soil, etc.,
- To identify the impact of mining on socio-economic environment, particularly on mine workers,
- To elicit people's perception about the effects of mining on environment,
- To assess possibilities of regeneration of land for agriculture, afforestation, etc., and

- To suggest preventive measures so as to improve the natural and social environment.

STUDY AREA

Hind Zawar lead-zinc belt located 44 km south of Udaipur

METHODOLOGY

Since the problem of assessment of environmental impact (EIA) of any mining activity is complex and multi-dimensional, involving impact on nature and society, an interdisciplinary approach was adopted. The approach was to measure the impact of mining on agriculture, forests and wasteland, etc., i.e. change in land-use pattern. Satellite remote sensing is the only technology, which provides the time varying data, essential for environmental change detection in any mining area at different points of time. Accordingly, the period of 28 years, i.e. from 1969 to 1997 was taken for the assessment of impact on the overall environment due to mining activity.

Secondary data was extracted from the Survey of India (SoI) toposheets for 1999, IRS-1A LISS-II, FCC 2, 3, 4 of 11th February 1989 and IRS-1B LISS-II, FCC 2, 3, 4, of 4th February1997 on 1:50,000 scale. The same data of 1997 on CD-ROM was digitally processed at Regional Remote Sensing Service Centre (RRSSC), Jodhpur and supervised classification was undertaken. Land use classification of National Remote Sensing Agency (NRSA) was adopted. Four samples of air, five of soil and ten of water were collected and analyzed. Noise levels at twenty work spots were measured using digital decibel meter. The socio-economic survey was conducted in mine colonies and nearby five villages using specially designed interview guides and observation schedules.

RESULTS/OUTPUTS

It was found that forest of the study area was highly damaged in the leasehold as well as surrounding areas. Further, wasteland had increased by 600 % in block 1 where currently mining was going on. The area under mine/dump was only 0.24 sq. km in 1969, which had increased to 1.93 sq. km in 1989. However, it decreased to 1.49 sq. km in 1997 due to plantation on old tailing sew. The most affected was the dense forest which declined by 38.74 sq. km from 45.93 sq. km in 1969 to 6.59 sq. km in 1997; thus, 80 % of the dense forest had disappeared in 28 years. Open forest covered an area of 153.43 sq. km in 1969, but occupied 101.2 sq. km in 1989 and only 15.14 sq. km in 1997; hence 90% of the open forest had disappeared in the same period. Similar phenomena also took place in the area covered by five lease hold blocks. In 1969, scrub forest covered an area of 98.04 sq. km, which increased to 177.35 sq. km in 1989, but decreased to cover only 82.20 sq. km in 1997. In 1969, only 21.93 sq. km of the total area was wasteland; it had marginally increased to 28.15 sq. km. However, there was a phenomenal increase in the area covered by wasteland between 1989 and 1997 when it had covered 202.36 sq. km, which means wastelands had increased by 1000% in 28 years. During the same period, wasteland had increased by 600%

in Block -1. In Block -1 A, there was no wasteland in 1969, while in 1989 it covered only a small portion but by 1997, 84.6% of this block came under wasteland. The similar was the case in other blocks.

The area under agriculture was least affected and more or less remained the same over these 28 years as it was restricted to river beds and its traces. However, the area under built up-land saw a phenomenal increase, from just 1.22 sq. km in 1969 to 13.82 sq. km in 1997. Most of the increase was between 1989 (2.29 sq. km) to 1997 (13.82 sq. km), while some of this may be due to increased activity at the mine sites. It may be attributed to expansion of areas of villages consequent to increase in population. The area under water bodies had remained more or less same during this period.

Air pollution had affected mine workers, as 16.5 % of the workers reported eye infections, 60 % of the patients taking treatment at HZL Hospital were reported suffering from lung-related diseases like T.B., etc. The noise levels were very high, i.e. up to 111.2 dB on the work spots, sometimes leading to hearing loss. Similarly, high Pb, Zn and Cu values in farmlands may be entering food chain. Hence, these anomalous parameters needed to be addressed to have sustainable environment for Zaawar group of mines. Temporal remotely sensed and other ancillary data along with ground truth had enabled in detecting large-scale changes in forest cover and development of wasteland. The mining activity had increased the polltion of air, soil and noise, leading to health hazards among the mine workers and the people living in the area. It was realized that their impact on human and animals required to be further evaluated for sustainable environment at the Zaawar group of mines.

2.13

ENVIRONMENTAL IMPACT ASSESSMENT ON LIGNITE MINING IN NEYVELI, TAMIL NADU USING GROUND DATA AND REMOTE SENSING TECHNIQUES

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INTRODUCTION

Environmental Impact Assessment (EIA) in respect of the potential mining area (Neyveli lignite) provides a good indication of the changes in the geological, physico-chemical, hydro-geochemical, bio-geochemical and socio-economic elements that have already occured due to the mining activity and are likely to happen as a consequence to the expansion of mining activities. One of the major problems in this area is the confined aquifer lying below the lignite deposits which has to be depressurized to a large extent to excavate lignite mine by open cast mining methods. This will lead to excessive influx and pumping of groundwater in the mining area, which can be a natural hazard to both safety and economy of lignite mining, the changing hydrologic regime/groundwater flow mechanism from recharge to discharge zone and sea water intrusion and massive pumping of groundwater to the surface supplying water to the surface ponds/tanks/streams and utilize them for activities like agriculture.

The remote sensing data and Geographic Information System (GIS) techniques may be used as an additional tools along with ground truth verification for understanding and monitoring the environmental changes in land and water due to the open cast lignite mining activity in the Neyveli region.

OBJECTIVES

- To Conduct an Environmental Impact Assessment (EIA) study in the Neyveli region of Tamil Nadu, and
- To understand and monitor the environmental changes in land and water due to the open cast lignite mining activity in the study area.

STUDY AREA

Neyveli mining area located between latitude 11° 40´ to 11° 25´ North and longitude 79°25´ to 79°40´ East, which is about 200 km south of Chennai in the Cuddalore district of Tamil Nadu

METHODOLOGY

The remote sensing data and GIS techniques were used as additional tools along with ground truth verification in understanding and monitoring the environmental changes in land and water. Base maps were prepared using Survey of India (SoI) toposheets. IRS LISS II data of May 1989 was used for visual interpretation. In order to assess the present day water quality, surface water (streams, ponds, fly ash ponds and rivers, etc.) and groundwater (both shallow and deep) samples were collected analyzed following the standard procedures. In total, around 257 water samples were collected and analyzed. Thus, soil, fly ash and sediment samples were also collected and analyzed. Soil/Sediment was analyzed for sediment-logical and environmental parameters.

RESULTS/OUTPUTS

Thick Cuddalore formation croped out as a band in the middle of the study area, striking generally north-east and south-west and was overlaid by cretaceous and tertiary sediment towards the east. Cuddalore sand stone occupied 735.9 sq. km, followed by 536.5 sq. km of alluvium, 46.7 sq. km Cuddalore L. St. and argillaceous calcareous sand stone of 9.5 sq. km. On the basis of remote sensing and geotechnical elements, the area was divided into four geomorphic zones as flood plain, sedimentary plain, shallow ground-I and shallow ground-II. Most of the area was occupied by sandy clay, followed by red sandy clay. Aerial estimates obtained from remote sensing images for 1989 and 1998 showed perceptible, if not spectacular changes. The major cause of reduction in irrigated lands was due to land acquisition for mining, lack of water supply from streams, tanks and groundwater table depletion due to pumping. Fallow lands, and plantation area were increased and overburden from mine areas was developed with plantation in recent years to reclaim the area.

Mine-I had expanded from 0.78% in 1989 to 1.15% in 1998, while Mine -II had expanded from 0.22% in 1989 to 0.75% in 1998. The Dumpsite-I increased from 0.29% to 0.4% and Dumpsite -II from 0.36% to 0.51% during 1989 to 1998. This showed that the mining activity and lignite producers had increased two-fold during these years. Mine-I registered an increase of 47 % and Mine- II of 23.9 % during 1989 to 1998. This led to the loss of agriculture land and water bodies, with groundwater depletion in deep aquifers, whereas the Dumpsites showed only marginal increase, viz. 37% for Dumpsite-I and 39% for Dumpsite-II during 1989 to 1998. This was mainly due to the massive afforestation programme carried out by Neyveli Lignite Corporation (NLC) after 1990.

It was found that the lignite-based thermal power generation in Neyveli now produces about 1000 MW electric power from the power plant bottom ash and the recovered fly ash constituted solid wastes. Lignite excavation through opencast mining, depressurization of the confined aquifer and excess pumping, thermal power generation, industrialization, loss of agricultural land and associated urbanization and migration of local people were found closely linked with the problem of environmental degradation, especially of the land, water and air. It was realized that a pragmatic and integrated approach of mining and reclamation activities by NLC had compensated the adverse effect on environment and partially, the impact of water contamination.

2.14

MONITORING ENVIRONMENTAL CHANGES DUE TO INDUSTRIALIZATION AND IDENTIFICATION OF HOT SPOTS IN VAPI-VADODARA PART OF THE GOLDEN CORRIDOR

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INTRODUCTION

The traditional agriculture-based economy of Gujarat has undergone major changes in the recent past with the advent of industrialization. The trend of industrialization has gained momentum following the economic liberalization drive of the Government of India since 1991 and this has encouraged several multinational companies to invest in the Gujarat state by setting up their industrial units. Since then Gujarat has undergone rapid industrial transformation from its traditional agricultural and textile base to chemicals, petrochemicals, drugs and pharmaceuticals, food products, machine and machine tools, pulp and paper, dyestuff, fertilizer industries, etc. Currently, Gujarat is the second most industrialized state of India, next to Maharashtra.

A review of Gujarat Industrial Policy - 2000 implies the determined actions by the state government towards accelerating the pace of industrial growth. Fiscal incentives, faster licensing procedures through single window clearances, improved communication and telecommunication networks, and better infrastructure facilities have all been instrumental in attracting nation-wide entrepreneurs, Foreign Direct Investments (FDI), as well as Non-Resident Indians (NRIs). The concept of development of industrial estates with the efforts of state government is one positive step towards encouraging planned development of industries as these estates would enable facilities of collective treatment and disposal of effluents at affordable cost. Further, the state intends to strengthen the industrial clusters developed at various locations at local level with the help of Industrial Associations and Research and Development Institutions. The report on Vision 2010 prepared by the Government of Gujarat for infrastructure enlists 389 projects for implementation with private sector participation. An Asset Management Fund has been introduced in Gujarat Industrial Investment Corporation (GIIC) covering debt and equity fund to provide financial assistance for implementing the industrial and port development projects.

One of the most important limitations of the industrial policy in the Gujrat state is that it does not give adequate importance and attention to the preservation of environmental and natural resources in the state. Although the policies vow to strictly implement pollution control and environmental protection measures for safeguarding nature and natural resources, they do not lay emphasis on the internalization of the adverse impacts of industrial development. The environmental protection measures, according to the policies, are mainly focused on setting up of common effluent treatment plants, development of common effluent disposal channels and hazardous waste disposal sites. A major transport link connecting Delhi in north and Mumbai in south is passing through the state. This industrial belt along NH 8 accounts for around 60 % of large and medium scale industries in the state of Gujarat. A majority of the chemical industrial are located around this belt which makes this region an industrial hub of the state, and thus, environmentally most sensitive area of the state.

Impressive development is observed in the small-scale sector too. The number of small-scale industries crossed the figure of 2 lakhs in 1997 and rose up to 2, 27,644 in the year 2000. The number of factories has also increased from 3,911 in 1960 to 22,387 in 1995. These belts aim at identifying environmental changes due to industrialization and demarcating “hot spot” in the region. The changes in the land use, soil composition, weather condition, air composition can best be studied by using modern technologies like remote sensing and geographic information system (GIS) technology in conjunction with traditional survey technologies.

OBJECTIVES

- To identify the hot spot zone by using latest technology, namely remote sensing and geographic information system (GIS) technology, and
- To suggest policy directives and remedial measures for achieving sustainable industrial development with least environmental degradation.

STUDY AREA

The industrial belt which stretches from Vadodara to Vapi running parallel to the Mumbai-Ahmedabad railroad and the National Highway (NH) No.8, the area is also known as the golden corridor which lies approximately between longitudes 72° 30’-73° 20’ East and latitudes 20° 15’-22° 32’ North covering four districts; viz. Vadodara, Baruch, Surat and Valsad.

METHODOLOGY

The time period selected was 1988, 1992 and 1997, i.e. the years of pre-and post-liberalization and accordingly, the satellite data were procured for these years to visualize the industrial growth through ascertaining the changes in land use, environmental and socio-economic conditions of the region over time and hence identifying areas vulnerable to the detrimental effects of industrialization, i.e. hot spots. To study the changes due to industrialization over time, the parameters considered were the changes in land use, settlement pattern, demographic profile, agriculture and cropping patterns in the region. The sources of the data were secondary such as census reports, and reports of the Directorate of Agriculture, Gujarat Pollution Control Board, Gujarat Industrial Development Corporation, etc. During the ground truth, a primary survey was also conducted of few villages. Soil and water quality data were analyzed for single time period, as it was not available for multi-date. The remotely sensed satellite images were used to identify the real-time changes in the land-use/land-cover. The primary survey was carried out for about twenty villages. A series of discussions with senior officers was also carried out to substantiate the result from the primary survey. According to the criticality of changes in each of the thematic layer for different years, the weightages were assigned. Higher the environmental criticality, higher was the value of weightages.

The data derived from various sources, spatial and non-spatial, was also analyzed to identify the hot spots using Geographic Information System (GIS). After studying each taluka with respect to different parameters such as physical parameters, environmental parameters, socio-economic parameters including the infrastructure facilities, natural resources and their quality, change in land use, change in agriculture practices, and demography, etc., they were analyzed first to identify the changes and then to identify the 'hot spot' in the study region.

Arc/Info GIS software was used to analyze various thematic maps, and to assign weightages and were superimposed to find the existing pattern, identify the changes and analyze the environmental condition. The secondary data collected was analyzed and associated with maps in GIS environment. Accordingly, the hot spots were identified. Recommendations were given at each level of analysis. Discussions were held with the senior officials of institutions and departments mentioned above to discuss the results of this study and to evolve the direction of environmental preservation at large.

RESULTS/OUTPUTS

It was found that out of the 16 taluks chronically affected by heavy metal contamination of ground-water in the state, 12 taluks fall in this region. The changes in the economic structure had shown indirect impacts on the environmental conditions and had also brought about changes in the socio-economic profile and the settlement pattern.

The transportation network, river and drainages (nalas) around the industrial estates are though important for industrial development as they play very critical role in environment condition. Roads were used to transport raw materials and remove the wastes generated by the industry. Most of the unlawful dumping of the solid and liquid wastes within 500 m either sides of the road had been observed off-side the road network. Thus, the buffer of 500 m was generated along the road network. Rivers, tributaries, nalas and other natural drainages were used as principal dumping places of effluents generated by industry. Amlakhadi, Mini, Par and Damanganga were found as the best examples. The data on water quality from rivers, nalas and other drains proved degradion of environmental conditions. The third feature, the industrial estates, were classified according to the input used and the amount of hazardous waste generated. All non-chemical industrial estates, which were low polluting and produce non-hazardous wastes, were classified in low environmental degradation category. The area of environmental impact was considered up to 3 km around the estate. All chemical industrial estates, which add pollutants in solid, liquid and gaseous forms, were assigned larger area of environmental impact than non-chemical industrial estates in the study region. The level of pollution and quality of hazardous waste, both were higher in the chemical than non-chemical industries. Hazardous wastes contained toxic heavy metals, persistent organic pollutants, and lots of other chemicals. Three parameters were taken into consideration to identify the area on environmental impact. These were: (i) number of chemical industries, (ii) type of input used, and (iii) quantity of generation of hazardous wastes. Based on these parameters, all chemical industrial estates falling in the study region were analyzed and classified into different categores in the range from 5 km to 17 km of area of environmental impact. Nandesari Industrial Estate was classified in the largest area, i.e.17 km, followed by Vapi Industrial Estate with 12 km and Ankleshwar Industrial Estate with 9 km. Rest all chemical industrial estates of study region were classified in the least zone of 5 km.

2.16

ASSESSMENT OF LAND DEGRADATION DUE TO TANNERIES – A REMOTE SENSING APPROACH

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INTRODUCTION

Rapid industrialization without due regard to its likely impact on environment, has led to serious, land, air and water pollution. Sustainable development calls for the optimal utilization of available land and water resources, based on their potential and limitations in order to have a harmony with environment. Equally, if not more, important is to make adequate provision for safe disposal of industrial and domestic wastes. In India, the expansion of industries has been towards capital and energy-intensive sectors, many of which are of polluting nature. The small-scale industries account for 60-65 % of the total pollution. Additionally, the use of toxic chemicals has grown phenomenally. An estimated 50% of the large or medium scale industries have provided complete / partial emission / effluent control system and many of them do not meet the stipulated standards.

The leather industry providing employment to an estimated 2 million people in India, contributes significantly to environmental pollution. Various sub-processes like bating, pickling, tanning, dyeing and fat liquoring cause water pollution. Initially, the skin or hide is treated with a mixture of sodium sulphide and lime. The sulphides, used in this operation, are the source for generation of toxic and foul-smelling hydrogen sulphide. During the tanning process, meant for preparing well-preserved and aesthetically appealing product, sodium chloride and chromium salt are commonly used and hence these are present in the effluent in abundance. The effluent affects the land to which it comes in contact with and leads to its degradation in varying degrees, depending upon the physico-chemical characteristics of the effluents. The enrichment of soils with sodium chloride leads to the development of salinity and/or alkalinity in soils. Information on the nature of pollutant, its sources, extent of damage is a pre-requisite for taking up any reclamation or prevention measure.

OBJECTIVES

- To delineate the spatial extent of salt-affected soils, and
- To monitor their temporal behaviour, which has developed due to tanneries effluents.

STUDY AREA

Dindigul town of Anna district, Tamil Nadu, bounded by geo-coordinates 10° 20' to 10° 26' North and 77° 52' to 78° 0' East and covering 56 sq. km. The study area in the North Arcot district extends along the river Palar and its tributaries, namely Goddar, Malattar and Poiney covering the industrial area around Vaniyambadi, Pernampattu, Gudiyattam, Walazapet, Vellore and Arcot of the Vellore district. In the Dindigul test site, the tanneries were confined along the periphery of Dindigul town. There were 518 tanneries in the test sites.

METHODOLOGY

Database was created on the location of tanning units and associated drainage pattern in a Geographic Information System (GIS) environment and delineation of salt-affected soils in a Silicon Graphic (Octane) based system using ERDAS/IMAGINE version 8.3 software, vis-à-vis ground truth data and ancillary information. Indian Remote Sensing Satellite (IRS-1C) Linear Imaging Self-scanning Sensor (LISS-III) and Panchromatic (PAN) sensor data were used.

RESULTS/OUTPUTS

Over the years, the development of soil salinity and/or alkalinity due to tanneries' effluents was found as well as the potential of space-borne multi-spectral data in the delineation of salt-affected soils was duly established. Salt-affected soils were confined to areas where tanning units were concentrated, and the effluent was let into the land. Lands affected by soil salinity and /or alkalinity were, generally, either lying barren or supporting vegetation or crop with poor to very poor growth. Such soils were confined to nearly levelled to very gently sloping valleys which received tanneries' effluents regularly through drains or streams acting as conduit of such effluents. During the rainy season, paddy was taken whereas these lands remained fallow during dry season. Salt efflorescence of white to grayish brown colour was very common in salt-affected soils, which were lying barren.

Vaniyambadi and Dindigul sites exhibited a significant increase in the spatial extent of lands affected by effluents. The pollutants' level in groundwater was far beyond the stipulated threshold value for various chemical parameters for potable water. The native upland scrub vegetation was not affected by tanneries' effluents. The impact was highly localized. The affected areas, in general, were completely devoid of vegetation due to high concentration of tanneries' effluents or supported only tolerant species like *Prosopis juliflora*. The biophysical parameters monitored in the tolerant species like *Prosopis juliflora* exhibited considerable changes. Bio-physical measurements coupled with bio-chemical investigations needed to be taken up for furthering understanding on the effect of tanneries' effluents on vegetation distribution and productivity.

2.17

EVALUATION OF IMPACTS OF LAND USE CHANGES ON ENVIRONMENTAL QUALITY (AIR, WATER, SOIL AND BIO-ENVIRONMENT) OF HYDERABAD AND ITS SURROUNDINGS USING REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEM AND FIELD STUDIES

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INTRODUCTION

In recent years, there has been a growing concern in India about the increased deterioration of the country's environment. A large number of studies have been conducted on the impact of urban growth, population increase and land-use/land-cover changes on the water quality in areas like Delhi and Mumbai using remote sensing and GIS. But such integrated studies have not been carried out in Andhra Pradesh, especially in the Hyderabad city. These studies are crucial for the evaluation of the overall environmental quality of Hyderabad.

As the urban environmental quality depends on the land usage, it is necessary to determine the quality of the environment by studying the land-use features and their associated impacts. The total area of Municipal Corporation of Hyderabad (MCH) is 179 sq. km of which 134.54 sq. km 87% is occupied by residential land-use, followed by wasteland (9%), agricultural land (3%) and industrial area (1%). Keeping this in view, the impacts of these land-use/land-cover dynamics over spatial and temporal scales on the groundwater quality and its suitability for drinking in terms of water quality rating was critically examined in 11 planning zones of MCH.

OBJECTIVES

- To assess the overall environmental quality of Hyderabad,
- To prepare various thematic layers such as land-use/land-cover changes.
- To establish zone-wise monitoring network for determining the quality of surface and groundwater in and around Hyderabad,
- To generate thematic maps showing zone-wise spatial distribution of important air quality indicators,
- To create spatial database for zone-wise pollutants and zone wise mapping of demographic aspects along with spatial distribution of health problems, and
- To evaluate spatially the biological environments to assess the impact of land-

use patterns on biodiversity.

STUDY AREA

Hyderabad, the capital city of Andhra Pradesh, which is located at 17° 20′ North latitude and 78° 30′ East longitude.

METHODOLOGY

Two databases, viz. spatial database and attribute database were created integrating remote sensing, GIS and *in situ* field studies. Based on these databases, various thematic layers like land-use/land-cover, drainage, geology, transport network, hydro-geomorphology and groundwater potential maps were generated employing visual interpretation technique. A good number (301) of groundwater samples were collected and analyzed for physico-chemical parameters, including heavy metals adopting standard protocols. Spatial distribution maps were generated employing Arc/Info and Arc View software for detecting variations in the concentration of the parameters analyzed. The Water Quality Index was computed and the range of indices obtained which provided basis for rating the water quality. For a better interpretation of the results the overall land use of MCH was categorized into four broad classes, viz. (i) residential, (ii) wasteland, (iii) agricultural, and (iv) industrial areas. Accordingly, the water quality was classified into good, poor and unfit categories for all the above four major land-use classes, which was further overlaid on land-use map.

RESULTS/OUTPUTS

Water samples were collected from all the land-use classes in Hyderabad. In the dense residential area, the quality of groundwater was found good in 33 locations (19.8%), poor in 56 locations (33.7%), and unfit in 77 locations (46.3%). The results indicated that the groundwater quality was adversely affected in 133 locations which could be attributed to unplanned urbanization and haphazard residential agglomeration compounded by lack of adequate sewerage network facilities, leading to discharge of huge volumes of domestic wastes in open drains. Infiltration / seepage from such activities had contaminated the groundwater, as evidenced by the presence of parameters like TDS, hardness, nitrates, sulphates and fluorides in concentrations above the permissible limits.

In medium residential sub-class, of the 54 groundwater samples 18 (33.3%) were of good quality, 19 (35.1%) were poor and 17 (31.4%) were unfit for drinking. The poor quality of groundwater could be due to the fact that some of the sampling sites were located in the industrial area (Sanathnagar) and around hospitals, which could potentially contribute to the contamination of groundwater. Of the total ground water samples collected in sparse residential area, 50% were of good quality, 13 (30.9%) and 8 (19%) were of poor quality and unfit for drinking, respectively.

Within wastelands i.e. barren rocky/ sheet rock area, land with scrub and land without scrub 6 (21.42%) groundwater samples were unfit, 13 (46.42%) were poor and 9 were of good quality. Most of the groundwater samples (52.63%) collected in land without scrub were of poor quality and were unfit for drinking. The water quality rating in land with scrub class was more evenly distributed showing 33.33% in all the three categories, i.e. good, poor and unfit. The poor water quality in barren rocky / sheet rock areas was mainly due to leaching and chemical weathering of rocks which increases the fluoride and total dissolved solids concentration in the groundwater evidenced in some locations like Bandar hills and Jubilee hills.

Samples were collected from different parks located in Hyderabad and from agricultural lands situated at Tolichowki. Of the total 9 samples analyzed, 60% of the samples were unfit, 20% were poor and 20% were of good quality. The poor quality in these areas was quite possible due to the application of pesticides, which eventually find their way into the groundwater through seepage from runoff carrying agricultural wastes.

Location of few small-scale industries within the city in areas like Sanathnagar, Hasan Nagar, Chandrayangutta, Azamabad and Karwan showed an adverse impact on the groundwater quality. The samples collected from these locations exhibited a very poor quality, which could be attributed to improper treatment and discharge of wastes into open drains.

Biodiversity studies in aquatic environments included physical, chemical, heavy metal and biological characteristics of a habitat. In practice, phytoplankton, zooplankton, fishes and macrophytes were often employed as bioindicators of aquatic pollution. Due to increased population, rapid industrialization in the pre-catchment area and unplanned urbanization in and around the twin cities over the past few decades, surface water bodies have been subjected to varying degrees of pollution and consequent eutrophication. In this scenario, immunological studies were conducted to assess the physico-chemical characteristics of the medium and the current patterns of plankton bio-diversity in these water bodies and the corresponding results were presented.

Based on current water supply in areas under MCH and Hyderabad Development Authority (HDA), the projected demand of water for increasing population was examined and suggestions for improving the same have been made.

The traffic flow, transportation and road network infrastructure in MCH and HDA area were critically examined and suggestions for decongestion of MCH areas have been made. The air quality was the air pollutants, viz. NOx, SOx, RSPM, TSPM in different land-use classes determind by assessing air and the corresponding results with their spatial distribution have been presented .

Based on the identified impacts and cadastral data, various mitigative measures were proposed for improving the water quality, traffic decongestion, road widening, counter magnets for central area decongestion, constructions of bridges on Musi, truck terminals, wholesale and other markets, development of greenbelt, air quality, MSW management, etc. Recommendations have been made for environmental planning. The Hyderabad Environmental Information System (HEIS) had been developed by overlapping spatial-topographic, remote sensing and municipal maps combined with cadastral, census and field-survey data of physiology, environmental quality, and demographic factors, urban land-use structure of Hyderabad.

2.18

IMPACT OF HUMAN SETTLEMENTS ON SOME RURAL LAKES OF KASHMIR USING REMOTE SENSING TECHNIQUES

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INTRODUCTION

An appropriate conservation policy is required to be implemented at an earliest so that rural lakes of Kashmir continue to provide resources to the people, increase fishery production and tourism for the economic benefits of the community. Such a step will help sustain plant, animal and human life and will also help in flood control, natural sewage treatment, shoreline stabilization and recharge aquifers. Thus, the main focus should be on conservation of the representative treasures of nature for sustainable and equitable development through a multi-pronged strategy, with a stress on community-based approaches. Therefore, restoration /conservation of these lakes has a great significance.

Although a number of development plans have been evolved for a few lakes like Nilnag, Wular and Anchar, no significant steps have so far been taken towards their conservation. To restore these lakes, some of the important problems may be dealt with. These include parameters like protection of the existing lake body, to arrive at correct land-use strategy and also to arrive at flood control strategy for the valley. In addition, to assess the total raw sewage and sewerage entering the lake body and reduce the nutrients entering the lakes, upgrading fish potential, installation of buffer strips and raising the socio-economic status of people within the lake body catchments, periodic monitoring of lake and its surroundings and community participation and public awareness are equally important steps. A baseline data is needed on the water quality, socio-economic status of people living in the periphery of these lakes and the land-use pattern of the lake surroundings. Therefore, an attempt is required to develop a conservation strategy for the lake and eco-systems by identifying the causes of the deterioration of water quality and shrinking area of these water bodies. The present research exercise was designed to study the impact of human settlements on some rural lakes of Kashmir using remote sensing techniques.

OBJECTIVES

- To obtain basic information on the environmental quality of some selected rural lakes of Kashmir and record changes in biotic components of the eco-system,
- To develop tropic gradient in terms of human stress, and

- To identify causes and impacts of human activities and develop conservation strategy.

STUDY AREA

Rural lakes of Kashmir viz, Wular, Anchar, Ahensar, Waskur, Sheikhsar, and Nilnag

METHODOLOGY

The watershed, morphometry, land-use and vegetation cover were studied using remote sensing techniques, while water analysis was carried out using different methods after Macrath (1973). The base maps were prepared form Survey of India (SoI) toposheets on 1:50,000 scale surveyed during 1961-62 and updated in 1971-73 and the land-use/land-cover details were delineated from IRS-1C satellite imagery of the year 2004. The surrounding areas that had bearing on the carrying capacity of the lake were also delineated. The doubtful areas were thoroughly checked in the field. The socio-economic data was collected by collecting information from villagers and local officials.

RESULTS/OUTPUTS

It was found that the lakes had a varied trophic status, ranging from meso-trophic (Nilnag, Ahensar, Waskur) to hyper eutrophic (Sheikhsar and Anchar). It was an event of the past 10-30, years coinciding with a marked civilization evolution in the surrounding areas. A result of heavy anthropogenic pressure, the lake systems were not only shrinking in their surface areas but their waters were also deteriorating, posing hazards to the habitants. The main threats to these lake systems included: (i) pressure on the lake systems due to accelerated land-use which was promoting higher disposal of domestic refuse, garbage and sewage into the water, (ii) higher silt load agricultural run-off plant debris, other allocthoncous material resulting in the filling up of the lake periphery,(iii) land reclamation for agriculture and habitation, and (iv) exploitation of the produce available in these lakes like fish, nadroo, water-chestnuts, etc.

IMPACT ASSESSMENT OF SUGAR INDUSTRIES ON WATER QUALITY OF EASTERN UTTAR PRADESH

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INTRODUCTION

Sugar industry is the second largest industry in India. Out of 448 sugar mills in India, 119 units are in Uttar Pradesh (UP). As per records of the UP Pollution Control Board, 35 distilleries are also operational in the state. Owing to favourable agro-climatic conditions, the eastern UP including the Terai region, emerged as a major sugarcane producing belt. Consequently, bulk of sugar factories and a few distilleries were installed during early-1930s, particularly in the parts of eastern UP. The advent of sugar industries has played a significant role in the socio-economic development of eastern UP, but, at the same time, the threat pollution has also increased manifold. Due to progressive rise in the odour nuisance and pollution load generated by the sugar mills and distilleries due to disposal of untreated/partially-treated effluents, possibilities of deterioration of quality of both surface water and the groundwater of the area cannot be ruled out. Hydro-geological studies conducted by Central Ground Water Board (CGWB) during 1991-92 had established the relevance between surface water contamination and effluent disposal from the sugar mills in parts of Deoria (now Kushinagar) district of Uttar Pradesh .

In general, most of the sugar mills and distilleries release the entire effluents outside their premises, which gradually spreads through the low lying areas adjacent to the factories and/or discharges into natural water course. The untreated/partially-treated effluents contain organic and inorganic impurities. Land disposal of the effluents of sugar mills and distilleries and its eventual discharge into surface water bodies can create serious consequences leading to health hazards because part of effluents may percolate down contaminating the shallow aquifer(s). Effluent discharge into streams and rivers is largely responsible for surface water pollution.

OBJECTIVES

- To assess the present status of effluent spread, physico-chemical quality of effluents, surface water and groundwater,
- To detect changes in the status in space and time and evaluate the pollutant load, its flux during off-season and peak season,

- To study the lithologic profile of vadose zone, soil properties, infiltration rate and demarcation of potential areas for surface water and groundwater contamination,
- To analyze in detail the physico-chemical parameters of the effluents vis-à-vis groundwater and soil and their interrelationship,
- To assess the quality of water and its suitability for irrigation and domestic use as well as identification of areas showing chemical parameters in excess of permissible limits, and
- To suggest suitable steps for minimization of severity of the problem and identification of safe areas/zones for drinking water supplies.

STUDY AREA

Kushinagar district of Gorakhpur dvision, located between latitudes 26°50' and 27°0' North and longitude 83°40' and 84°0' East that lies to the north of river Ghagra. It is covered in the Survey of India (SoI) toposheet No. 63N/13.

METHODOLOGY

The data used in the study included Survey of India (SoI) toposheets 63 N/9 and 63 N/13 (1:50,000 scale), multidate, multi-sensor, remote sensing satellite data, viz. IRS IC LISS III geocoded of 63 N/9 image pertaining to the Path and Row of 102/052 (April and December) on 1:50,000 scale and IRS IC LISS III geocoded data of 63 N/13 image pertaining to the Path/Row of 103/053 (April and December) on 1:50,000 scale and IRS IC LISS III + Pan merged satellite product on 1:25,000 scale. Further data were collected about ground water, surface water and effluent samples twice during off-season (April) and peak season (December). The data collection on hydro-geology was also undertaken. Soil profiling and coring for evaluation of hydraulic conductivity, etc. was done and geo-electrical resistivity sounding was undertaken. Comprehensive chemical analysis was done for determination of physico-chemical parameters of surface water, groundwater and soils.

The base maps were prepared on 1:50,000 scale showing main features along with locations of sugar mills and distilleries. Pre-field visual and subsequently, digital interpretations of satellite data were done for preparation of hydro-geomorphological, effluent spread and aquatic vegetation maps. Field checks were performed for finalization of these maps. The groundwater, surface water and effluent samples were collected in two different periods to detect the temporal change in water quality from off-season to possibility of downward migration of contaminants.

Infiltration test on the selected sites was also conducted to assess the time period of percolation of effluents through vadose zone. Geo-electrical soundings were carried out for evaluation of nature and extent of unsaturated zones. Comprehensive chemical analysis of water samples and soil samples was done in the laboratory for determination of physicochemical parameters. Integration of relevant parameters was done through GIS for detection of potential areas for groundwater contamination and identification of groundwater potential zones for maintaining safe drinking water supplies and suggesting remedial steps to check/minimize the severity of contamination of aquifer(s).

RESULTS/OUTPUTS

Disposal of untreated effluents from six sugar mills and one distillery was being continued for more than 60 years in the Padrauna-Kaptanganj area. The local inhabitants had voluntarily abandoned the shallow dug well (6-8 depth) because of groundwater contamination. Good permeability (5.08-1.97 cm/hr) of the soils in Padrauna area appeared to have promoted the leaching of the untreated effluents. There was a significant decrease in the pollution load, especially after installation of Effluent Treatment Plants (ETPs) in the study area. Occasional deviation from the recommended standards in the case of sugar mills suggested that the ETPs do function efficiently. However, the Kaptanganj distillery still appeared to discharge effluents, which were not in confirmation to the standards.

Stagnant effluents in the south of Ramkola and SSW of Kaptanganj and its flooding during the rainy season was a causative factor for land degradation as well as contamination of surface water bodies. Leakage from partially lined/unlined trenches carrying the partially-treated effluents from the Kaptanganj distillery spreads in a large area before joining the Maun nala. Shallow water level and moderate hydraulic conductivity of the soils near the effluent discharge site of Maun nala suggested strong possibility of groundwater contamination.

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ASSESSMENT OF IMPACT OF HYDROPOWER DAMS ON VEGETATION USING REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

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INTRODUCTION

Remote sensing technology is a well-established and essential tool for natural resource assessment and management because of its advantages like multispectral sensing, synoptic view, repeated unbiased recording, etc. It is further strengthened with invention of Geographic Information System (GIS). Integrated approach of GIS and remote sensing has become an essential tool for natural resource assessment, management and impact analysis.

The purpose of construction of dam in India is to generate hydropower, flood control, irrigation and groundwater recharge. Whenever a dam project is constructed particularly in hard rock's terrain, it causes impacts on vegetation growth. The impound water in the reservoir seeps down to recharge the groundwater, which directly enhances the growth of vegetation in downstream low lying areas. But, in a country like India where many parts suffer from severe water scarcity in summer time, the construction of reservoir means immediate submergence of land part and inhabitation problems.

OBJECTIVES

- To develop a remote sensing and GIS based methodology for assessing the impacts of hydropower dams on vegetation,
- To assess the impact of four recently constructed hydropower dams on vegetation using an integrated approach of remote sensing and GIS, and
- To prepare futuristic scenarios for each site to show the change in vegetation that may occur in downstream region.

STUDY AREA

Four hydropower dams, viz. Pandoh, Chamera, Rajghat and Sardar Sarovar, situated in different geological and topographical terrains.

METHODOLOGY

In this study, a ratio technique was developed to assess the impacts of reservoir towards vegetation growth in downstream area. I this ratio technique, a ratio was derived between benefited areas vs. submerged areas. Using this ratio technique, quantitative assessment of impacts of reservoirs on vegetation growth emerged. Further, this simple ratio technique also provided opportunities to make a comparison among impacts of different reservoirs on vegetation growth. This methodology was tested on four hydropower dams, viz. Pandoh, Chamera, Rajghat and Sardar Sarovar. Further, the impact on vegetation growth and groundwater recharge of about 21 small reservoirs / ponds present in the vicinity of the large reservoirs was also studied.

RESULTS/OUTPUTS

Construction and operation of hydropower dams had an effect over the environment both on upstream and downstream areas. The downstream area was specifically chosen because it was devoid of perennial flow of the stream after the construction of dam. Rajghat Dam was located in the granitic terrain and in this area, ratio of benefited to submerged area was observed. The recharged or vegetated area due to the reservoir was the benefited area and the area under the reservoir was the submerged area. The ratio was prepared for 21 reservoirs around Rajghat reservoir area. It was observed that except one reservoir, the ratio was greater than one, which meant that there were more benefited areas than the areas that were submerged. The ratio ranged between 0.66 to as high as 28.18 with an average of 9.87. On a comparison of pre-and post-construction Normalized Difference Vegetation Index (NDVI) images, it was observed that there was a marked increase in the growth of vegetation in the downstream side.

The reservoir filling in the Saradar Sarovar dam started only in the year 2000 and hence the impact of reservoir on vegetation growth was not significant. However, it was expected that with time it should improve, because there were signs of recharge of groundwater and growth of vegetation in another adjacent reservoir (viz. Karjan Dam), located in almost similar terrain conditions and close to Sardar Sarovar Dam. After the filling started, the groundwater recharge took place during the past two-three years. The NDVI had also supported these findings. Based on the other parameters, the modelling of groundwater recharge in downstream area and submergence in upstream of Sardar Sarovar Dam was simulated.

In the Pandoh reservoir area, a possible correlation was attempted on the condition of groundwater before and after the construction of reservoir by means of x-y plot of rainfall, depth of groundwater table. In this case, the data sets were available for a period of 15 years and after the construction of reservoir, there was an abrupt increase in annual rainfall in Pandoh area (i.e. from 147.06 mm to 1303.8 mm). A hilly area showed a comparatively high fluctuation in groundwater. After the construction of dam, marked difference in water table rising was observed. A rise in the water level indicated that accretion to groundwater storage was taking place. In the Pandoh reservoir area, during the pre-dam construction period, the fluctuations in pre-and post-monsoon depths of water table followed the trend of the rainfall received in that year, but, for post-dam construction period, the dependency on the rainfall as it seemed, reduced considerably, indicating that the fluctuation in depth to water level values was stabilized. In Chamera also, the depth of water table stabilized after the construction of dam.

The NDVI map was prepared from satellite data to study the growth of vegetation in both the areas over a period of time. From the study, it was observed that the vegetation cover had increased, but this increment was significant in certain parts of the area. These sub-parts lied in the topographical low relief areas. That means that these were the slopes along which rivers that were flowing or these were downstream sides of rivers. The small patches of vegetation decrease were due to loss of vegetated area by forest fire, landslide, etc.

In the exercise, an attempt was also made to study the impact of four recently constructed dam projects on vegetation growth by using integrated techniques of remote sensing and GIS. The impact areas were comparatively easy to identify in hard rock rolling topography than in hilly terrain. From other spatial themes, suitable impact areas were identified using image interpretation, weighted overlay and NDVI. Image interpretation was used to find out benefited vs. submerged area ratio. This benefited area vs. submerged area ratio technique was developed in the present project. Weighted index overlay was used to find out groundwater prospective zones; NDVI showed the changes in vegetation growth. The simulated reservoir was modelled to delineate the benefited area by making a comparison with the knowledge of pre-existing reservoirs in more or less similar topographical and geological terrains. Finally, it could be concluded that reservoirs have positive impacts on groundwater and vegetation in terms of good recharge of groundwater and increased vegetation in the downstream areas of rivers. It may also be pointed out that the methodology developed in this project if applied could directly benefit the country in better planning, management and prediction of hydropower projects and particularly the impacts of such developmental activities on vegetation coverage.