Environmental Problems Analysis of Coal Mining in Raniganj & Asansol Blocks (West Bengal) Using Remote Sensing and GI S.

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Abstract:

Coal mining destroys or significantly alters all the physical features that influence the capabilities of the land. Mining is the only land use for a long time without reclamation mining operations usually produce large qualities of wastes, overburden and under grade ore materials etc. The present study of areas Asansole and Raniganj blocks situated in Raniganj Coal Belt (RCB), which lies in Burdwan districts of West Bengal state in India. Two time data of IRS 1C 1D LISS III (1999) and IRS 1A/ 1B LISS I/II data 1988/1989 used for studied on PC based ERDAS IMAGINE 8.3.1 and PC based ARC VIEW 3.1 software for change detection and impact analysis. Raniganj coalfields (RCF) where extensive and rapid underground and Open Cast Mining (OCM) is going on continuously land use studies are paramount importance.

This paper discusses the remote sensing and GIS techniques used for identification of various land use / land covers of satellite imagery and identification of time sequential changes in land use patterns. A no. of image processing operations have been carried out on remote sensing data for enhancing land use patterns. Time sequential surface changes that have occurred in the RCF since 1999 and particularly between 1999 to 1989 have been investigated. For change detection analysis, data manipulation in several steps involving preprocessing, processing and colour display have been carried out. Land changes have been detected by different algorithm. The total area 221.28 sq km area was studied throughout the different villages. About 142.02 sq km areas were identified affected in different category it is digitally identified.

Mining is the dominant among all the mining activities for environmental degradation. Due to mining processes, there are changes in natural environment. The changes develop adverse impact on the entire vegetative community, human & wildlife however, in spite of many adverse impacts. Large areas of forest, agriculture & pasturelands have been converted in to collieries, colonies & fallow lands due to rapid expansion of coalmines.

Keywords: RCF, GIS, coal, RCB and remote sensing.

1.0 Introduction:

India with about 206 billion tonne of coal reserves is well placed with respect to the sources of energy. The country stands third in terms of coal production in the world after China and USA and in the year 2000-2001 it produced about 310 million tonne of coal out of which nearly 75% was used for thermal power generation.

Coal mining (Fig.1) in the coalfield was started in the last decade of the 19th century. The coalfield having an area of about 450 sq km belongs to Gondwana group of Permian age and has Talchir, Barakar, Barren and Ranigunj measures. It is a sickle shaped coalfield occuring in the form of a basin truncated with a major boundary fault on the southern flank.

Mining has been defined as the removal of minerals from the earth's crust in the service of humans Down & Stock (1978). Mining & industrialization play an important role in national economy. Their number & aerial extent have been increasing with the increase of population & subsequent developmental activities irrespective of any adverse impact on the surrounding environment. The first and foremost consequence of any mining operation including the coal mining is the removal of vegetation and the degradation of land. These problem need to collect base line data about mining processes damaging to the landscape extent, amount of damage & the related impact in the an ecosystem. Any study pertaining to the an environs of the developmental activity must encompass spatial, dynamic & temporal attributes of the environment to obtain comprehensive & reliable results. In India, major coal fields are located in state of west Bengal, Bihar and Orrisa. Raniganj, Jharia and Giridih as are having major coal mines. There are more than 800 coal mines in India. India occupies 3rd position in the world in the field of coal production. Raniganj coal belt is an important coalfield located in Damodar river valley. It is spreaded around 240-sq. km area. It contributes 30% of total coal production of the country. Coal is the pre - dominant primary commercial energy source in India. In India maximum coal is found in son, Damoder, Gowdavari & Wardha etc. These are situated in valley of river. Gondwana land parts contribute 98% parts of total coal, mainly two type coal are found bituminous & anthracite. Bituminous type coal has carbon quantity 75 to 80% & Anthracite coal has 80 to 90% of carbon quantity. Anthracite coal is good, bright, black colour, maximum temperature & low smoke quality & Bituminous is also called secondary coal, it is black, maximum temperature, low smoke & water parts contain 25 to 30%. Gondwana land's coal found maximum in West Bengal, Bihar, Orissa, Madhya Prdesh, Maharastra & Andhra Pradesh etc. state.

According to Geo Survey of India (1 January 1992), total coal in India has been 1,96,022.90 million ton (in depth 1200 mt)). West Bengal state has 2512.4 billion ton total reserve coal. Total coal reserve up to 600 Mt depth is 35 billions tones, about 23 billion tones in West Bengal. The total extractable reserve of coal has been accessed as 8 billions tones, this includes 6 billion tones in West Bengal & 2 billion in Bihar. Before coal was discovered in Raniganj in the late 18th century, this area was a forested District known as Jangal Mahal (Paterson, 1910).

Physio-graphically, the Raniganj coalbelt overlies the granite plateau fringe of Chota Nagpur with a general elevation of about 100meters.Permo carboniferous rock formations of Talcher, Barakar, Barren Measures, Raniganj & Panchet series are3 exposed in many planes with small isolated occurrences of upper Gondwanas near the southern boundary fault. Among the rock formations, the Raniganj & Barakar series contain some of the thickest & best coals of India (Bose, 1968).

Remote sensing technology has made it possible to detect coal fires and study their effects. Thermal and optical images along with field-based measurements are used to determine the location, size, depth, propagation direction, burning intensity, temperature, and coal consumption of a fire (Zhang et al., 2002, in review; Vekerdy et al., 1999; Prakash and Gupta, 1999).

This paper gives an overview of the theory and case studies of detecting coal fires by using remote sensing techniques. Coal fires, either man-made or spontaneous combustion, not only cause losses of natural resources, but also cause environmental problems. The surface feature and by-products of coal fires include pyro-metamorphic rocks, fumarolic minerals, burnt pits and trench, subsidence and cracks, and surface thermal anomalies. These features can be detected from visible, near infrared, short-wave infrared, radar and thermal infrared remote sensing images.

The impacts of mine fires on the environment are very severe. It causes major perturbation of macro as well as micro environment of the locality. When the fires are limited to underground workings only, the effects are confined, but once they become surface fires, the environment of the locality is put under stress. The major adverse impacts of mine fires are observed on all the four basic components of the environment viz. air, water, and population.

2.0 Study area:

Asansol, the coal-mining-industrial centre, is the second largest city in West Bengal, after Kolkata. Asansol lies on exposed Gondwana rocks and consists mostly of undulating laterite soil. It forms the lower edge of the Chota Nagpur plateau, which occupies most of Jharkhand. Raniganj Coalfield, is the birth place of coal mining in the country. Ranigunj Coalfields covers an area of 1530 sq km spreading over Burdwan, Birbhum, Bankura and Purulia Districts in West Bengal and Dhanbad District in Jharkhand.

The study areas Asansol & Raniganj blocks falls in Burdwan district of West Bengal, bounded by Ajoy River in North and Damodar River in South. The areas are lies in latitudes 23° 35` to 23° 45` N and longitudes 86° 50` to 87° 10` E. This areas are represented on a 1:50,000 scale topographical sheets no. 73-M/2 & 73-I/14 of the survey of India.

3.0 Material & Methods

- IRS-1A LISS –I digital data of 28- Feb –1989.
- IRS-1D, LISS -III digital data of 25- March-1999.
- Survey of India (SOI) Topo-sheets Maps (73-M/2 & 73-I/14) Scale –1: 50,000
- Block maps of Asansole & Raniganj & Village maps.
- Cadastral map of study area.
- Global Positioning System (G.P.S.)
- Profarma (field form) for collecting socio- economic data

The methodology consists of the study & analysis of remote sensing data, collection of ground truth information, collection of socio-economic data & creation of data base for all the required physical & cultural parameters & the overlaying, integration & analysis of all spatial, non-spatial & attribute data bases. The Methodology in detail has been categorized under the following (Flow chart-I).

3.2 Pre-Field Work, 3.3 Field Work & 3.4 Post –Field Work

3.2 Pre-Field Work:

The pre-field work also consists of the following main activities.

3.2.1 Preparation of questionnaires:

The necessity for acquiring such information was felt on the basis of secondary information & the type of information acquired by direct observation during the reconnaissance field visit.

3.2.2 Base map preparation:

The base maps indicating permanent and artificial features such as roads, rivers, Habitation points, railway lines, forest areas & village location points were prepared in Arc view 3.1 software. For this, survey of India toposheet (73-M/2 & 73-I/14) were used as reference materials. The permanent fixtures were transferred in digital format through digitization , initially, the survey of India toposheet were georefernced using Geographic Latitude/ Longitude WGS 84 co- ordinate system.

3.3 Field Work :

3.3.1 Collection of ground truth information.

Initially rapid traverse of the test site was made to identify the sampling points on the FCC image and in the field. The exact locations of such variable feature were noted with help of GPS for assigning the training samples during Digital Image Processing. Detailed field investigations were carried out in various physiographic units. The entire field activities have been categorizes under following to develop interpretation criteria of ground features. At each site, the associated characteristics land cover/ land cover and socio-economic with environmental problems related information etc was collected.

3.3.2 Collection of Socio-Economic Data :

Mining operations not only affect the physical & biological structure of an area; it leads an overall change of the surrounds i.e. the socio - economic status. The loss of agriculture land & village settlement bring about a drastic change on demography & life style. It is, therefore, apparent that the development of mining changes the land use & landholding pattern all over the Raniganj area. The rural settlements of the region became urban with a shift in their functional structure. Prior to mining development, the means of livelihood of the local inhabitants were based on agriculture & forest. But the development of mining has brought about job opportunities with the subsidiaries, associated contractors & ancillary industries. It has also eliminated many traditional sources of income.

3.3.3 Sorting, out of tabulation of field data :

The socio-economic data collected from each of the house –holds selected randomly from 10 & 15 villages of Raniganj & Asansole blocks respectively were compiled, sorted out, & tabulated. The criteria of sorting out of the data has been based on the condition of changes on the land use/ land cover & their impact based on the responses recorded from each house - holds.

3.4 Post Field Work:

3.4.1 Analysis of field data:

The tabular information of ground truth was used while assigning training samples. Both ground truth information & socio-economic data were sorted out with respect to each cover type & village / house hold wise information from each block. The socio- economic data were tabulated in accordance with the required information, which express its linkage with the impact of coal mining activities. The point database of ground truth spots were created using ARC VIEW 3.1 and image processing in ERDAS IMAGINE 8.3.1 software. GPS (Global Position System) point (latitudes and longitudes) used for identification of training samples.

3.4.1 Digital Analysis of Remote Sensing Data:

The wide use of digital technique for image analysis is mainly because of the amenability of digital data through computer assistance techniques. In the present study, the *ERDAS IMAGINE* 8.3.1 system was used to perform the number of digital image enhancement techniques & digital image processing. The enhancement techniques include principal component analysis, band rationing, image subtraction various stretching techniques of the DN values, density slicing & addition (band combination for generative FCC's.

3.4.1.i. Digital Image Enhancement

Histogram equalization is one of the techniques of non- linear contrast enhancement. Histogram Equalization (Uniform Distribution Stretch) provided maximum contrast for identifying coalmines & other features. Spatial Feature Manipulation technique was applied for highlighting the forest vegetation & coalmines. Filter algorithms for performs image enhancement, they suppresses certain frequencies (de-emphasize) & pass (emphasize) other frequencies.

3.4.1.ii. Digital Classification:

The computer assisted digital classification technique has come to a stage for thematic mapping with all detailed information or more numbers of classes . The following types of classifications have been performed. The final out put of remotely sensed data is the thematic information depending on the objectives. The following types of classifications have been performed.

3.4.1.iia Supervised Classification:

Supervised classification(Fig. 3 & 4) procedures are the most important analytical tools used for the extraction of more information from remotely sensed digital image data. Supervised classification was performed using maximum likelihood classifier. In the present study, before starting this procedure the possibility of separation of each class was determined from various enhancement & unsupervised classification techniques. The digital data images of (IRS- I A)1989 & (IRS-1D) 1999 were geometrically corrected & masked according to the boundary of study area. .Remote sensing technology has been proved to be a very useful tool for mapping and monitoring of the land use and land cover classes (Pant & Singh, 1972). Supervised classification was performed using maximum likelihood classifier. The GPS points indicating geographical coordinates of each cover type, have been considered. The database for the features like road, villages, sample points, household samples for collecting Digitizing them on ARC VIEW 3.1 assigning the attributes generated the socio- economic data.

4. 0 Result & Discussion:

4.1 Impact Analysis :

In order to find out the impact of the social changes among land use/ land cover types, socio-economic responses were taken from different house holds of different villages falling in Raniganj & Asansol blocks. It was knows from the sample study that the following types of impacts are related to the coal mining activities & the subsequent changes among land use / land cover types(Flow chart-II).

- Land Subsidence
- Noise Pollution
- House Cracking
- Scarcity of Water
- Contamination of Water
- Air Pollution
- Changes in land use types due to reduction of suitable area for agricultural land.
- Disease due to Coal Dust.

The socio-economic data analysis recorded all the above impacts

Napur, Bellunia, Siarsole & Shreepur villages are less affected. Around 42% & 43.5 % of houses in Raniganj & Asansole blocks respectively are affected by house cracking. There are 26% & 8.75% areas in Raniganj & Asansole blocks respectively are affected by land subsidence. 44% 38.75% persons in Raniganj & Asansole blocks respectively are affected by noise pollution Environmental pollution due to coal dust cause respiratory diseases to the inhabitants of Raniganj & Asansole blocks by 6% & 10% respectively (Table I & Fig.2).

Water ponds are the main source of drinking water to the villagers. But these ponds are highly polluted by domestic waste & coal dust. In some places dense growth of water hyacinth on water ponds has created the scarcity of water.

Rice, Pigeon pea & wheat are major crops grown in this area. Increase in coal mining activities in the area converted agricultural land in to fallow / barren & degraded lands. Area under land subsidence is increasing due to underground coal mining. As a result of this water holding capacity of agricultural & other land is reducing .It was known all the type of impacts have been decreased as under above cause the failure of crops. Therefore, the farmers have left their farming & are forced to become laboures in the of other mining areas. Villagers are suffering from a respiratory disease known as pnumoneocosis, from ECL that 0.3 to 0.5-micron size of coal dust particles are harmful for lungs.

(1) Land Subsidence & Loss of Agriculture:

Land degradation & land subsidence arised due to coal mining activities. This kind of impact capacity of soil & resulting the failure of crops. In total, 8.75 % and 26% percent peoples suffered in Asansoleand Raniganj due to land subsidence. Their total agricultural lands are now converted in to fallow land / barren lands. The villages like Phatehpur, Barachak, Narsamuda & Egara villages are severely affected by land subsidence this kind of impact.

(2) Scarcity of Drinking Water:

Due to under ground mining, pond's water level & water on the wells went down & even most of the ponds get dried. Scarcity of drinking water for the number of house holds in Asansole & Raniganj blocks is found as 31.25% & 32% respectively. Phatehpur, Narsamuda, Barachak, Ratibati & Kalipharai villages are severely affected by this impact.

(3) Noise Pollution:

Under ground mining activities for coal extractions are carried out at a depth of to 800-900 mt. the process of coal blasting. It has caused a lot of noise problems. Narsamuda, Ratibati, Barachak & Tilayabad villages are mostly affected by this kind of impact. In Asansole & Raniganj area, around 38.75% & 44% villages are affected respectively due to this problems.

(4) House Cracking:

This is a major problem in both the blocks. On the basis of people's responses & the evidences at the spots 43.75% & 42% houses of the villages have developed cracks affected in Asansole & Raniganj blocks, respectively. House cracks were specifically developed due to under ground blasting for extracting the coal. Some houses have also got subsidence due to coal mining activity. Examples of house cracks were clearly seen in Kalipahari, Barachak, Ratibati, Narsamuda, Ttilayabad, Ramjeebanpur, Raghunathpur, Shreepur & Nischintapur villages.

(5) Respiratory Diseases:

Peoples of coal mining area are suffering from respiratory diseases. Presence of 0.3 to 0.5 micron coal dust particles are harmful for lungs.10% peoples of Asansole & 6% peoples of Raniganj blocks are affected by this disease based on the analysis of primary data, a few villagers of Ratibati, Narsamuda, Siarsol, Mangalpur & Baradhema are affected by this diseases.

Based on the secondary data recorded from ECL (Health Dept.) 8, 2, 11, 2 & 2 peoples (reported cases) affected , diseases due to coal dust have been recorded during the period 1994, 1995, 1996, 1997, 1998 & 1999 respectively (Table-II).

(6) Ecological Impact:

The major impact on existing land use / land cover during the major mining activities on land is the creation of an external over burden dump of mining waste materials. The patchy & continuous mining activities have degraded the forest & other land cover types. The lands are loosing their productive potential with the passage of time. The cracks developed on the land surface above underground mine are accelerating the soil erosion, land subsidence. & land submergence. This all have caused disturbance in vegetative communities in relation to loss of density & species richens reduction of bio- diversity. The contamination of water & subsequent loss of aquatics life has also become a serious impact. The villages actively induced in coal mining activities are Ninga, Ratibati, Narsamuda, Satgram, Baradhema, Barachak & Phatepur.

There are two types of coal mines viz. (1) Underground (2) Open cast . Both the types of mines are occurring on degraded/ scrub & agriculture land. Open cast mining was observed on almost fallow / barren land & plain area.

5.0 Conclusion :

Coal mining will continue to expand in foreseeable future in India , and an attempt has been made to bring out the adverse effects to mining and associated activities on land use. Extensive mining activities in Raniganj & Asansol blocks of Burdwan district, West Bengal , have changed the overall socio-economic condition & land use pattern of the area. It has also been highlighted that the effects are ultimately regional and invariably interfere with the natural regime of land, water and air. The main adverse impacts of such changes have been assessed in the field of water scarcity, water contamination & disease. The remotely sensed data of the year 1989 & 1999 has shown the excellent results with respect to land use / land cover changes. The analysis of primary data pertaining to the socio-economic condition of the sampled house holds has revealed the impact of these changes. The main adverse impacts of such changes have been assessed in the field of water scarcity, water contamination & diseases. The study reveals that the forest ecosystem and socio environment of the area near to mines being disturbed due to open cast coal mining. Remote sensing technique also helped in the identification of lineaments through which pollute material reaches to ground water. These changes have been verified on the ground through the responses given by the local peoples. Mine fire is one of the serious problems of Indian Coal Mining industry and needs serious attention. It is high time and a great challenge for the scientists, academicians, and industry people for preparing appropriate strategies and action plan for dealing with mine fires to minimise its menace. It can not only help in saving a lot of valuable coal resources which is lost due to burning, but also in reducing the adverse impacts on the environment.

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Table : I

Problems Due to Coal Mining Activities Based on Socio-Economic Responses (Raniganj & Asansole Block, Burdwan Districts, W. B.)

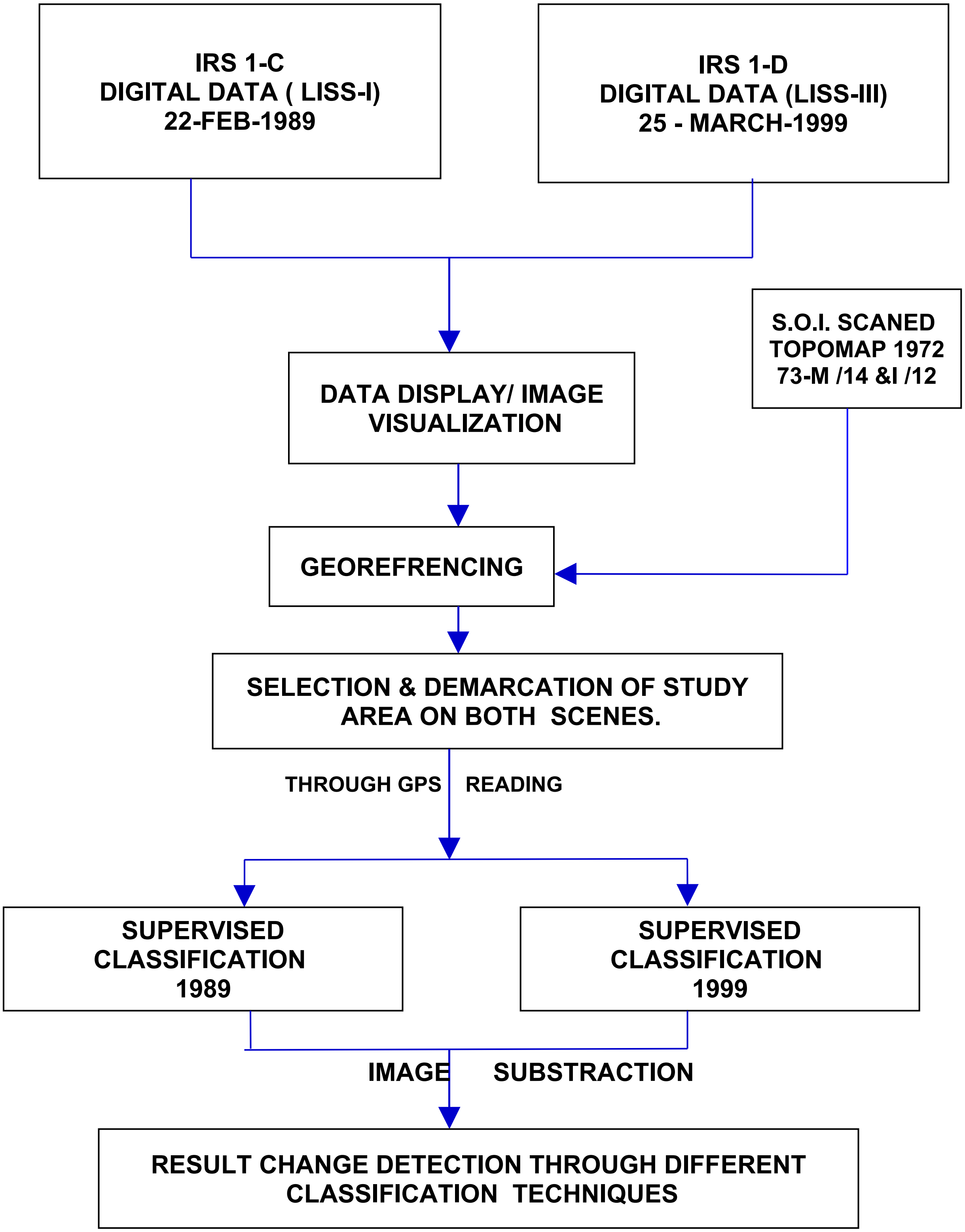
Sl. No.	Types of Problems	% of total house holds (Raniganj)	% of total house holds (Asansol)
1	Land subsidence & loss of agriculture	26%	8.75 %
2	House -cracks	42 %	43.75 %
3	Scarcity of drinking water	32 %	31.25 %
4	Environmental pollution due to coal dust etc.	6 %	10 %
5	Noise problem due to blasting	44 %	38.75%

Table : II

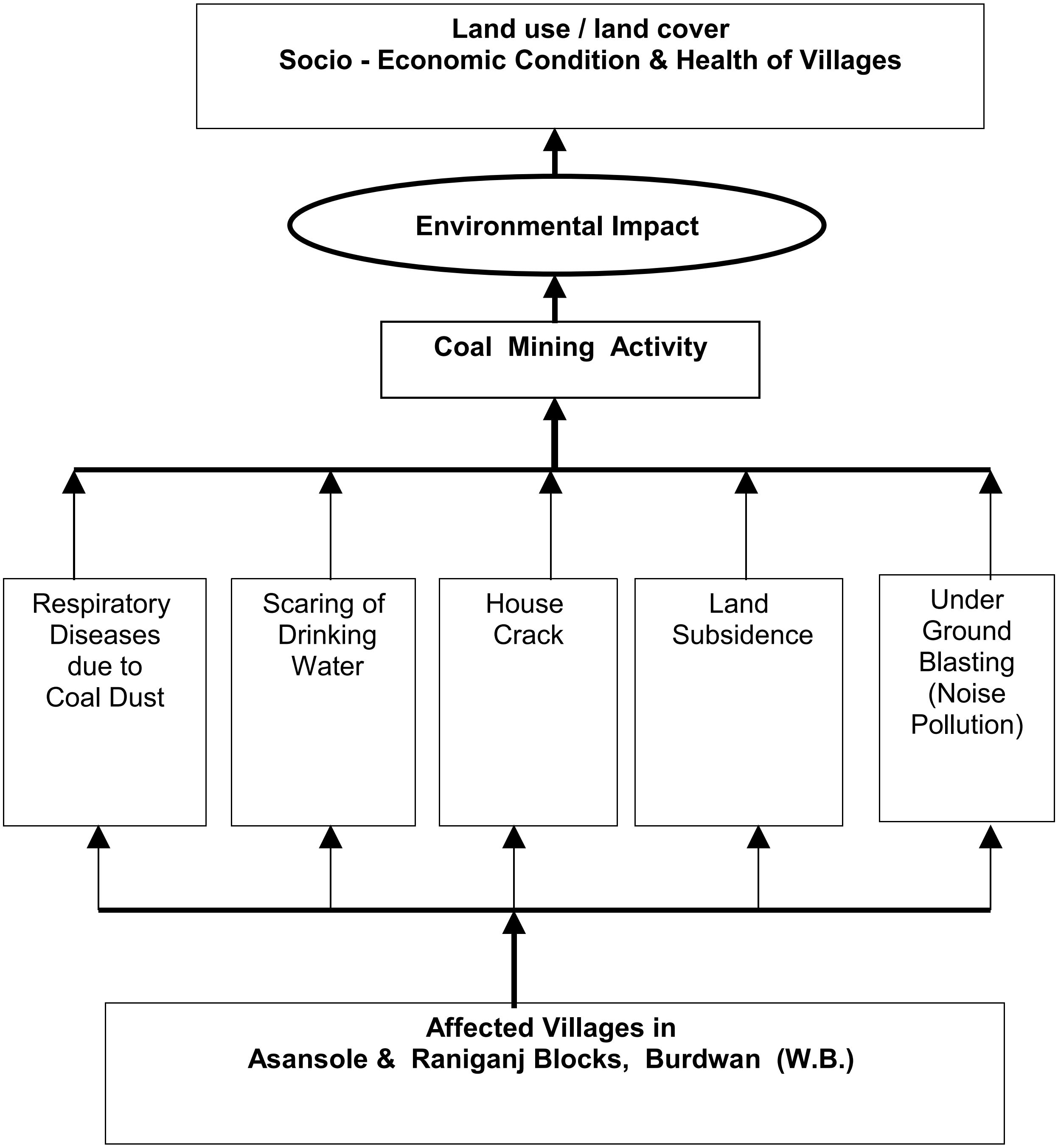
Year Wise Reported Cases Of Disease (Pneumoconiosis) Due To Coal Dust

Sl. No.	Year	Reported Cases
1	1994 - 95	8
2	1995 - 96	2
3	1996 - 97	11
4	1997 - 98	2
5	1998 - 99	2
6	1999 -2000	**

Source : ECL, Health Dept. , Sanctoria, W.B.



Flow chart: 1. STEP METHODOLOGY CUM APPROACH.
(DIGITAL ANALYSIS OF REMOTE SENSING DATA)



Flowchart: 2. Problems which are facing by Villagers

Fig. 1 open - Cast Mining- (Village - Mangalpur, Block - Raniganj)

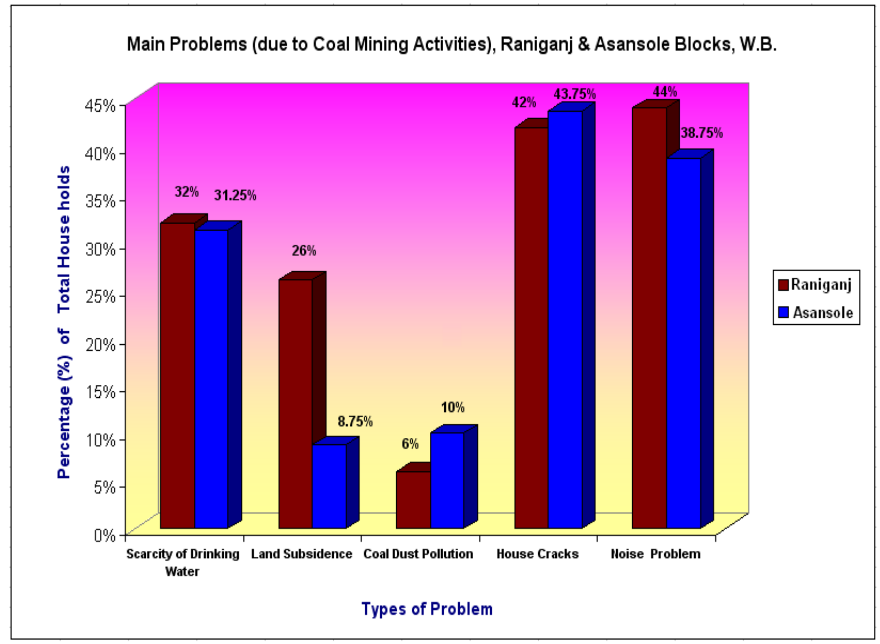


Fig.2

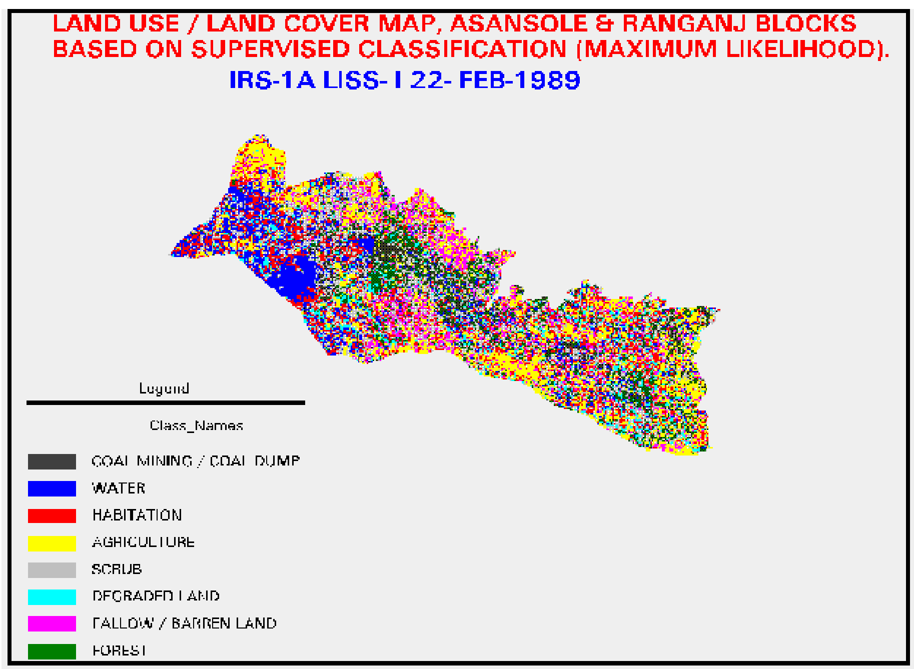


Fig. 3

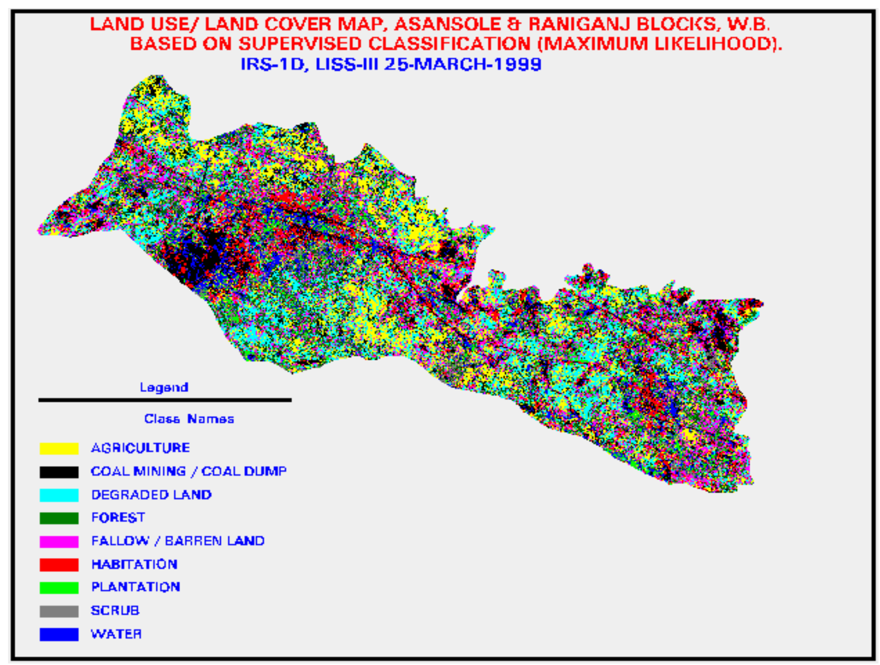


Fig.4