CHAPTER - 3

METHODOLOGY

The main objective of the present study was to evaluate and map the resource potential and to assess the environmental impacts arising out of mining and thermal generation. Both remote sensing methods as well as conventional methods were used during the study. In the remote sensing methods visual interpretation technique was used to map the various natural resources and for mapping of area affected by air pollutants especially dust and flyash and water quality of the reservoirs (plate 3.1,3.2,3.3 and 3.4). The ambient air quality in terms of Suspended Particulate Matter and various water quality parameters were measured by standard laboratory methods. The details of the methodology used in the present study is given below:

3.1 DATA PRUDUCTS

In the present study multidate satellite data pertaining to 1986, 1989, 1992, 1993, 1997 and 1998 were used. The details of the satellite data used are given in Table 3.1.

3.2 ANCILLARY DATA

The secondary and other collateral data used in the study were :

i. Survey of India topographical (SOI) maps on 1:50,000 scale- 63 L/12 & 16 and 64 I / 9 & 13.
ii. Mining maps and literature available from Northern Coalfields Limited (NCL).

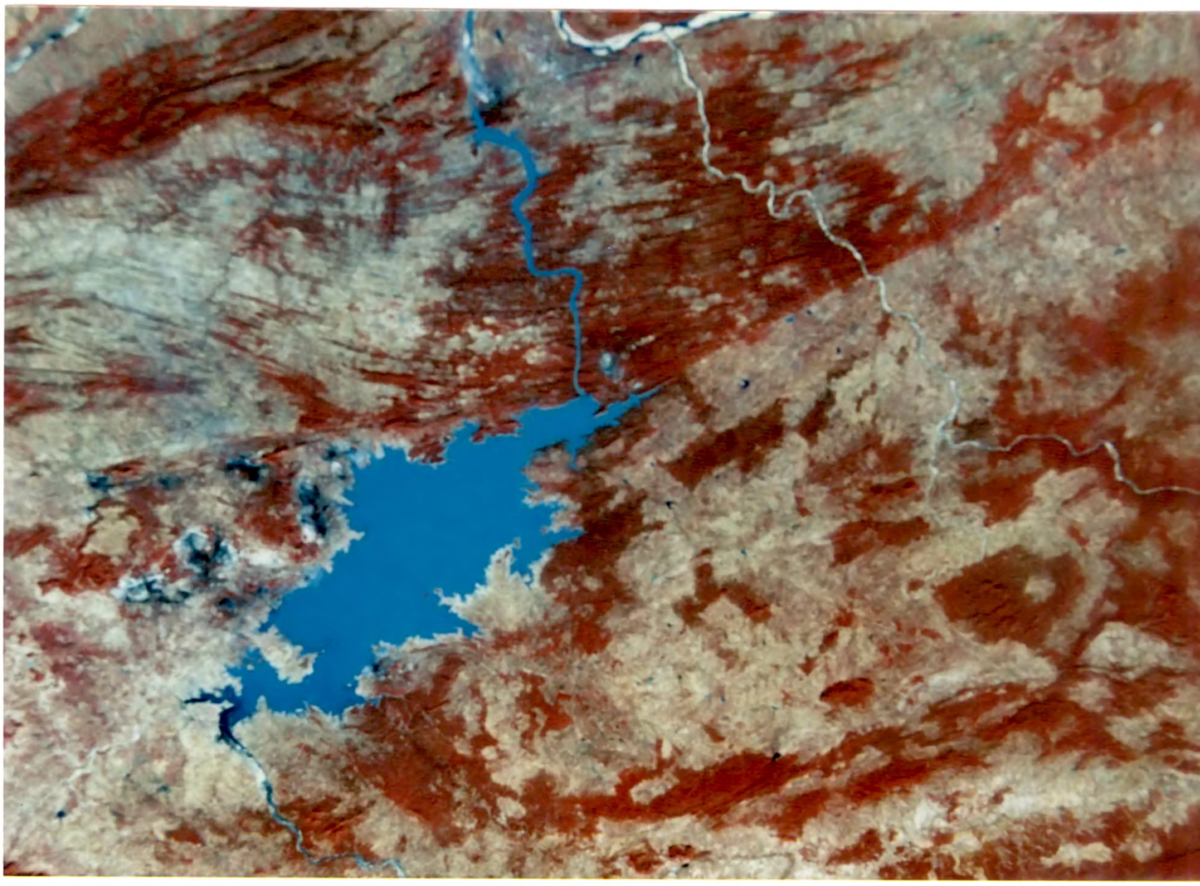

Plate 3.1 Satellite Data of Landsat TM (FCC) 4th March 1986.

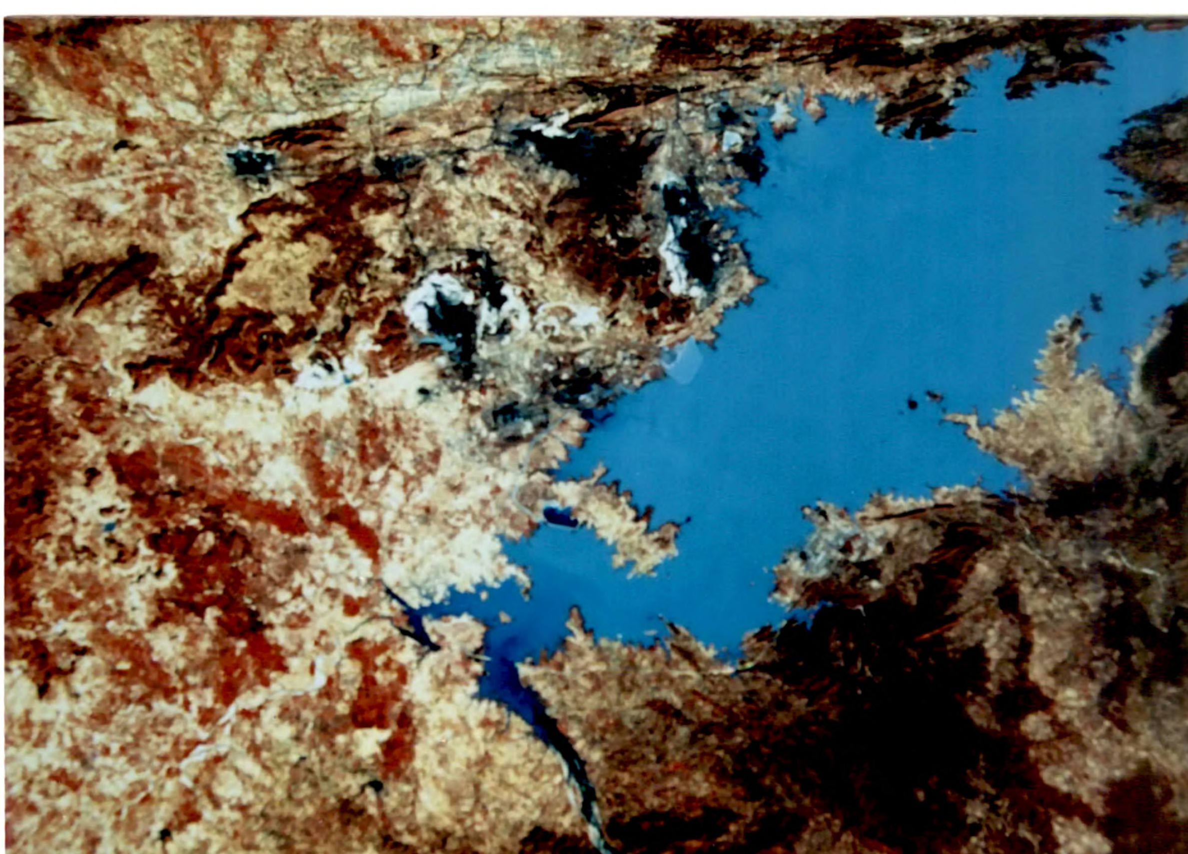

Plate 3.2 Satellite Data of IRS 1B (FCC) 4th February 1992.

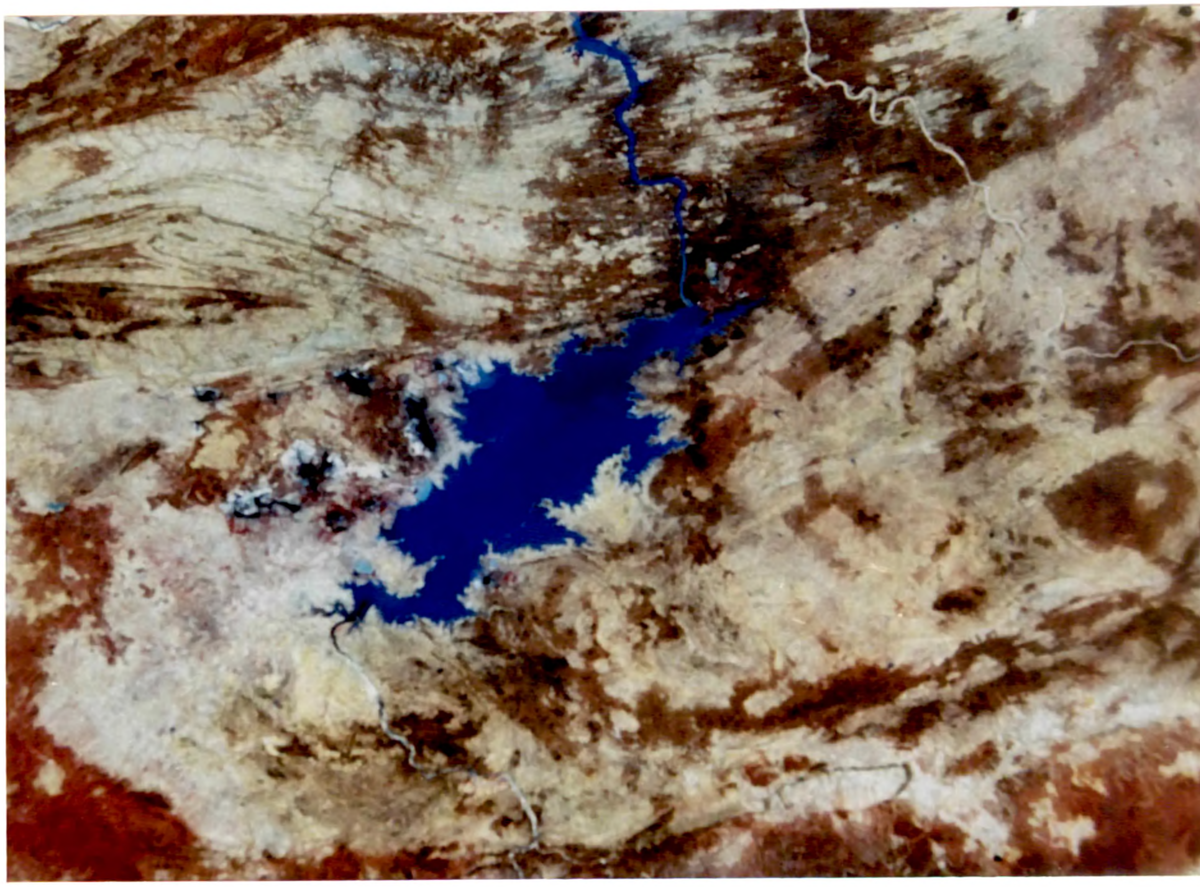

Plate 3.3 Satellite Data of Landsat TM (FCC) 4th May 1993.

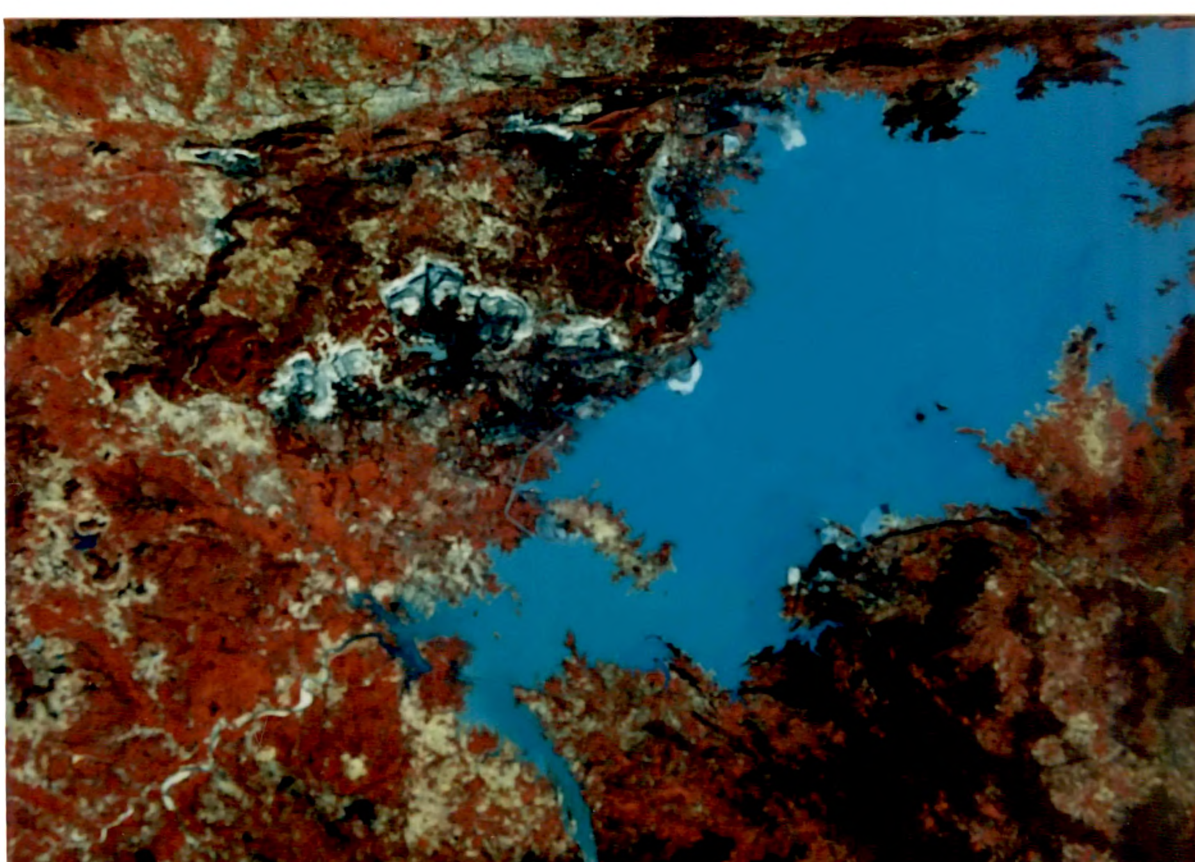

Plate 3.4 Satellite Data of IRS 1B (FCC) 5th February 1998.

Table 3.1 Satellite Data Used

S.No	Satellite	Sensor	Data Product	Date
1.	Landsat	TM	FCC	4 March 1986
2.	Landsat	TM	FCC	5 November 1986
3.	Landsat	TM	FCC	3 February 1989
4.	IRS - IB	LISS-II	FCC	4 February 1992
5.	IRS - IB	LISS-II	FCC	9 November 1992
6.	IRS - IB	LISS-II	FCC	4 May 1993
7.	IRS - IB	LISS-II	FCC	9 November 1997
8.	IRS - IB	LISS-II	FCC	5 February 1998

3.3 VISUAL ANALYSIS

Visual interpretation technique was used for mapping of landuse/landcover, slope, geomorphology, area affected by flyash deposition, change in stream courses and surface water spread. Prior to interpretation of multidate satellite data, a reconnaissance survey of the study area was done to develop a classification scheme based on local knowledge and ancillary information. An interpretation key was also developed based on standard photo-elements like tone, texture, size, shape, association, pattern, location etc. to identify and map different classes (Appendix I). With the help of interpretation keys, preliminary interpretation of satellite data were done after enlarging it to desired scale using Procom II.

3.3.1 Ground truth verification

Entire study area was visited to get an acquaintance of different ground features and cover types with respect to the satellite data. The doubtful areas on preliminary interpreted maps from satellite data were carefully verified in the field. Since it was not physically possible to collect the actual ground truth pertaining to older date, mapping was done for the current satellite data of (1998) and the same was used as a template to analyse the older data i.e. 1986 and 1992.

3.3.2 Base map preparation

Base maps were prepared using SOI topographical sheets on 1:50,000 scale. Various prominent land features like rivers, roads, railways and major settlements were marked on the base maps which acted as controls while doing mapping.

3.3.3 Final map preparation and area estimation

The final maps were prepared after transferring the finalized details of satellite imagery on to a tracing paper. Thus a set of landuse/landcover maps for different years were prepared. Prints of different maps were taken and these were used for area calculation. The areal extent of each class was calculated using digital planimeter. During estimation, every care was taken to move the dot exactly on the boundary of the theme, so that exact area could be estimated.

3.4 THEMATIC MAPPING

3.4.1 Landuse / landcover

Information on pre and post-mining landuse/landcover pattern and their spatial distribution forms the basis for any impact assessment. The landuse/landcover map were prepared for the year 1986, 1992 and 1998 using multidate satellite data . The pre-mining landuse/landcover map has been prepared from SOI toposheet for the year 1976. In order to monitor the change in landuse/landcover over a period, great care was taken in selection of temporal data. Ideally the data chosen should be of same date/season but due to non-availability of cloud free data, nearby period data was selected. Landuse/landcover map were prepared adopting the standard classification system (*Technical Guidelines, Landuse/Landcover Mapping using Satellite Imagery*, 1989, Part I and II, NRSA.). However for delineation of mining area classification is adopted as per area needs. The interpretation key developed for identification and mapping of different landuse/landcover categories is presented in Appendix II.

3.4.2 Slope, aspect and altitude

The information on slopes, aspect and altitude was derived using SOI toposheet on 1:50,000 scale. Based on All India Soil and Landuse Survey (*Soil Survey Manual, IARI*, 1971) guidelines, seven categories of slope were identified. For categorisation of different classes, the vertical drop was estimated from contour intervals, whereas horizontal distance in between the contours was obtained by multiplying the map distance with scale factor. Using the following formula slope was calculated :

$$\% \text{ Slope} = \frac{\text{Vertical drop}}{\text{Horizontal distance}} \times 100 = \frac{\text{Contour interval (m)}}{\frac{\text{Map distance (cm)} \times 50{,}000}{100}} \times 100$$

Aspect, altitude was also derived from the SOI toposheet directly. Slope, aspect and altitude is important for assessment of land capability. The categories of slopes and corresponding contour spacing on 1:50,000 scale are given in Table 3.2.

3.4.3 Drainage / surface waterbody / watershed

Survey of India topographical sheet on 1:50,000 and satellite data were used for preparation of drainage, surface waterbody/watershed map. Major rivers, streams and streamlets were drawn from SOI toposheets.

Table 3.2 Slope Classes and Contour Spacing on 1:50,000 Scale

S.No.	Slope category	Slope in %	Upper and lower limit of slope %	Upper and lower limit of contour spacing
1.	Nearly level	0-1 %	0-1%	> 4 cm
2.	Very gently sloping	1-3	> 1% upto 3%	> 1.33 cm and upto 4 cm
3.	Gently sloping	3-5	> 3% upto 5%	> 0.8 cm and upto 1.33 cm
4.	Moderately sloping	5-10	> 5% upto 10%	> 0.4 cm and upto 0.8 cm
5.	Strongly sloping	10-15	> 10% upto 15%	> 0.26 cm and upto 0.4 cm
6.	Moderately steep to steep sloping	15-35	> 15% upto 35%	> 0.11 cm and upto 6.26 cm
7.	Very steep sloping	> 35	> 35%	0.11 cm and less

The drainage network was overlaid on to the satellite data to mark change in water courses due to mining and overburden dumps. Waterdivide lines were drawn to find out the river catchment, then further subdivisions were made into a number of smaller sub-catchment and these sub-catchment were divided into watersheds. Hierarchical system of watershed delineation like region, basin, catchment, sub-catchment and watershed was adopted from All India Soil and Landuse Survey (AIS & LUS) of the Ministry of Agriculture. However, further subdivision of watershed was carried out on the basis of criteria developed by National Remote Sensing Agency, Department of Space, Govt. of India for development of land resources *(Technical Guidelines,IMSD,1995)*. Six level delineation system was followed :

1. Catchment
2. Sub-catchment
3. Watershed
4. Sub-watershed (30-50 sq km)
5. Mili watershed (10-30 sq km)
6. Micro-watershed (5-10 sq km)

3.4.4 Hydrogeomorphology

The hydrogeomorphological map was prepared by demarcating the lithology and geomorphic units and landform using satellite data on 1:50,000 scale. Gemorphic units, landforms were delineated based on photographical and geo-technical elements like tone, texture, colour, shape, association, drainage, slope etc. Structural information like fold, faults, fractures, lineaments, structures, trend lines and lithology was also incorporated to assess ground water potential of the area. The legend were classified based on origin and chronology. The youngest geomorphic units were placed on the top and oldest on the bottom of the legend. The available geological maps, published literature and other information were also used in enriching the geological and geomorphological details. The doubhtful areas were verified on the ground and after incorporating suitable corrections geomorphological map was finalised.

3.4.5 Soil

Soil map was prepared on 1:50,000 scale with the help of toposheet information, geology, geomorphology and by using image interpretation elements. Physiographic units were delineated based on variation in geology, landform, parent material, elevation, slope aspect, natural vegetation etc. Soil samples were selected on the basis of variability in the landform, geology and image interpretation elements (colour, tone, texture etc.) Horizon-wise soil samples were collected to analyse physical and chemical properties of soil. A location specific relationship with different geological formation, land cover condition and physiographic setting of the soil was established to facilitate interpretation work into information classes. (*Soil Survey Manual, Indian Agricultural Research Institute*, 1971). Based on the findings of the field studies, interpretation was modified and numerical values were assigned to each of the mapping unit. The mapping unit used in interpretation comprised individual soil series or association were transferred over the transparent overlays drawn from Survey of India toposheet.

Soil series, taxonomy, capability, suitability, irrigability was classified according to United States Department of Agriculture (USDA) Soil Taxonomy Classification System (*Key to soil taxonomy*, 1994).

3.4.6 Transport network, settlement location and village boundary

Transport network, settlement location and village boundary map was prepared on 1:50,000 scale from SOI toposheet. The extent of settlements were incorporated from satellite image wherever possible. In case of sparse distribution of individual hamlets, the main village location was shown. The village boundaries were drawn from small scale revenue map on 1"= 4 mile, after optical enlargement on 1:50,000 scale using Optical Pantograph.

The major classes of transport network i.e. roads and railway were demarcated. The roads were further classified into metalled and unmetalled road. Metalled road can have a black top or without black top. Unmetalled road were cart track and foot path.

3.4.7 Mapping of area affected by flyash / coal dust deposition

Satellite data were enlarged to 1:250,000 scale using PROCOM-II for the demarcation of areas adversely affected by flyash/coal dust deposition. Location of various mines and thermal power station were marked on the base map. The coal dust deposition in the vicinity of coal mines and coal handling plants were delineated on the basis of tonal variation of flyash and coal dust deposited areas on satellite data. Final maps were prepared for an area of 10 km radius around the mid point of thermal power station and coal mines.

For monitoring of ambient air quality, only Suspended Particulate Matter (SPM) was considered in the study. For measurement of SPM in ambient air, Gravimetric High Volume method was applied. The sampler was installed on the flat roof of the building at various zones for 24 hours. The concentration of suspended particle ($\mu g/m^3$) was computed by measuring the mass of collected particulates and the volume of air sampled.

3.4.8 Mapping of water quality

Based on tonal variation in satellite data qualitative assessment of surface water quality was done into clear water and polluted water. The mapping was done on 1:250,000 scale.

Water samples from various sampling stations viz. river (up-stream and down-stream), flyash pond, Govind Ballabh Pant reservoir were collected during pre-monsoon (February) and post-monsoon (November) for determining the trend in the pollution of waterbodies. Water samples collected were preserved in cold storage and analysed for Hydrogen ion concentration (pH), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), oil and grease within two days from the date of sampling. Analysis was done as per the methods of APHA, *Golterman*, ***et.al.,*** (1978) and *NEERI* (Anonymous 1986). The analytical procedure followed are as following.

Hydrogen ion concentration (pH) was measured on the spot with the help of portable battery operated digital instrument.

TSS was determined as residue left over on Whatman paper after filteration of known volume of sample as per the procedure in standard methods (Anonymous 1995).

TDS was determined as residue left over after evaporation of known volume of filtered sample (passed through Whatman paper) as per the procedure in standard methods (Anonymous 1995).

BOD was determined by diluation and incubation method. It was estimated as the decrease in Oxygen level after incubation in dark at 20^0c. for five days as suggested by NEERI (Anonymous 1986). COD was determined by potassium dichromate reflux method as per the procedure in standard method (Anonymous 1995).