CHAPTER - VIII
SUMMARY AND CONCLUSION

The present study carried out in Singrauli district of Madhya Pradesh where Singrauli coalfield is located, has economic and industrial significance, since apart from coal mining, power production units, cement plants etc are also present. Physiographically, the study area is mostly covered by low hills, plateaus in the north and undulating fertile plains in the south where agriculture is the dominant activity. However in the Central and Eastern part of the study area coal mining is the dominant activity. Geologically the study area is broadly represented by six series of formations i.e. Talchir, Barakar, Barren measure, Raniganj, Panchet and Mahadeva. The major rivers which traverse through the area are Son and Rihand, however smaller streams such as Kachni, Mayar, Matwani, Baliya nala and Bijul also flow through the area. Geomorphic units exposed in the area are Low lying flats, Structural Plateau, Structural Hills, Denudation Hills, Residual Hills, Colluvial foot slopes, and Badlands. Singrauli has a tropical monsoonal climate with extreme temperature ranging from 47.2°C in summer to 2°C in winter. The climate data analysis of 1978 to 2003 shows that the average minimum and maximum temperature has increased by 0.11°C, 0.44°C and 0.27°C for summer, winter and monsoon seasons respectively. The rainfall data analysis shows a decline of about 313 mm during the past 33 years from 1978 to 2010 which clearly demonstrates changing climate in the area.

The digital elevation model (DEM) and slope map has been generated from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data of 30 meter resolution. DEM shows higher elevations ranging from 501m to 618 m above MSL are confined to structural hills in north-west and central part, whereas elevation ranging between 477 m and 501 m above MSL are the characteristic of erosional plains in the north-east, north-west and central region. Low lying plains in central part and at few places in the north show elevation ranging from 406 m to 477 m above MSL. The lower elevations from 265 m to 406 m above MSL are confined along the plains of Tusa/Sasan and G. B. Pant reservoir in the southwest. The slope map derived from DEM was categorized into four classes of equal intervals i.e. gentle
Gentle slope (0° to 7°) is found in major part of the study area in north and south approximately covering 87.15% area, whereas moderate (7° to 15°) and steep slopes (15° to 22°) are encountered in parts of north, north-east and center covering 9.8% and 2.33% area respectively. Very steep slopes (22° to 29°) are scattered at small places in the north, north-west and centre along the east – west trending ridges occupying barely 0.71% area. The soil map represents four major soil types in the study area, namely Pelluderts (Deep black soil) is the dominant soil group which covers about 52.5% area mainly in the south on the gentle slopes (0° – 7°) representing elevations from 300 m to 406 m. Ustocherpts (Shallow Black soil) covers 23.5% area mainly in central part extending from east to west, generally found on all slopes representing higher elevations. Rhodustulls (Red and Yellow soil) covers 19.8% area in the north, confined to elevations ranging from 442 m to 548 m on gentle slopes (0° – 7°). Haplustslfts (Red sandy soil) covers only 4.2% area in the north east and central parts showing varying slopes from very gentle to steep with elevation ranging between 422 m and 618 m.

The main objective of this study is to assess land use/land cover changes using multi-temporal IRS data of 1993, 2001 and 2010 in a time series domain. Land use/land cover mapping has been carried out using visual image interpretation technique and land use/land cover categories such as dense forest, open forest, open scrub, cultivated land, uncultivated land, mining pit/operating mine, overburden dumps, wasteland, rocky barren/stony waste, settlement/built-up, ash pond, water body, thermal power plant, dry river channel and plantation have been delineated.

Land use/land cover change information can be obtained by map to map comparison. Map to map comparison has been adopted in which images were first classified and then maps were generated to compare the change in land use/land cover that has occurred. The analysis of remotely sensed time series data shows that major changes have taken place in last 17 years due to natural and anthropogenic activities. Dense forest has reported a loss of 48.9 Km² (6.7%) area out of which 24.58 Km² (3.37%) has been lost from 1993 to 2001 and 24.33 Km² (3.37%) from 2001 to 2010 primarily due to expansion of mining activities into deep inside the forest areas. Dense forest has also been degraded and changed into open forest due to clearing of
trees as a result of expansion of mining areas. Open forest show overall increase of 4.1 Km² (0.6%), but from 1993 to 2001 it shows a decline of 1.15 Km² (0.16%), however, from 2001 to 2010 an increase of 5.23 Km² (0.72%) area has been reported especially along the periphery of the G. B. Pant Sagar in the south east of the study area. Open scrub shows an overall increase of 17.7 Km² (2.4%) out of which 5.20 Km² (0.71%) has increased from 1993 to 2001 and 12.48 Km² (1.17%) from 2001 to 2010. This increase is mainly due to degradation of open forests and growth of scrub on the abandoned lands which were left vacant due to lack of irrigation facilities and resettlement of farmers to other places under rehabilitation schemes. Cultivated land has reduced by 21.2 Km² (2.9%) out of which 8.59 Km² (1.18%) was lost during 1993 to 2001, whereas 12.59 Km² (1.73%) was lost from 2001 to 2010. The area under cultivated land has reduced due to decline in rainfall which has affected rainfed agriculture as people have shifted from cultivation to the other occupation. Another reason is steady decline in water table over the years, leading to dry wells in many parts. Uncultivated land has increased by 4.9 Km² (0.7%) out of which only 1.6 Km² (0.21%) has increased from 1993 to 2001, whereas 3.3 Km² (0.46%) has increased from 2001 to 2010. The increase in uncultivated land is due to the conversion of cultivated land to uncultivated land because of decline in rainfall, decline in depth to water table.

The area under mining pit/operating mines has increased by 3.6 Km² (0.5%) out of which 0.9 Km² (0.12%) has increased from 1993 to 2001, whereas 2.74 Km² has increased from 2001 to 2010. The increase in mining pit/operating mines is necessitated due to increase in coal demand for industrial purpose. More coal production also produce more overburden material which show overall increase of 20.6 Km² (2.83%) area from 1993 to 2010, out of which 11.81 Km² (1.62 %) has increase from 1993 to 2001 and 8.80 Km² (1.12 %) from 2001 to 2010. Dense forest and open forest adjoining to mining pits/operating mines were mostly targeted for dumping of huge quantity of overburden material which results in development of artificial landforms and reduction in forest area. Area under wasteland has increased by 6.25 Km² (0.86 %) from 1993 to 2010, out of which 3.7 Km² (0.51 %) has increased from 1993 to 2001, and 2.55 Km² (0.35 %) from 2001 to 2010. The area under wasteland has increased due to the degradation of top soil and discharge of
chemical from industries and overburden dumps into open lands making them unsuitable for any use. Settlement/Builtup area has registered a major increase of 12.8 Km² (1.8%) area, mostly from 2001 to 2010 which shows rapid industrialization of the area demands more workforce and hence increase in demand for residential purpose housing. The increase clearly indicates that more workforce are coming to the region for jobs in industrial sector which results growth of villages, towns and cities. Ash ponds are used for disposal of ash generated by coal based thermal power plants which shows an increase of 6.14 Km² (0.85 %), out of which 2.60 Km² (0.36 %) has increased from 1993 to 2001 and 3.54 Km² (0.49 %) from 2001 to 2010. The number of ponds has also increased from 2 to 5 from 1993 to 2010 to dispose of huge quantity of ash. Major change has been observed in the surface water body which overall has lost 21.6 Km² (2.97 %) area in areal extent from 1993 to 2010, out of which 6.8Km² (0.94 %) from 1993 to 2001 and 14.8 Km² from 2001 to 2010, especially along the periphery of G. B. pant sagar. The loss of area is mainly due to decline in rainfall, siltation by washed out material from dump sites, increase in consumption of water in mining and for cooling of generators of thermal power plants resulting in lower reservoir level. Dry river channel has shown an increase of 2.9 Km² from 1993 to 2010 due to decline in rainfall leaving no runoff in the streams. Plantation by NCL and NTPC started from 1985 has bought encouraging results as the area under plantation has increased by 12.6 Km² from 1993 to 2010, out of which 5.90 Km² (0.81 %) has increased from 1993 to 2001 and 6.73 Km² (0.93 %) from 2001 to 2010. The plantation was mostly done under different scheme like operation green gold by NCL and social forestry scheme by NTPC in Dasauti, Nawanagar, Gharauli, Banauli, Gharda, Jayant colony, Saraswal, Ranibari, Kota, Hardua villages and Dasauti, Garda, which are now changed into NTPC and NCL residential colonies.

The study also makes an attempt to ascertain the quality of water by analyzing samples from the study area. Ten samples from surface water and seventeen samples from ground water have been collected for analysis, to assess the quality of water for drinking and irrigation purposes. The result of the analysis suggests that pH is slightly more than 7 which indicate alkaline nature of water. TDS is below 1000 mg/l in 15 samples which are in fresh water category and 12 samples exceed standard value and fall in brackish water category. So it indicates most of the samples (55%) are suitable
for use and rest (44%) is unsuitable for use. Most of the samples show slightly higher conductivity values than the permissible limit prescribed by WHO, 2011 but can be used for drinking, however two samples show higher value and fall in medium conductivity class I. Phenolphthalein alkalinity in the area is zero indicating absence of carbonate and hydroxyl ions. The value of total alkalinity ranges from 65mg/l to 585 mg/l, only eight samples show value within desirable limit and majority of the samples (19) indicate higher values of alkalinity. Total alkalinities higher than the desirable limit indicate pollution of water because of waste water runoff from the coal mine, industrial and residential areas. Total hardness of the samples ranges from 28mg/l – 148mg/l which indicates that water is soft to moderately soft.

The major cations Ca and Mg are within the desirable limit. Sodium exceeds the desirable limit which indicates high concentration in all samples and its suitability for irrigation or domestic use is not fit. Water classified on the basis of sodium percentage shows 81% sample are under doubtful, 14.81% under permissible limit and only 3.7% shows unsuitable for use. Potassium is within the desirable limit except sample No 8 (Baliya nalla) which shows higher concentration because water is directly discharge from coal washeries through this nalla which finally joins the GB Pant sagar. Chloride concentration is also above the desirable limit due to the wastewater coming from industries, municipal waste and combustion of coal. Sulphate values are within the limit in 25 samples but in rest 2 samples value is higher than the permissible limit.

The minor ions like copper and zinc are within desirable limits whereas nickel exceeds the desirable limit in 8 samples due to discharge of effluents from mine waste deposits, industries, residential areas and makes water unsuitable for drinking purpose. Iron in the study area is under desirable limit in most of the samples but 8 samples show values above the prescribed limit of W.H.O, 2011. Magnesium and Zinc in the water is under desirable limit which shows water is free from contamination of these elements. Cobalt shows higher values than desirable limit which results in poor quality due to mining or industrialization. Chromium value exceeds in 9 samples which suggests that water is not fit for drinking but in 18 samples it is within the desirable limit.
The irrigation quality of water has been classified by U.S salinity laboratory classification using SAR and Conductance values. 44% samples show low salinity with low sodium which clearly indicates that water may be used for irrigation. 44% samples depict moderate salinity with low sodium which shows this type of water is used with moderate type of leaching and plants have moderate tolerance and can grow without salinity control. 7% samples shows medium salinity and medium sodium water which depicts that plants should have moderate tolerance can grow with salinity control and water may be used on course texture or organic soil with good permeability. 3% sample cannot be used on soil and may produce harmful level of sodium exchange and require special soil management. This clearly demonstrates that water quality in the area is suitable for irrigation purpose at most of the places but near mining area and in Mahajan chowk (wasteland) area, water quality for irrigation is not suitable.

Residual sodium carbonate (RSC) has been determined to know the quality of water for irrigation. RSC analysis reveals that 14 samples (51.8%) fall in unsuitable class, 5 samples (18.5%) falls in Doubtful class and 8 samples (29.6%) fall under good class which suggests that at most of the places water is not suitable for irrigation purpose.

The water composition in the area can be identified by using hydrogeochemical facies in piper trilinear diagram, 85% of the sample falls in area 7 whereas 11% in the area 9 which indicate two types of water composition. The field 7 is the dominant type indicates Na-Cl or Na-HCO3-Cl type non-carbonate alkali exceeds fifty percent and the chemical properties are dominated by alkalies and strong acid whereas field 11 shows no one cation-anion pair exceeds fifty percent.

Moreover, industrialization has also been responsible for land use/land cover changes in the area, polluting the land and water resources. The study based on multi temporal remotely sensed data demonstrates that coal mining and its associated activities are responsible for major change in land use/land cover. This is evident from the poor quality of water, land degradation, depletion of forest cover, shrinkage of cultivated land etc.
The study has presented the latest status on the environmental degradation of the area which has been monitored using time series remotely sensed data. It has brought out the major land use/land cover changes taken place as a result of rapid industrialization due to coal mining and its associated activities. Water quality in the area has also been severely affected due to mining activities which has led to many adverse impacts. Efforts should be made by NCL, NTPC and other industries operating in the area to make an ecological balance by taking extensive plantation drive in the region. Moreover, efforts should be taken up as a corporate social responsibility (CSR). Safe methods of waste disposal should be followed by industries so as to minimize the soil and water pollution prevailing in the area.