CHAPTER 3

STUDY AREA

3.1 Description of the study area

The study area lies in the eastern part of the state of Madhya Pradesh (M.P) falling in the Singrauli district and few portions lie in the north-east Sonebhadra district of Uttar Pradesh. The study area is covered between coordinates latitudes 24°00′ to 24°15′ North and longitudes 82°30′ to 82°45′ East. The area has been developed as one of the largest thermal power complexes. In November 1985, the area was renamed Northern Coalfields Limited (NCL) with its headquarter at Singrauli.

The coalfield area is well connected by motorable road with Varanasi (220 km), Mirzapur (215 km), Rewa (206 km) and Siddhi (130 km). The nearest railway station is Singrauli on the Chopan-Katni line passes parallel to the northern periphery of the coalfield and Renukut which is 45 km from Singrauli.

It is spread over nearly 2,200 km^2 but only a small part of the coalfield, around 300km^2 area is exploited for coal. It is covered by the Survey of India Toposheet No. 63L/12. The mining block of the singrauli is roughly W-shaped. The Singrauli Coalfield has been divided into eleven mining blocks viz. Khadia, Dudhichua, Jayant, Moher, Gorbi, Kaki, Bina, Marak, Nigahi, Amlohri and Jhingurdah. They contribute 101.50 MT in 2018-19, approx. 14% of the total coal production through mechanized opencast mining.

The Singrauli coalfield can be divided into two basins, viz. Moher sub-basin is situated in the northeast and the main basin situated in the southwest. The Moher sub-basin is promising and actually has better-developed coal seams and the main basin is largely unexplored. The present coal mining activities and future blocks are concentrated in the Moher sub-basin. The major part of the Moher sub-basin lies in the Singrauli district of Madhya Pradesh and a small part lies in the Sonebhadra district of Uttar Pradesh. The location map of the study area is shown in Figure 3.1.

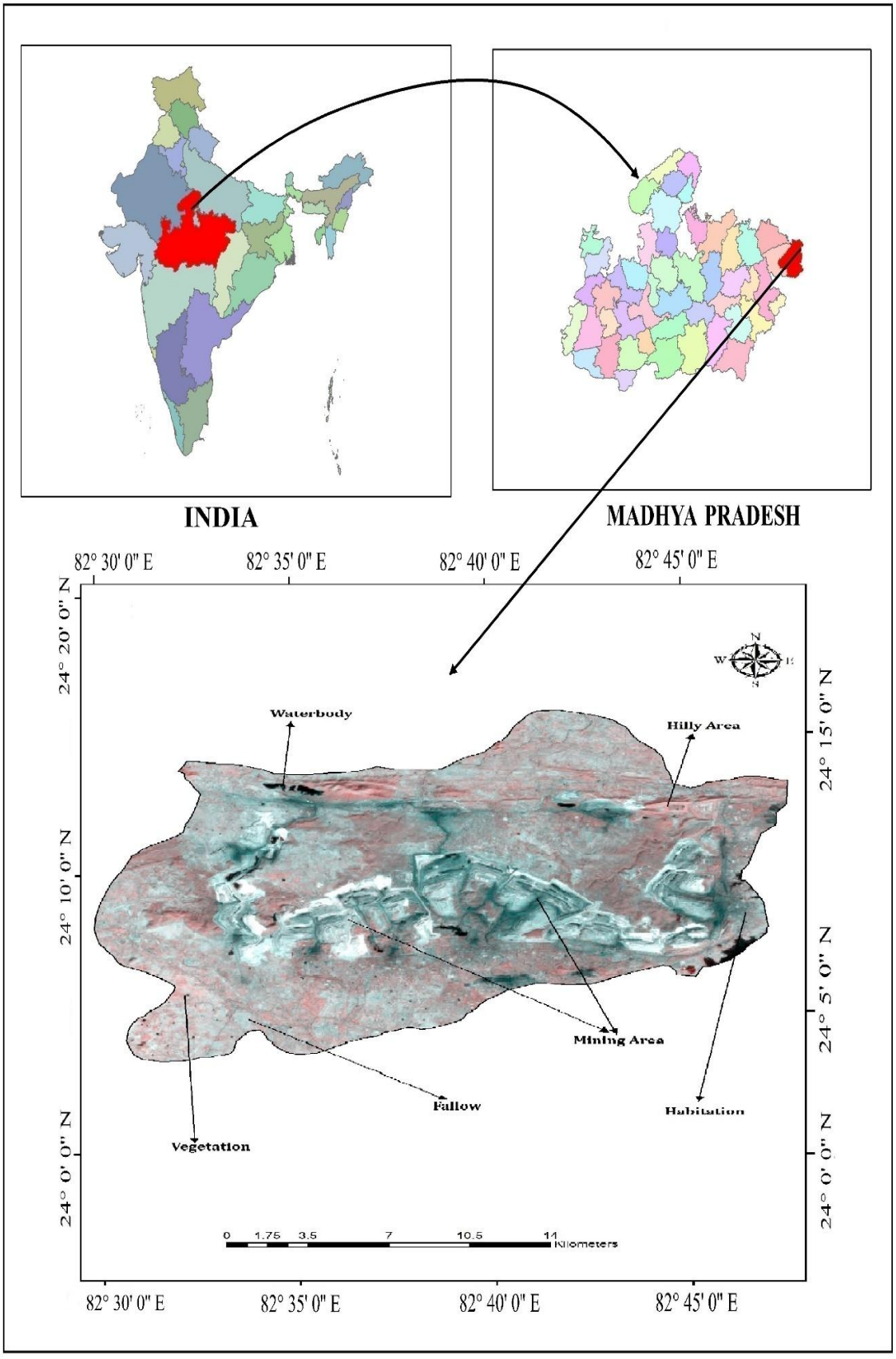

Figure 3.1 False Colour Composite (FCC) of the study area

Several energy-producing industries such as Singrauli super thermal power plant, Vindhyachal Super Thermal Power Plant, Northern Coal Limited, Kanoria Chemicals are regularly rising the amount of pollution via disposing of organic, inorganic, degradative non-degradative materials in the local environment which affect the human health

The major towns in the study area are Singrauli colony, Gorbi colony, Jayant colony, Jhingurdah colony, Teldha, Waidhan, Majan, Naugarh, Pipra, Tusa, Sasan, Kota Basti and Dasauti, however, the main town is Waidhan which is also the district headquarter of Singrauli. As per the 2011 census, the total population of the district is 11, 78132 which constitutes 1.62% of the state population. The population growth in Singrauli during the 2001-2011 period is about 28%. The district comprises 728 villages having a population density of 208 persons per sq. km in 2011. Singrauli has an average literacy rate of 62.4% which is less than the national literacy rate of 74.04 % whereas male and female literacy rates are 73.8% and 49.9% respectively (http://www.singrauli.nic.in, http://censusindia.gov.in/).

3.2 Topography of the study area

The contour map of the study region was derived from ASTER Satellite data and GDEM with a resolution of 20 m and which shows a typical erosional topographic landscape with plain and plateau. The study area is undulating and hilly terrain. The coal mining project is located on elevated grounds. The mining block area maintains an undulating rugged topography sloping toward east, west and south. The coalfield stands as a high plateau over the surrounding plains covered by Talchir sediments and the base of the plateau extends with elevation around 300m above MSL. The general elevation above mean sea level (MSL) varies from 220 meters on the plain to over 500 meters on the plateau. Physio-graphically, the eastern part of the study area in the U.P. is characterized by a

cluster of hills and plateau to the north and undulating plain to the south. Towards the north-west and western region, several high elevation areas (Near Amlohri mine Block) such as Khadia Tola (490 m) and Mukhiya Tola (482 m) are prominent geomorphological topographic features. The mining of coal by opencast methods causes changes in topography. The contour map of the study area is shown in Figure 3.2.

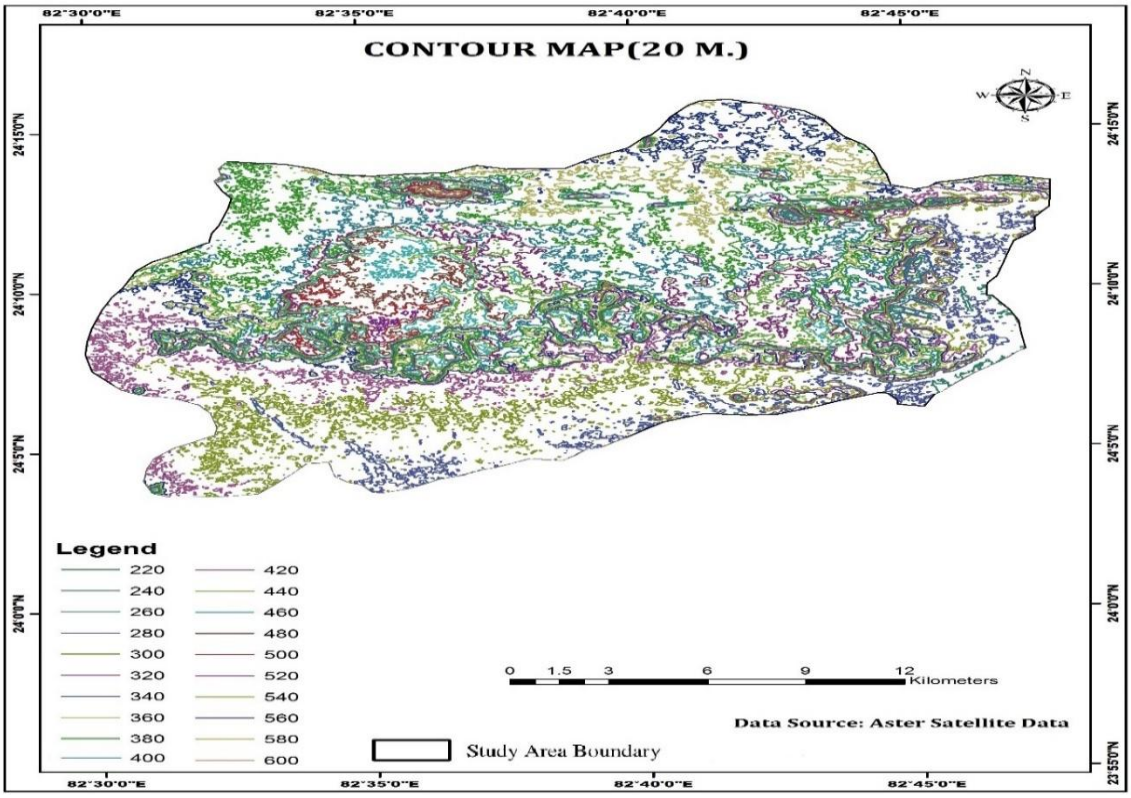

Figure 3.2 Contour line map of the study area

3.3 Geomorphology of the study area

The Geomorphological map is created by digitizing the geomorphology map of the study area obtained from the BHUVAN (http://bhuvan.nrsc.gov.in). The Singrauli coalfield occupies a junctional region between the east-west trending Damodar-Koel-Tatapani graben and North West –Southeast trending rift zone of the Son Mahanadi valley (Rao, 1983). The main different geomorphic features of the study area are Structural hills, Structural Plateau and Low-lying flats (both pediment and peneplains). Structural hills

occupy from east to west part of the study area and are represented by a series of east-west trending strike ridges formed by resistant Precambrian rocks. Low lying flats area is located mostly in the northern and southern portion of the study area. Low-lying flats characterized by a gently-undulating topography with a general slope towards south-east in the central part of the areas. Figure 3.3 represents a geomorphological map of the study area.

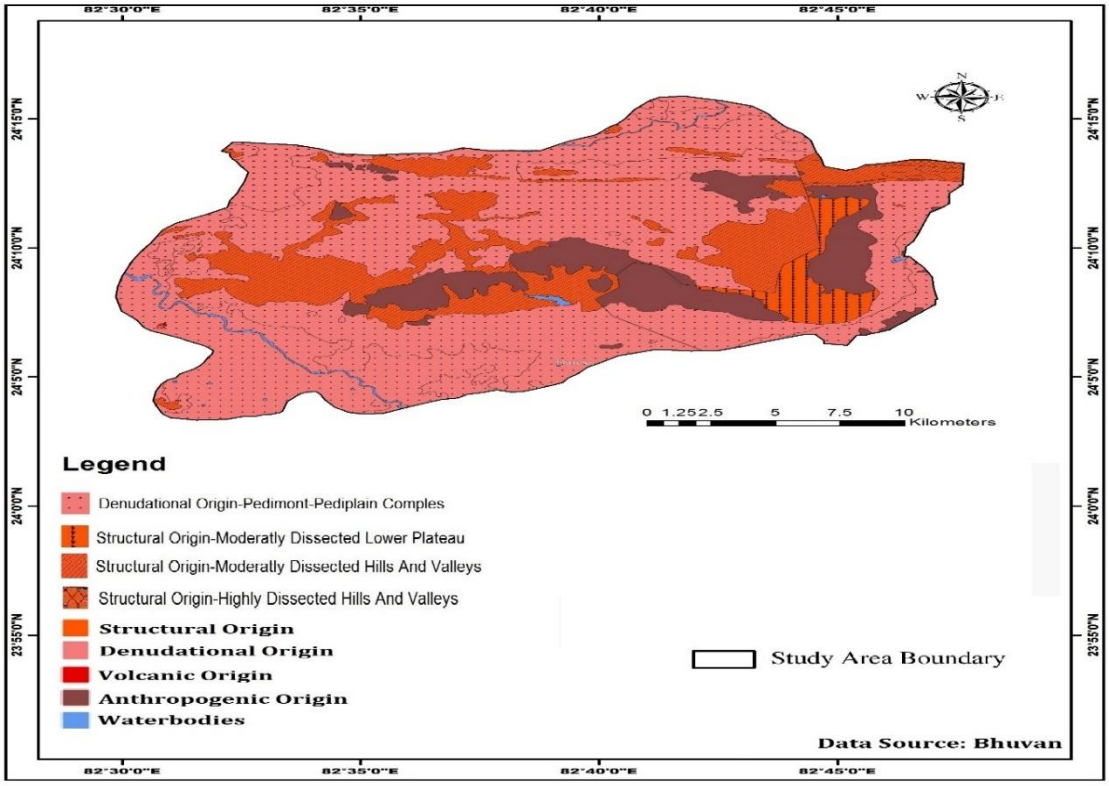

Figure 3.3 Geomorphological map of the study area

3.4 Geology of the study area

The geological map was collected from the Central Mine Planning & Design Institute Limited, Singrauli and digitized in ArcGIS platform. The Geology of Singrauli coalfield and adjacent area has been studied in detail by Rao, (1986); Mishra and Singh (1990); Vishnu et al., (1990); Majumdar and Sarkar (1994); CMPDI, (2005); Singh and Singh (2006) and others. The Singrauli coalfields are divided into two Basin namely Main Basin

and Moher-sub basin. The sediments of Permian representing Talchir, Barakar, Barren Measures and Raniganj formations are extensively exposed in the Moher sub-basin whereas the Triassic sediments belonging to Panchet (Pali) and Mahadeva (Parsora) formations are mainly confined to the Singrauli main sub-basin. The Northern part of the study area is covered with Metamorphics. The only difference between both the sub-basins lies in the amount of coal reserves found in them.

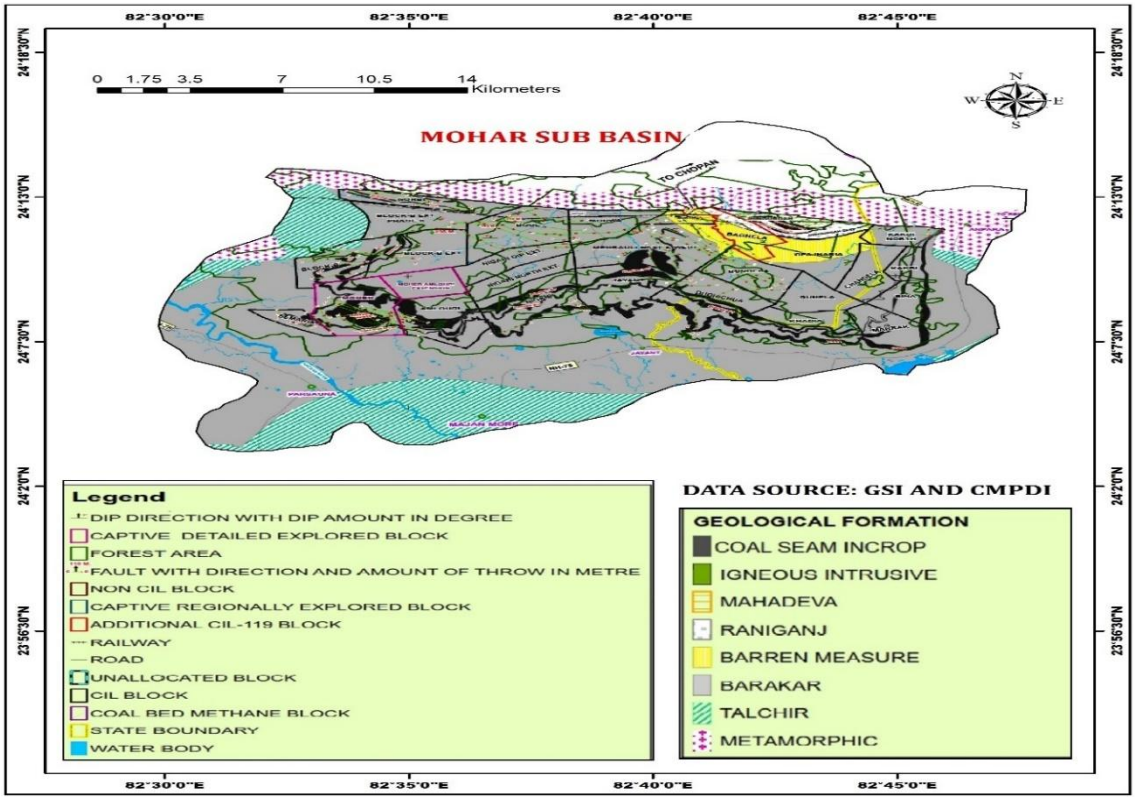

Figure 3.4 Geological map of the study area

The Singrauli coalfield occupies the junctional region of the east-west trending Koel-Damodar and northwest-southeast aligned Son-Mahanadi valleys. The northern limit of the coalfield is defined by the east-west trending boundary fault, which is probably an offshoot of the Son-Narmada lineament. The Geological map of the Singrauli coalfield is shown in Figure 3.4**.** The General stratigraphic succession of the coal-field is given in Table 3.1.

Table 3.1. General stratigraphic succession of the Singrauli Coalfield (Vijaya et al. 2012).

Age	Formation / Group	Thickness	General Lithology
Recent			Alluvium
Cretaceous	Basic intrusive		Dolerite dykes and sills
Early Triassic	Pali (Panchet)	700 m +	Greenish yellow to reddish yellow, medium-to-coarse grained sandstone with variegated siltstone and clay
Late Permian	Raniganj	215 – 400 m	Fine-to-medium grained dirty to buff coloured subarkosic to feldspathic wacke with alternation of thin lamination of grey and carbonaceous shale along with impersistent coal seams
Middle Permian	Barren Measures	110 - 300 m	Dark brown to brownish yellow to greenish grey, medium-to-coarse grained flaggy sandstone with thin grey clay bands in between
Early Permian	Barakar	325 - 550 m	Dirty white fine-to-coarse grained sub-arkosic to arkosic sandstone along with siltstone, shale, carbonaceous shale and coal seams
Early Permian	Talchir	75 - 230 m	Dark greenish grey to grey shale, fine-grained sandstone diamictite, siltstone pebbly sandstone and boulder bed
----------Unconformity----------			
Precambrian	Mahakoshal		Granite, gneiss, quartzite, phyllite, schist and pegmatite

3.4.1 Precambrian Basement

The Precambrian basement, on which the Gondwana sediments rest with a profound unconformity, comprises schists and gneisses in the south as well as quartzites and phyllites in the north. A series of ridges, comprising meta-sediments, demarcate the northern boundary of the basin in the north-eastern part.

3.4.2 Talchir Formation:

Talchir formation represents the basal part of the Permian sediments and comprised of sandstone, shale and boulder bed. It is gradationally succeeded by the Barakar formation. This formation is characterized by an alternating sequence of coal seam; medium to coarse, massive sandstone; shale, carbonaceous shale with occasional clay lenses. In the eastern part of the coalfield, the Talchir Formation is exposed in the south and east. A narrow strip of Talchir formation is also exposed around Parari village in the north-

western part of the coalfield. The thickness of the outcrop varies from 3 km to 8 km which increases towards the west. The strata are only about 50 m thick and have limited development as compared to the main Talchir outcrop in the south. A large part of Talchir formation has been submerged by the G. B. Pant reservoir in the southeast of the study area (Rao, 1983).

3.4.3 Barakar Formation:

The Barakar Formation, to which the study pertains, covers a large tract in the eastern to western part of the coalfield. Barakar is the most important Gondwana formation of the coalfields since it contains the coal seams of the area. The rock type in Barakars is predominantly coarse, arkosic sandstone with pebbly inter-bands, carbonaceous shale, fir clays and coal seam. The upper Barakars are coal-bearing formations, whereas the lower Barakars are devoid of any coal seams. The Barakar Formation hosts six coal seams viz. Kota, Turra, Purewa Bottom, Purewa Top, Khadia and Pani Pahari seams from bottom to top separated by inter-seam partings of sandstone and shale. On average, the Barakar Formation is constituted of 68% sandstone, 6% shale and 26% coal. The Singrauli Coalfield has eleven mining blocks of which coal-bearing sequences of nine blocks such as Khadia, Dudhichua, Jayant, Kakri, Bina, Nigahi, Amlohri, Krishnashilla and Block B belong to the Barakar Formation, whereas the Jhingurdah mining block is in Raniganj Formation. All the nine mining blocks of the Barakar Formation have three coal seams, i.e., the lowermost Turra seam, middle Purewa bottom and the uppermost Purewa top coal seam. Following five coal seams occur in Barakar Formation are given below:

3.4.3.1 Kota seam:

Kota Seam is a very thin seam and it also that is in the Karharbari Formation. Kota seam is the lowermost coal seam in the Moher Basin. The thickness of the coal seam varies

from 0.35 to 3.16 meters. Kota Seam is commercially uneconomical and at present non-workable. The seam is very inconsistent and erratic in its lateral and horizontal extension.

3.4.3.2 Turra Seam:

Turra seam is the most potential coal seam of the Moher Basin occurring almost in all the blocks right from Kakri in the east to Block-B in the west just like a necklace around the hill. The Average thickness ranges from 17 to 18 meters.

3.4.3.3 Purewa Seam:

Purewa seam is occurring in two sections in the eastern and southern part of the Moher basin as Purewa Bottom and Purewa top seams. While in the western part, both the section coalesce into Purewa merged seam. The thickness of the Purewa bottom seam ranges between 8 to 15 meters. Purewa seam is highly interbanded. Purewa top seam, where it is occurring as top section ranges in thickness between 5 to 9 meters. In the western part of the basin, especially in Moher and Block-B, the two sections of the Purewa seam have merged into one seam as Purewa merged seam. The thickness of the combined seam is 25 meters (approx.).

3.4.3.4 Khadia Seam:

A local seam ranging in thickness between 1 to 2 meters occurs in Khadia but It is not developed as a workable seam anywhere. This is occurring 40 meters above Purewa Top.

3.4.3.5 Pani Pahari Seam:

Pani Pahari seam is occurring approximately 150 meters above the Purewa Top. The thickness of the Pani Pahari seam varies from 1 to 2 meters and this seam has not developed as a workable section in any of the blocks. Panihahari seam, Khadia seam, Purewa Top, Purewa Bottom, Turra seam and Kota seam belong to the Barakar Measures about 250 million years old (Tripathi and Dutta 1967).

3.4.4 Barren Measures

Barren Measure formation was first identified around Jhingurdah Village in the north-eastern part of the coalfield. The succeeding Barren Measures Formation is composed of very coarse- to fine-grained ferruginous sandstones, green clays and shale beds. In the western part of the coalfield of Main Basin, Barren Measures cover a large tract and are overlain by Raniganj formation. In this area coarse to very coarse-grained, white to yellow feldspathic sandstone, are ferruginous near the outcrop represents Barren measure. Carbonaceous shale and greenish shale are common in this part of the coalfield (Rao, 1983).

3.4.5 Raniganj Formation

The Raniganj formation covers an area in the northern part of the study area and the Raniganj Formation is disposed in a semi-circular pattern (Figure 3.4). It attains a thickness of about 400 meters. Jhingurdah Colliery is in Raniganj Formation and has the thickest coal seam (134 m) in India. It also has the deepest basinal area among all other collieries of this coalfield. The Raniganj formation is characterized by an alternating sequence of sandstone, coal seam, shale, carbonaceous shales and clays in this area (Table 3.1). The two types of coal seam are occurring in the Raniganj formation namely Jhingurdah Top and Jhingurdah Bottom.

3.4.6 Panchet Formation

Panchet (Pali) and Mahadeva (Parsora) formations are mainly confined to the Singrauli Main sub-basin. The Rocks described to Panchet formation are exposed in the Latajharia, Harauri Nalas and Gopad River (Main basin) section in the southern part of the coalfield. The rocks of the Panchet Formation lie unconformably over the Lower Gondwana Group of rocks and crop out in deep gorges cutting across the Mahadeva ranges. The Panchet

Formation is overlapped by the Mahadeva Formation by an angular discordance. It comprises a basal conglomerate bed consisting of sand, shale and coal pebbles derived from the underlying beds, coarse- to fine-grained ferruginous sandstones, yellowish to reddish clays, siltstones and shale beds.

3.4.7 Mahadeva Formation

Mahadeva beds having a great thickness covers a large tract in the southern and south-western parts of the coalfield up to the southern periphery. Excellent sections of Mahadeva beds are exposed west, south-west, south-west and south of the Gopad River. Mahadeva Formation comprises massive, thickly bedded and medium to coarse-grained sandstones with a yellowish to dark brown coloration. The sandstones are hard and resistant to weathering.

3.5 Hydrogeology

The study area underlain by different geological formations such as Barakars, Talchir and Metamorphic formations has different aquifer characteristics. The occurrence and movement of groundwater in different formations vary with rock type. The aquifer unit is present above the working coal seams are the major sources for groundwater inflow into the proposed mine working. With the presence of shale and compaction, the seepage from the floor may be considered as negligible. The major lithological water-bearing unit is Barakar sandstone which is medium to coarse and easily susceptible to erosion. The permeable formations within Raniganj formation behave as aquifer units and the thick coal seams and shale beds behave as impermeable beds i.e. Aquiclude. The three coal seams and shale beds behave as impermeable beds i.e. Aquiclude (Purewa top, Purewa bottom and Turra seam). The formation comprising mainly of alluvium, weathered sandstone and sandstone (thickness up to 98 m) lying above the topmost working seam

purewa top and behaves as the top phreatic aquifer. Whereas the lower formation consisting of compact sandstone with secondary porosity and behaves as semi-confined to the confined aquifer (CMPDI, 2005).The groundwater recharge zone is the western higher plain (RL>400m) covered with forests and the discharge area is Govind Ballab Pant Sagar located in the southeast (RL< 270m). The hydrogeological investigation carried out by CMPDI in the mining area reveals that the Transmissivity and permeability of the aquifer system lying above the working seam area are 82 m^2/d and k=1.0 m/d respectively.

3.6 Slope of the study area

The slope map of the study area was extracted from DEM generated from ASTER data and exported to ArcGIS software. The slope has been categorized into four classes i.e. gentle (0°- 4.24°), moderate (4.25°-14.03°), steep (14.04°- 39.16°) and very steep (> 39.16°) are shown in Fig. 3.5.

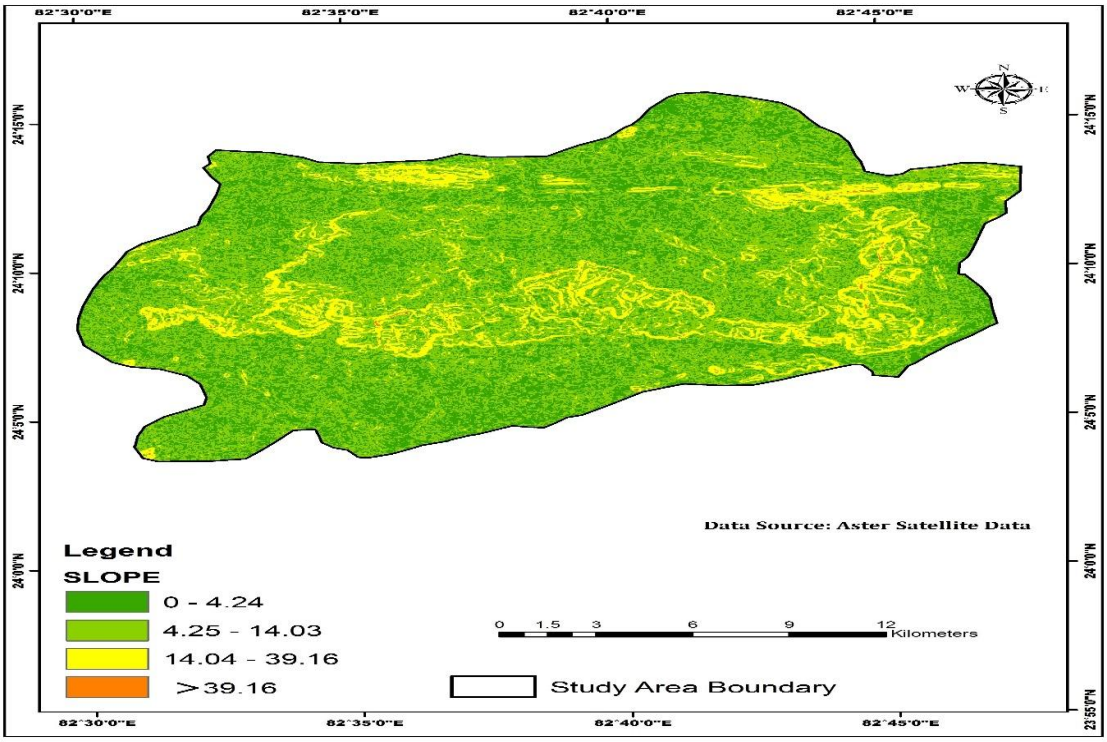

Figure 3.5 Slope map of the study area

Gentle slope (0°- 4.24°) is reported from the major part of the area in north and south, whereas moderate (4.25°-14.03°) and steep slope (14.04°- 39.16°) are encountered in the north, north-east and central part, very steep slope (> 39.16°) are present in the east and central part along the east-west trending ridge. The steep slope has occurred at the central portion of the study area in W-shape due to the overburden dump. The overall overburden dumps slope will be kept at 28° to prevent the dump slide. The coal mining project is located on elevated grounds.

3.7 Soil characteristics of the study area

The soil map of the area has been collected from State Agriculture Management and Extension Training Institute and digitized in the ArcGIS platform.The eco-environment, topography and soil have been substantially disturbed by mining activities.The soil thickness varies from 3m to 6m. Soil cover is very thin on the plateau.

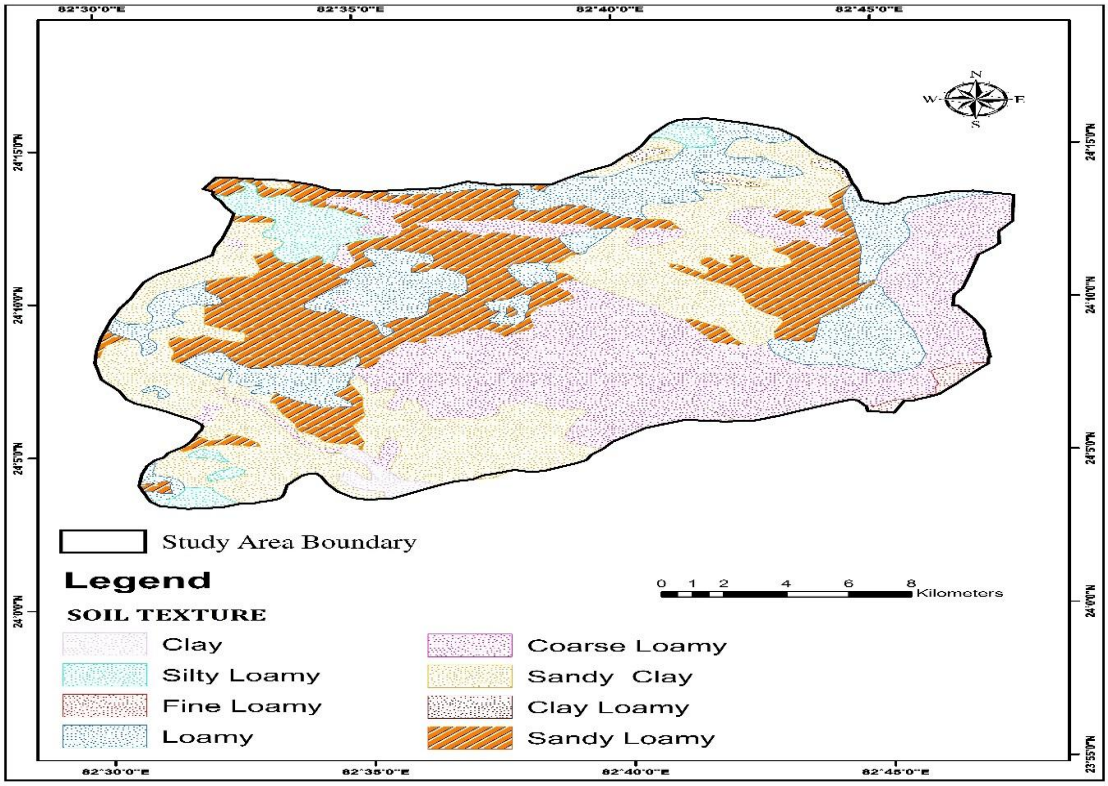

Figure 3.6 Soil map of the study area

In the study area, there are eight types of soil present in the study area such as clay,silty-loamy, fine-loamy, loamy, coarse-loamy, sandy-clay, clay-loamy and sandy-loamy are shown in the Figure 3.6.The soil layers have been totally disturbed at the central portion of the study area due to the expansion of coal mining activities.

3.8 Drainage pattern of the study area

The drainage pattern is the pattern formed by the streams, rivers and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks and the gradient of the land. The drainage pattern of the study area is Dendritic drainage pattern is developed which is totally controlled by lithology and topography. The major rivers in the study area are the Son and Rihand rivers. Five main perennial streams traverse through Singrauli are Kachan, Mayar, Motwani, Baliya Nala and Bijul.

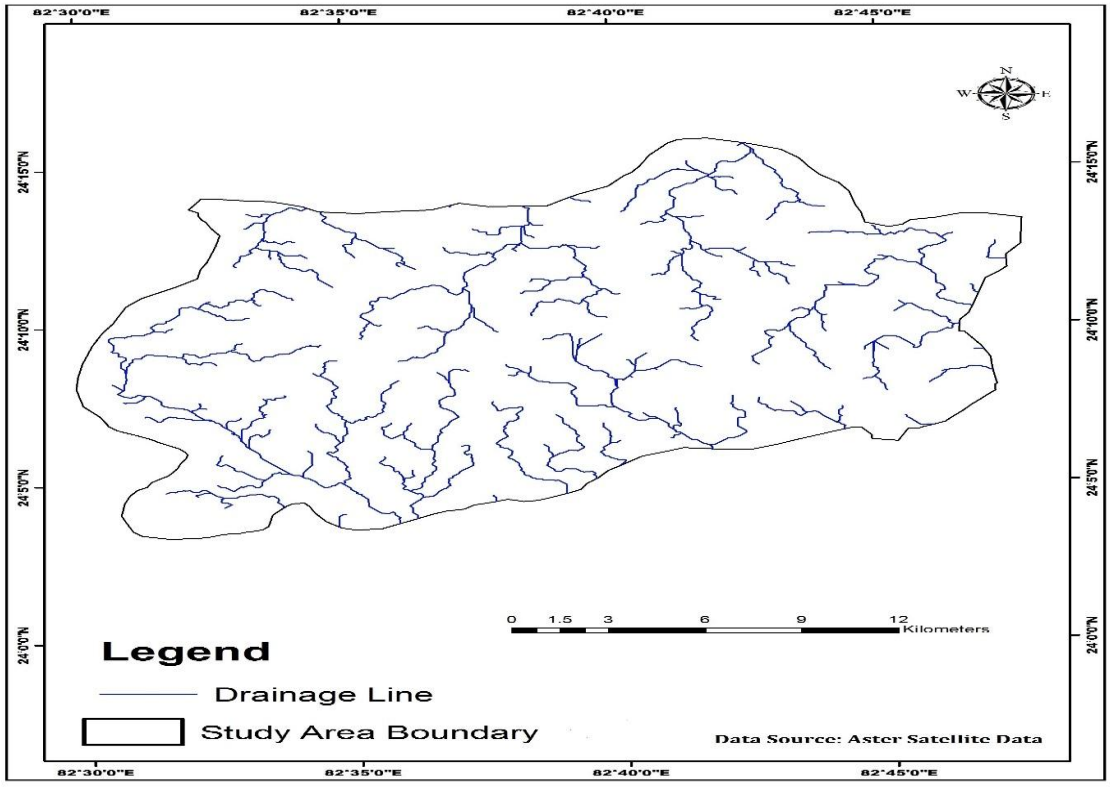

Figure 3.7 Drainage map of the study area

The perennial streams are Motwani and Balia Nala in the south and terminate into Govind Ballabh Pant Reservoir. The north-flowing streams join the Bijul River which is a tributary of Son. The south-flowing streams join the Kachan and Mayar, these two major rivers confluence near Tusa and terminate into Govind Ballabh Pant Reservoir. There are two small irrigation bunds on nalas rebounding from the plateau to the southern plains. One of the irrigation bund called Amjhor is located between Amlohri and Nigahi projects. Another bund called as Modwani Dam is located between Jayant and Nigahi projects. G.B. Pant Sagar reservoir is one of Asia's largest man-made reservoir formed by the Rihand Dam, a gravity dam.

3.9 Lineament feature of the study area

The Lineament map is created by digitizing the geomorphology map of the study area obtained from the BHUVAN (http://bhuvan.nrsc.gov.in). The lineament map of the study area is shown in Figure 3.8.

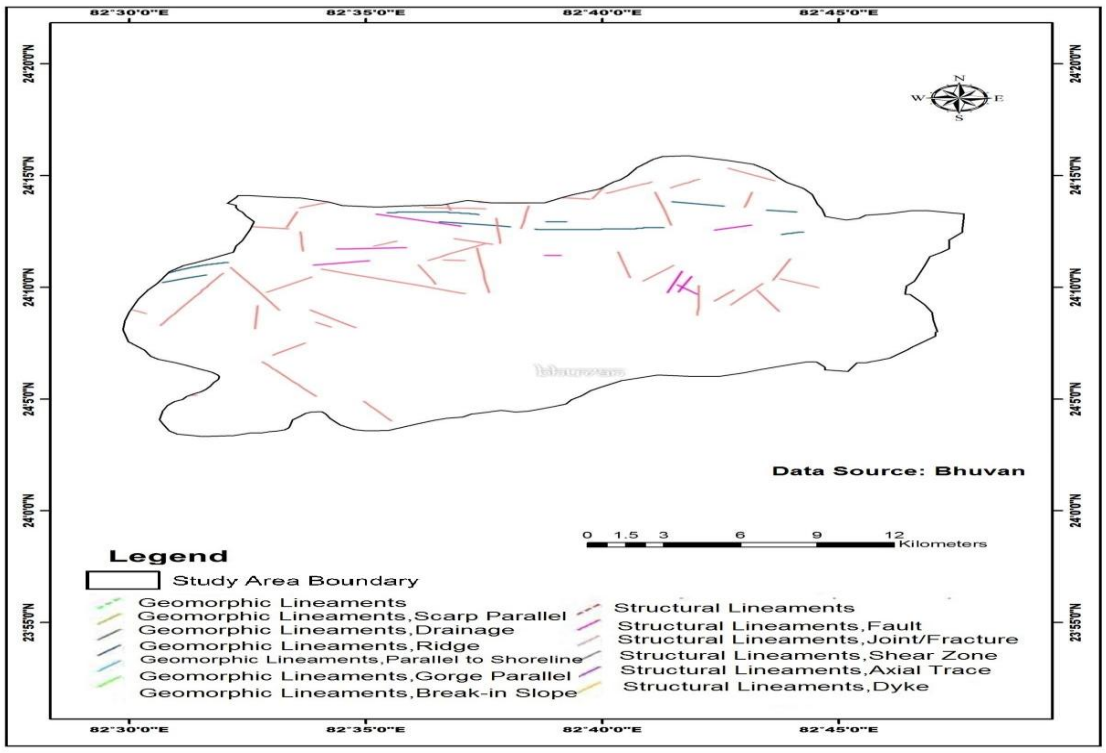

Figure 3.8 Lineament map of the study area

Lineament is directly related to fracture zones, cracks and fault in subsurface features which are considered as a means to store and transport groundwater in hard rock terrain. The northern limit of the Singrauli basin is defined by a prominent east-west boundary fault, which is probably an offshoot of the Son-Narmada lineament. The general strike of the coal-bearing is mainly toward East-West. The dip varies from 1° to 4° and dips toward the north. The northern and north-west portion of the singrauli coalfield is largely disturbed by a large number of various types of the fault system.

3.10 Flora and Fauna

The forests in the area consist of dry deciduous type. The density of vegetation varies with the topography, being relatively thick in the valleys and poor on hillocks. The principal species found are Sal, Saja, Tendu, Dhaora, Salai, Shisam, Mahua, Palas, and Bhira, etc. The main types of forest encountered in the area are: (i) Sal forest and (ii) Mixed forest. The Sal forests are found in the areas where moisture content is relatively high. In drier tracts, mixed forests are found.

The area was rich in wildlife including tigers, panthers, bears, antelopes, elephants, sambhers, bisons, hyenas etc. were quite common in the past. The degradation of forest, industrialization and extensive coal mining activities in the area are major threats to wild animals. The wildlife has got depleted or may have migrated to more remote areas.