Chapter- II

Study Area Profile

2.1 Location and Geographical Extent:

The districts of Surat and Bharuch adjoin the eastern flank of the Gulf of Khambhat. This region covers an area of about 4188.15 sq. km. and extends between 72°28'E to 73°3'E longitude and 20°59'N to 22°11'N latitude (District Census Handbook 2011). It occupies the south-eastern part of the mainland of Gujarat. The present study focuses on a selected segment of the Surat and Bharuch districts, an industrialized belt of Gujarat state. This region is surrounded by Anand district in the north, Navsari district towards the south, Tapi district in the south-east, Narmada district in the east and in the north-eastern part it is bounded by Vadodara district.

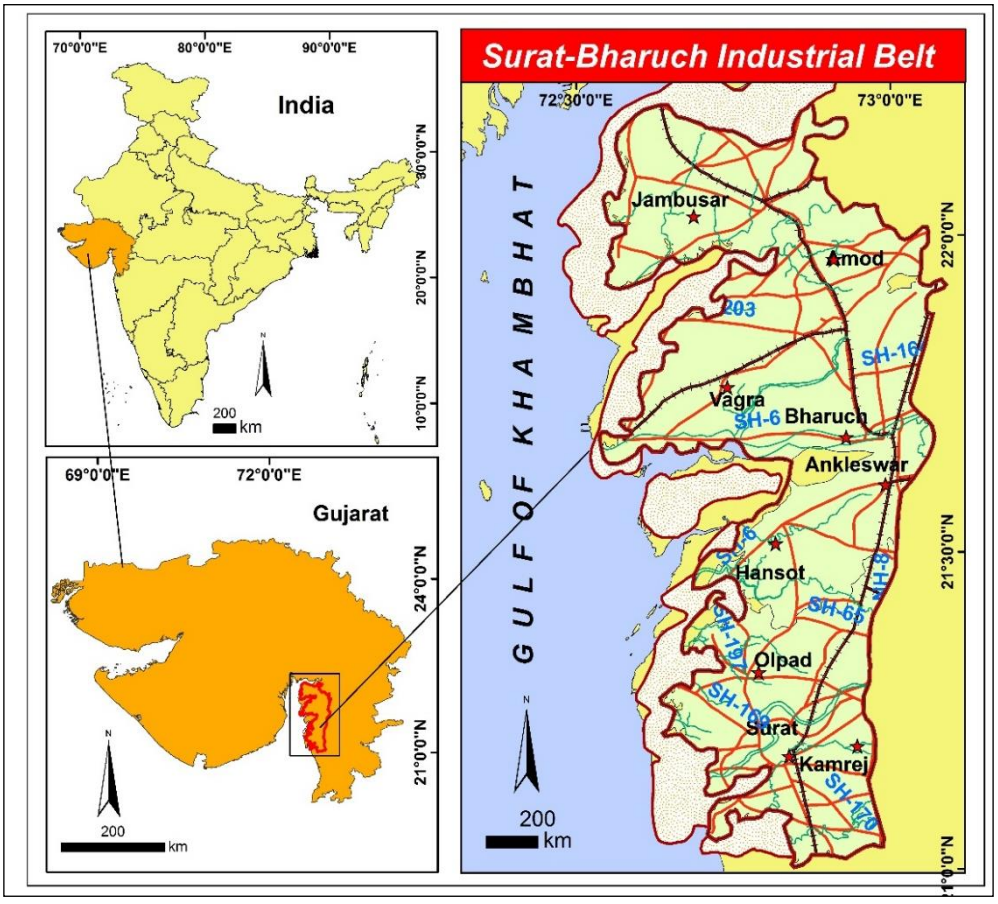

Fig.2.1: Location Map of the Study Area

The region's western boundary is formed by the coastline (Gulf of Khambhat). According to geographical divisions, six talukas of the Bharuch district, cover more than half of the study region. These talukas are Jambusar, Amod, Vagra, Bharuch, Ankleshwar and Hansot. Six talukas Olpad, Chorasi, Surat, Kamrej, Mangrol and Palsana of the Surat district cover the remaining area of the region (Fig. 2.2). This region is well connected to other parts of the state and the country. The study area includes two hundred twenty-six (226) villages. There are 24 Primary Health Centres (PHC's) in six talukas of Bharuch district and 18 in six talukas of Surat district (Fig. 2.1).

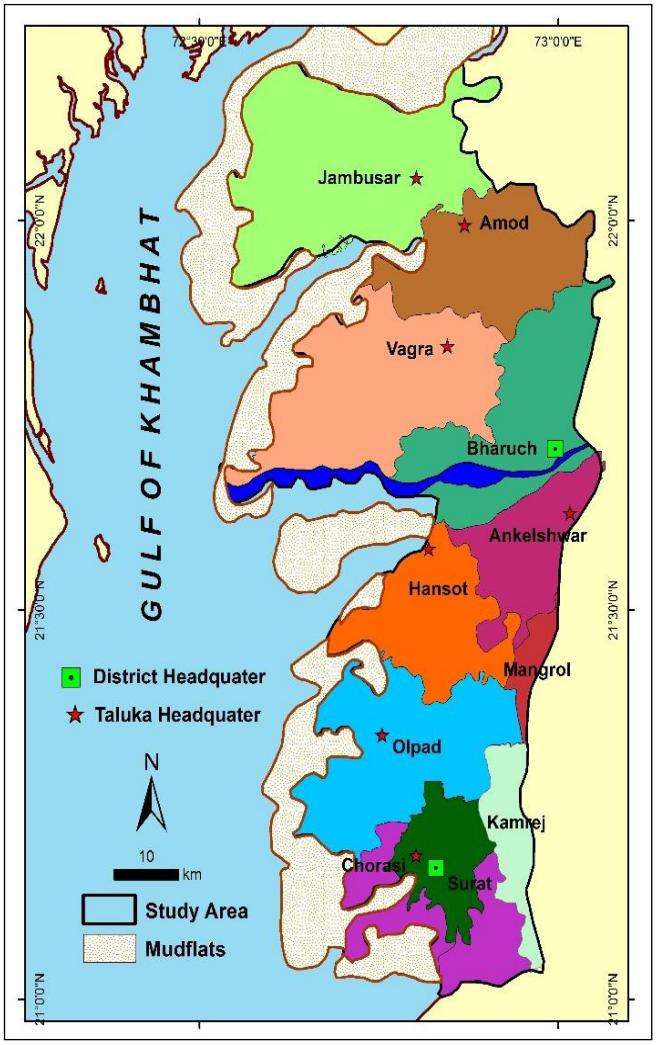

Fig.2.2: Taluka and District Headquarter of the Study Area

2.2 Physiography:

Surat and Bharuch districts are part of Gujarat Plain. The former is sub-divided into seven sub-micro regions and latter into eight sub-micro regions (District Census Handbook, Bharuch & Surat, 2011). The present study area comprises only four sub-micro regions from Bharuch district and three from Surat district (Fig. 2.3).

1. Khambhat Silt- This region covers the western part of Amod, Vagra, Bharuch and Jambusar talukas. The maximum height is noted in the eastern part (25 m above M.S.L) and the minimum elevation is (8 m) which is noted in the west. Geologically, this region is largely composed of alluvium, blown sand etc.

2. **Bharuch Plain-** It stretches across the parts of Amod, Vagra and Bharuch talukas. A gentle slope is observed towards the west. The elevation on the east is 20 m above mean sea level (M.S.L). Narmada River flowing from east to west is noted in this region.

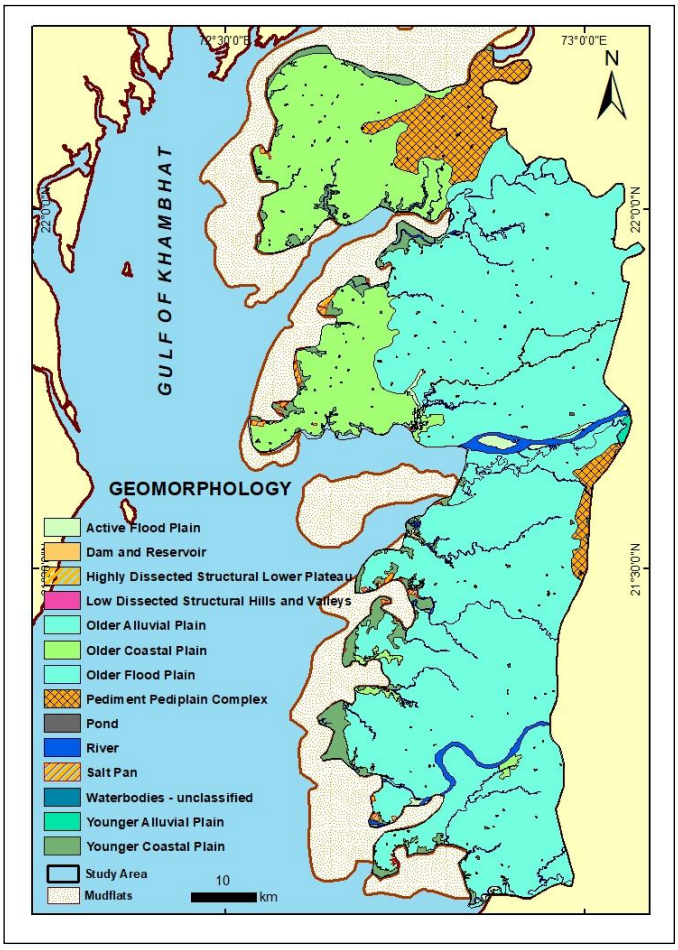

Fig.2.3: Geomorphology Map of the Study Area (Source: https://bhukosh.gsi.gov.in, Western Region, 2020)

3. Lower Narmada Valley- It occupies the parts of Bharuch, Ankleshwar and Hansot talukas. The maximum height observed in the eastern part is 100 m above M.S.L. near Rajpipla and the minimum elevation is 8 m found near Bharuch city. This valley is formed by River Narmada which flows from east to west. It is mainly composed of alluvium, blown sand etc.

4. Khambhat Coast- The region spreads over the western part of Hansot and Ankleshwar talukas of the Bharuch district and Olpad taluka of Surat district. The elevation of the region is gentle towards the west. The height in the eastern part is 15 m above M.S.L.

5. **Tapi Basin Region-** It occupies parts of Mangrol, Chorasi and Kamrej talukas. This basin is formed by River Tapi and it flows in the north-east to south-west direction. The region has the geological structure of alluvium, blown sand, deccan trap and undifferentified Eocene beds.

6. Mindhola-Purna Plain Region- The plain extends in the southern part of the study region and spreads over Palsana and Kamrej talukas. The elevation in the eastern part goes up to 35 m above M.S.L while the part of Palsana taluka attains a height of less than 35 m. This region consists of a decan trap alluvium, blown sand etc.

7. Chorasi-Palsana Coastal Plain Region- The region extends over parts of Chorasi and Palsana talukas. It is largely a lowland, with an elevation of 11 m above M.S.L in the eastern part and 67 m in the western portion.

2.3 Geomorphology:

The terrain is a flat level plain with an altitude varying between 5 m and 100 m above the mean sea level. The slope is 23.5° north-east which gets reduced to 5° south and south-west. The region is endowed with numerous mudflat sand marshy vegetation along the coast. This region is divided into two major plains, the northern part is Baroda plain and the southern part is Bharuch plain.

2.4 Geology:

Hydrogeological Setup:

Hydrogeologically, this area covers Bharuch and Surat districts and is largely affected by coastal salinity. Bharuch district is occupied by the semi-consolidated cretaceous, tertiary formations, unconsolidated alluvial deposits and hard rock consisting of multi–aquifer systems, therefore, exhibiting unconfined as well as confined sub-surface water conditions. In the Tertiary formations, sub-surface water quality is poor due to inherent salinity (Rina et al., 2013). The movement of sub-surface water is confined mainly to the fractures and joints in the limestones and sandstones. The discharge in dug wells varies from 30 to 50 m^3/day (Central Ground Water Board, 2014). The western part of Surat district, comprising of Chorasi, Olpad and Kamrej talukas is covered by alluvium. This aquifer can broadly be divided into two zones namely newer alluvium and older alluvium. The newer alluvium is present along the Tapi river and comprises fine to coarse-grained sand trap wash with clay intercalations (Central Ground Water Board, 2014). Sand is unconsolidated but shows some degree of cohesion at places. Older alluvium is present in inter river plains and comprises of sand, clay, kankar, grave and

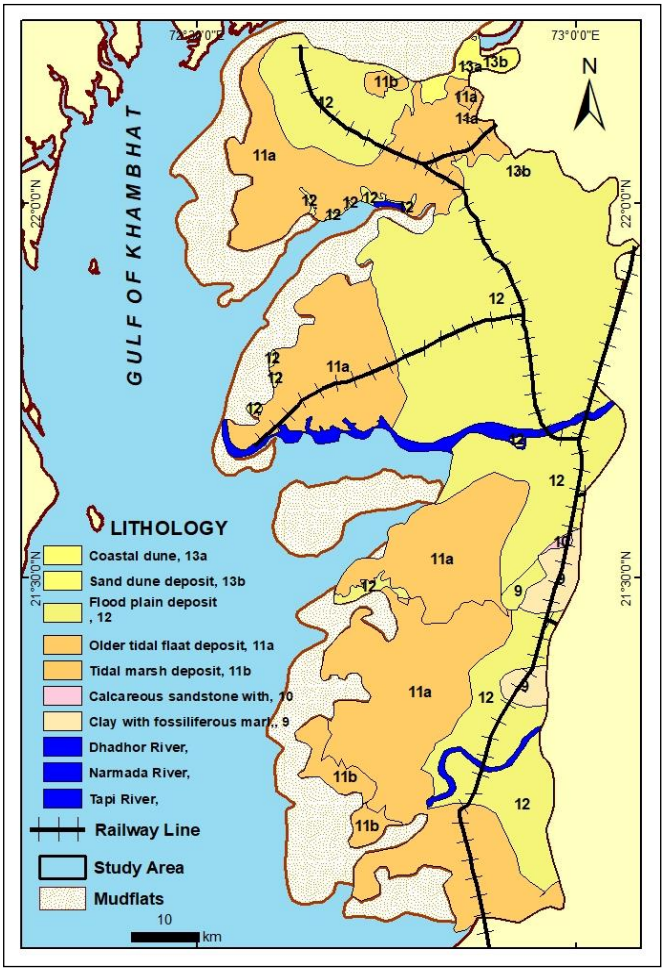

Fig. 2.4: Geological Map of the Study Area (Source: Geological Survey of India, 2020 https://www.gsi.gov.in)

silt. The sub-surface water in this part mostly occurs under unconfined conditions but probably due to the presence of clay lenses at some places semi-confined conditions are also observed. The sub-surface water levels in the wells range from 0.5 to 15 m bgl. Almost 90% of wells show water levels less than 10 m bgl (Fig. 2.4).

2.5 Drainage:

The major rivers of the Bharuch district are Narmada, Dhadhar and Kim. Narmada is the largest river that originates from Amarkantak of Madhya Pradesh and flows in the east to west direction. This river enters the Bharuch district and meets the Gulf of Khambhat. Bharuch and Ankleshwar towns are situated in its basin. Basin. Dhadhar is another significant river that flows in the north to south direction and enters the study region in Jambusar taluka which later meets the Gulf of Khambat. It has numerous tributaries which are noticed in the north-eastern part of the study region. The length of the Dhadhar River is 46 km. This river passes through Jambusar and Amod talukas and makes them fertile. Dhadhar, Viswamitr and Surya are parts of the Dhadhar basin that flow through the northern part of the study region and fall into the Gulf of Khambat. Kim River originates from Rajpipla hills and it flows in the east to west direction. This river enters the Bharuch taluka, drains at the central part of the study area and meets the Gulf of Khambhat. Kim river flows between the Narmada and Tapi rivers. Tapi is the second-largest river of this region after Narmada. It originates near Multai reserve forest in Betul district of Madhya Pradesh. The Purna river is one of the tributaries of river Tapi. It drains in the southern part of the Surat city (Fig. 2.5).

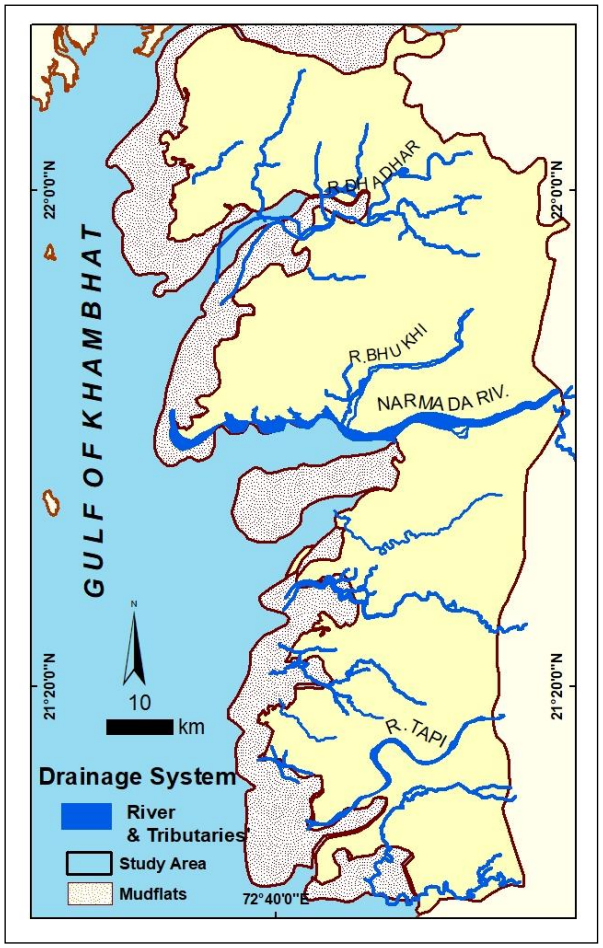

Fig 2.5: Drainage Map of the Study Area (Source: District Census Handbook (2011), Bharuch and Surat.

2.6 Soil:

Black cotton, gorat, bhatha, kyari, stony, light, khar and khajan types of soil are commonly found in this region. Black cotton soil is normally observed in Bharuch, Ankleshwar, Jambusar, Amod and Vagra talukas of Bharuch district and talukas of Kamrej, Palsana, Chorasi, Mangrol of Surat district. Khar and Khajan soils are mainly noted in the coastal areas. These types of soils are also found in the talukas of Olpad and Chorasi (Surat district). Gorat soils are found on the banks of Narmada, Dhadhar, Kim and Tapi rivers.

2.7 Climate:

The study area falls in the sub-tropical climatic region with a hot summer and general dryness except for, in the coastal region. The year may be divided into four seasons. The winter season begins from December to February followed by the hot season from March to May. The southwest monsoon season is between June to September and October to November is the post-monsoon season.

2.7.1 Rainfall-

The southwest monsoon is the main source of rainfall in this region. The average rainfall varies from 900 mm to 1100 mm. The maximum intensity of rainfall normally occurs from mid-June to September. Rainfall in the region gradually increases from west towards the east. However, scanty and uneven rainfall patterns are also observed in this region.

2.7.2 Temperature-

Temperature continuously increases from March to May. The average temperature varies between 8.9°C and 43.2°C. The average minimum temperature of the region was 10.7°C in 2016 and in the same year 41.4°C was the maximum. In summer months, between April and May, the temperature varies between 38°C to 44°C. The lowest temperature is in the months of December and January. After mid-November temperature gradually drops till the month of January.

2.7.3 Wind Pattern-

The wind in this region is predominantly seasonal. Generally, they are light to moderate during summer and this is the period of south west monsoon. During this time, the wind direction is predominantly easterly. The winds are westerly during the months of

November and December. The highest wind velocity is in the month of May and June (7 to 8 M.P.H) while lowest in November (2 to 3 M.P.H) (District Census Handbook, Bharuch & Surat, 2011).

2.7.4 Humidity-

Being a coastal region relative humidity is high. However, it varies spatially and temporally. In the monsoon season, humidity is very high, dropping in summer and winter. The maximum humidity is observed at Bharuch (84) and Ankleshwar talukas (89) in Bharuch district and Olpad (96), Mangrol (97), Kamrej (96), Palsana (98) and Chorasi (98) talukas of Surat district.

2.8 Vegetation:

Diversity of vegetation is observed in the study region. Seagrass, algae, mangroves, salt marsh etc. are commonly seen in the coastal areas. Mangroves are observed in the Vagra taluka (Khare & Shah, 2019).

2.9 Socio-economic:

2.9.1 Demographic Setup-

According to the census of 2011 the total population of this region is approximate 4,949,428 persons with 52.83% males and 47.47% females. The population density in Jambusar taluka was 136 persons per sq. km., Amod taluka (209), Vagra taluka (61), Bharuch taluka (714), Ankleshwar taluka (694), Hansot taluka (110) (Bharuch district) and Olpad taluka (288), Mangrol taluka (357), Kamrej taluka (492), Chorasi taluka (819), Palsana taluka (731) (Surat district). Sex ratio was 925 females per thousand males in Bharuch district and 787 females for every thousand males in Surat district. 81.51% and 85.5% of literacy rates was noted in the districts of Bharuch and Surat, respectively. Out of the total population, 30.48% was rural which was spread over in 218 villages and 69.52% was urban residing in 8 towns/cities.

2.9.2 Agriculture-

According to 2011 census, 52.89% of the population is dependent on agriculture in Bharuch district and 17.05% in Surat district. Food crops as well as cash crops are grown in this region. Principal food crops are paddy, sugarcane, green manure sugarcane, wheat, pulses, oil seeds, gram, rice, bajra, maize, jowar etc. Cash crops consist of cotton, castor oil, fodder, tobacco, groundnut, banana, cotton, flowers, fruits and vegetables etc. Pointed gourd, lady's finger, capsicum, chilies, cauliflower etc. is cultivated in few

villages in talukas of Bharuch, Ankleshwar and Hansot (Bharuch district). Jambusar taluka provides ample production of til (sesame seeds). Most of the crops are grown on the banks of Narmada and Tapi rivers (District Census Handbook, Bharuch & Surat, 2011).

2.9.3 Industry-

The two districts have many industrial zones like Jambusar, Vagra, Bharuch and Ankelshwar in Bharuch District and Olpad, Surat and Hazira in Surat District. Surat (54.96 Hectare) is the major industrial centre of the region. Besides it, the other important centres are Sachin (749.35 Hectare), Pandesaran (218.27 Hectare), Icchapore-Bhatpore Kawas (919.84 Hectare), Hazira (428.04 Hectare), Kathodara (3.08 Hectare) and Olpad (31.59 Hectare). Bharuch district too has a concentration of many small and large enterprises like –Dahej (438 Hectare), Ankelshwar (1770.97 Hectare), Panoli (879.50 Hectare), Bharuch (89.37 Hectare), Nabipur (12.84 Hectare), Pansoli (11.50 Hectare) and Jambusar (2.14 Hectare). The major industries of the region are Essar Power & Steel, Indian Oil Corporation Ltd. (Bhatpur, Kribhko, Kawas, Hazira road), Larsen and Turbo (Hazira road), ONGC, National Thermal Power Corporation. Gail–Gas Authority of India (Amod), Glaxo India Limited, Heuback Colour Private Limited (Ankelswar, Lupin) (DIP Survey Report, Bharuch & Surat District, 2016-17). These industries manufacture different types of chemicals, petrochemicals, polymers, polyesters, fibres etc. The salt industry is also well developed in this region. 116 salt works are established in Bharuch–Jambusar region. Salt refinery and iodizing factories are also found in this region particularly in Jambusar taluka.

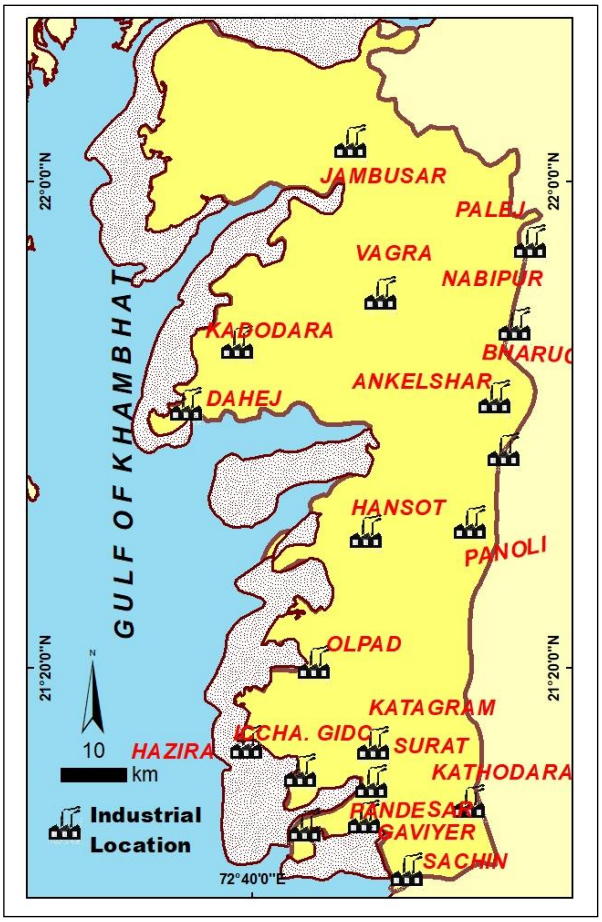

Fig.2.6: Industries of the Study Area (Source: Brief Industrial Profile of Bharuch and Surat District, (Govt. Ind., 2018))

2.9.4 Transport:

Surat-Bharuch industrial region is well connected by airways, highways and railways.

i) Air: The Airport at Surat city is in southern part of this region. It is a domestic airport which is connected with many major cities of the country. Mumbai and Vadodara are the other two nearest airports. Surat airport is further being developed and would soon get internationally connected.

ii) Railway:

Most of the places are of this region are well connected by railways. This region comes under the Western Railway zone. There are 53 railway stations with Surat, Bharuch and Ankelshwar being the largest ones connecting north to south and west to east.

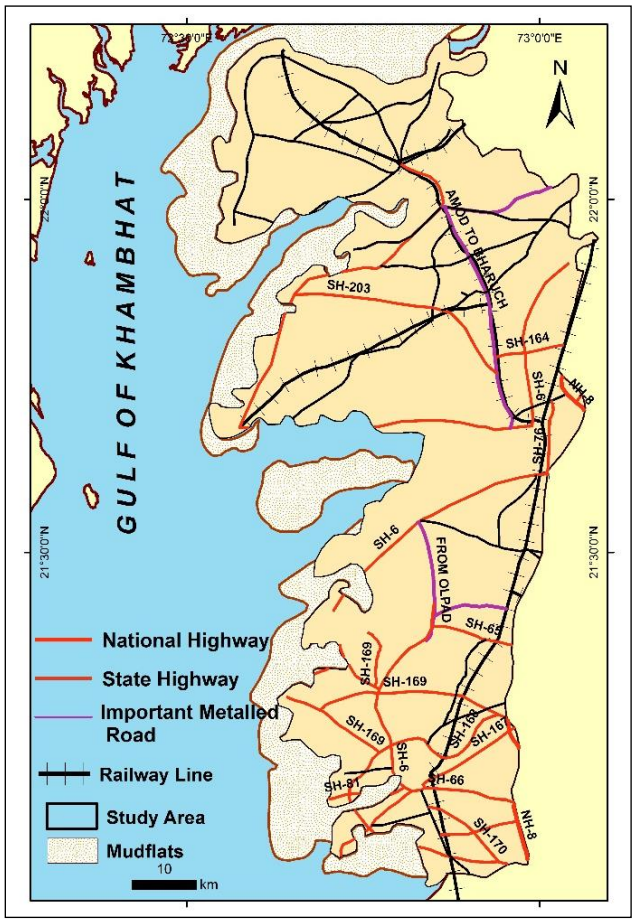

Fig.2.7: Transportation Map of the Study Area (Source: District Census Handbook [Bharuch & Surat], 2011))

iii) Road:

This region has a good network of roads. National and State Highway and Major district roads facilitates the industrial and development. Dahej, Hazira port, is operated by Gujarat Maritime Board (GMB) and is the major port through which commercial transportation is done. The study region is traversed by National Highway 08, which links Delhi and Mumbai. Several large and small industries are growing up based on railway connectivity which leads to overall development of the region.

2.9.5 Water Facility:

Surat-Bharuch industrial region has huge potential of surface water resources. Rivers Narmada, Dhadhar, Tapi, Viswamitri and Kim are major sources of fresh surface water. Furthermore, other sources of surface water are ponds, tanks and canal. Sub-surface water is found at moderate to greater depths; hence it is extracted

through hand pumps, tube wells and dug wells. There are number ponds and lakes in this area.

2.10 Ports:

This region has three important ports namely Bharuch, Dahej and Hazira. These ports are operational in all the seasons. Fertilizer, sulphur, iron scrapes and rock phosphate are imported to these ports and salt, betonies, onion, naphtha, sulphuric acid and oil cake are main items of exports through them.

2.10.1 Dahej Port-

Dahej is the largest port of the region and is developed for large and small-scale industries. This area is particularly designated as an Investment Region planned for the establishment of petroleum, chemical and petrochemical manufacturing facilities. It is located at the junction of Guljaria and Ban creek in Gujarat on the west coast of India and spans the blocks of Vagra and Bharuch in South Gujarat. Marine Shipbuilding Park (MSP) is situated at Dahej port.

2.10.2 Hazira Port-

Hazira is situated in the western most end of Surat city. It is one of the most industrialized areas of Gujarat as well as of the Country. It also known as the **'Gateway Port'** which serves the hinterlands of north, west and central India.

2.11 Land Use and Land Cover:

The entire region is mostly dominated by the agriculture land with an area of 3186.10 sq. km. It is about 76.07% of the entire study area. Built-up land comprises of 10.15% area. Water bodies/rivers/streams and canals together contain an area 4.03%. Saltpan and barren lands are spread over 375.76 sq.km which is 9.75% of the total area. 'Others Land' category is spread in 0.82% (Table 2.1 and Fig. 4).

Table 2.1 Percentage of the Land Use/Land Cover

Classes	**2017**
LULC (Category)	**Proportion (%)**
Agriculture	76.07
Build-up land	10.15
Saltpan	0.73
Wasteland	8.25
Waterbodies	4.03
Others Land	0.82
Total	100

Source- Computed

Resume:

This chapter, mainly focused on location and geographical extent, physiography, geomorphology, hydrogeological setup, drainage, soil, climate, vegetation, socio-economic setup, land use and land cover. The next chapter will discuss about the Spatio-temporal variability of hydrochemical and geochemical parameters of surface and sub-surface water.

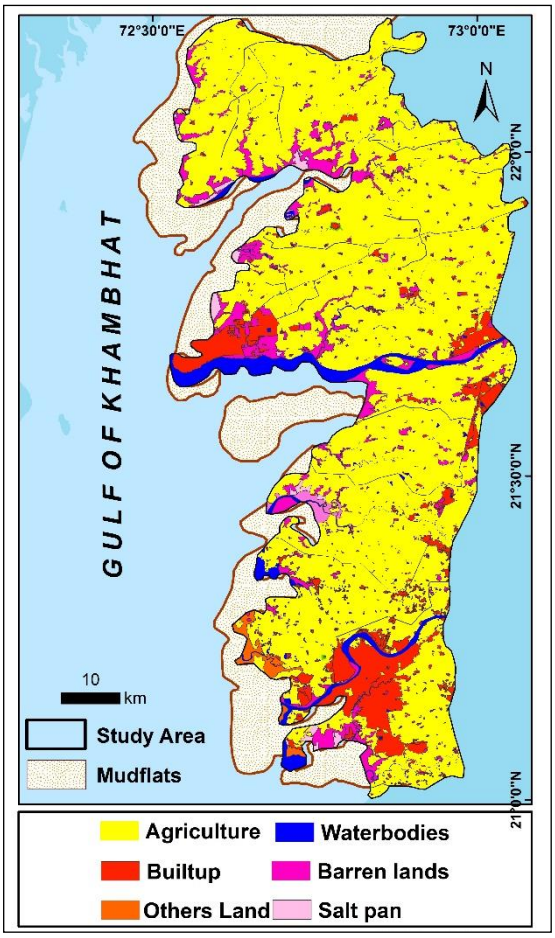

Fig.2.8: Land Use and Land Cover Map of the Study Region (Source: Computed)

Reference:

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