

Sarus Crane (*Grus antigone*)
Globally vulnerable, according to *Birdlife International*



ANAND PROJECT AREA (ANAND, KHEDA & VADODARA REGIONS)



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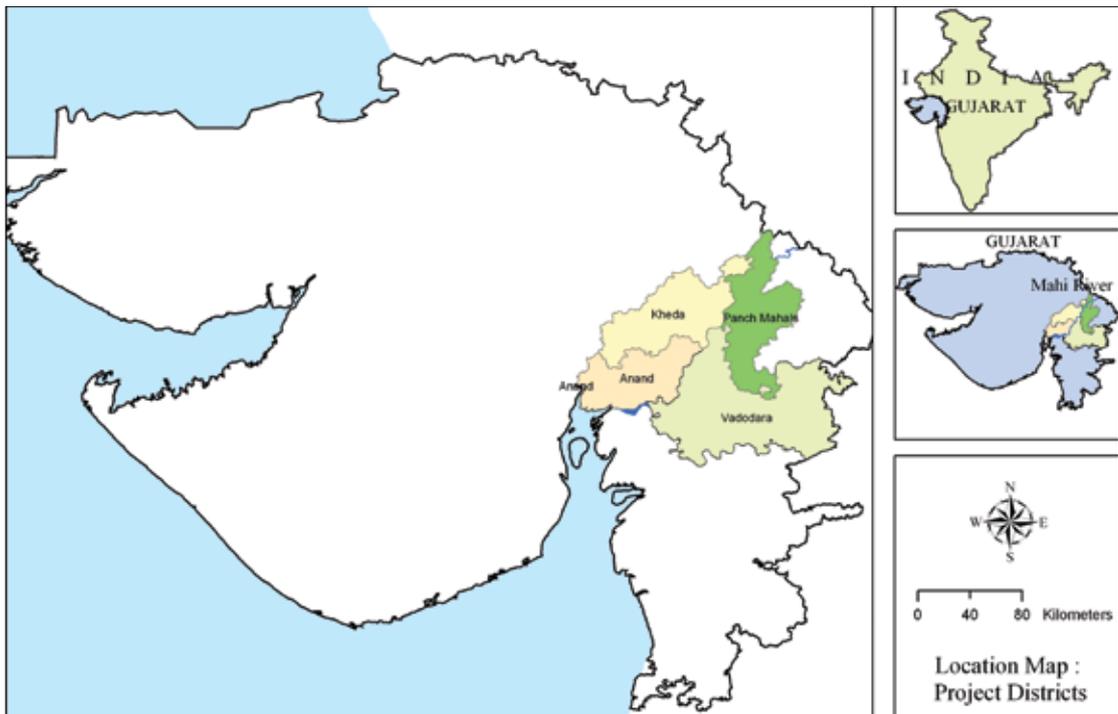
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1. Project Area Description

1.1 Introduction

The Anand project area spreads across four districts – Anand, Kheda, Vadodara and Panchmahal. The project area lies between N20°30' and 23°30' latitudes, E73°15' and 74°30' longitudes and is situated in central Gujarat covering an area of 19,502 sq km. Along with Sabarkantha district of Gujarat, the project shares its boundary with Rajasthan in the north. In the south, Bharuch district of Gujarat and the Arabian Sea surround the area. The States of Madhya Pradesh and Maharashtra on the east and south-east and Ahmedabad district of Gujarat in the west border the project area.

LOCATION MAP: PROJECT DISTRICTS



Vadodara

Vadodara district covering an area of 7,788 km², is bound in the west, south and north by Kheda, Bharuch and Panchmahal districts of Gujarat, and in the east and south-east by the States of Madhya Pradesh and Maharashtra respectively. It has a population of nearly thirty-one lakhs. The Mahi river, forming the north-western border of the district, flows in the south-easterly direction whereas the easterly flowing Narmada river forms the southern border of the district. The Orsang river and the Heran river are important tributaries of the Narmada river.

Kheda (Kheda and Anand districts)

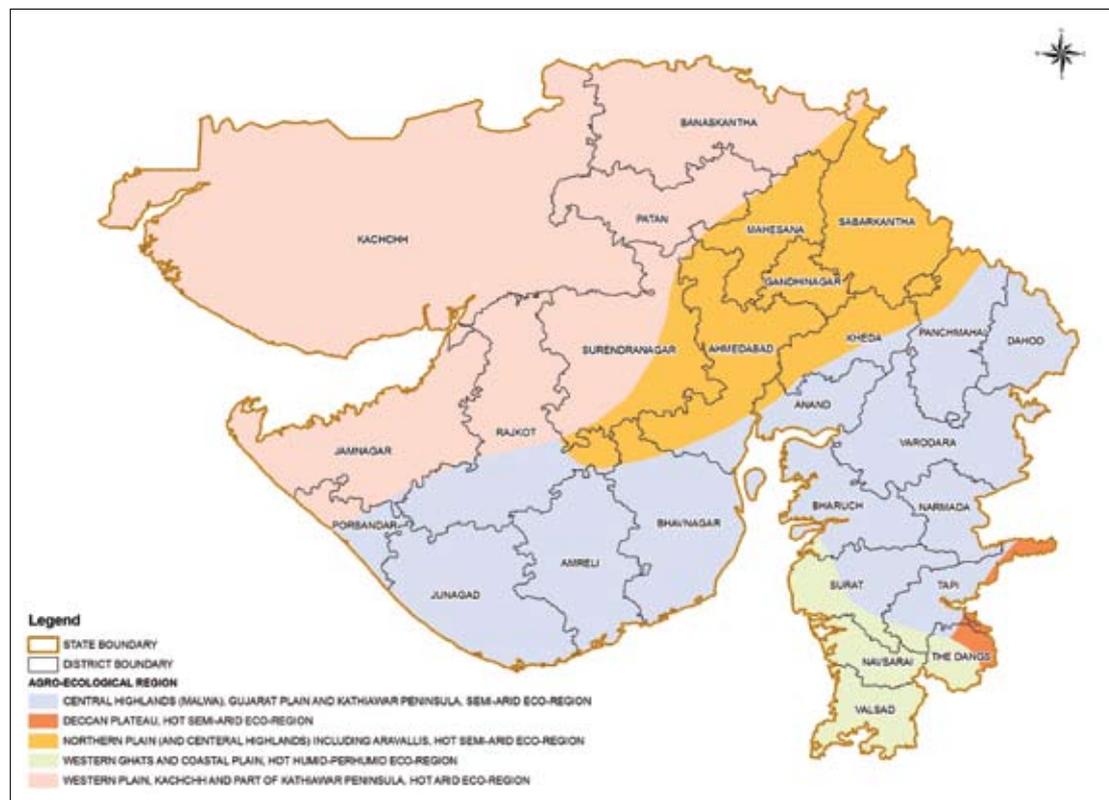
Kheda district derives its name from Kheda town, which is situated near the confluence of Vatrak and Shedhi rivers. Its area is about 7,194 km², which accounts for about 3.76% of the Gujarat state. Population of the district is nearly thirty-five lakhs. It is bounded by Ahmedabad, Sabarkantha, Panchmahal, Vadodara and Bharuch districts. The Mahi and Sabarmati are two main rivers of the district. The other rivers are Shedhi, Vatrak, Meshva, Khari, Mohar and Luni.

Panchmahal

The Panchmahal district forms the north-eastern part of the Gujarat State. It is bounded by the

Sabarkantha district of Gujarat and the Banswara district of Rajasthan in the north, and by the Jhabua district of Madhya Pradesh to the west. The district occupies an area of 8,866 km and has a population of nearly thirty lakhs. Lunavada, Santrampur, Jhalod, Shehera, Godhara, Limkheda, Dahod, Kalol, Devgarh Baria, Halol and Jambughoda are the 11 talukas. The Mahi river is the most prominent river along with its tributaries like the Karod, the Mesri, the Goma and the Panam. The average annual rainfall of the district is 90 cm.

AGRO-ECOLOGICAL REGIONS OF GUJARAT



1.2 Agro-ecological Regions

Agro-climatic zone is a land unit in terms of major climate types, superimposed on landform and the length of growing period (moisture availability period) (FAO, 1983).

Agro-climatic zones of Gujarat

Zone	Agro-climatic Zones	Rainfall (mm)	Main Districts
I	South Gujarat	>1,500	Dang, Valsad, Navsari
II	South Gujarat	1,000-1,500	Surat, Bharuch, Narmada
III	Middle Gujarat	800-1,000	Vadodara, Dahod, Panchmahal, Kheda, Anand
IV	North Gujarat	625-875	Gandhinagar, Sabarkantha, Banaskantha, Mehsana, Patan, Dantiwada
V	North-west Gujarat	250-500	Kuchh, Radhanpur
VI	North Saurashtra	400-700	Jamnagar, Rajkot, Surendranagar
VII	South Saurashtra	750-1,000	Bhavnagar, Junagadh, Amreli
VIII	Bhal and Coastal Areas	625-1,000	Ahmedabad District

1.3 Agro-climatic Characteristics

Area	Panchmahal and Vadodara Districts , Borsad Taluka of Kheda District
Rainfall (mm)	800-1,000
Type of Soil	Deep black, medium black to loamy sand (Goradu) soils
Soil Characteristics & Land Use Classification	Most of the area is cultivated. Some area non-cultivated under fallow and pasture forest.
Surface Colour	Reddish brown soil of east dark brown to dark yellowish brown and grey in alluvial
Predominant Texture	Alluvial soil. Sandy loam to loam (hilly area), clay loam to clay in mid-land, floodplain and coastal saline area.
Soil Slope	3.5% in hill plateaus and 0-1% and 1-3% in mid-land flood plains
General Fertility	N-low, P-medium, K-high
Cation Exchange Capacity	30-50 me/100 gm, in Vadodara and Panchmahal, 70 me/100 gm of soil in Bharuch district
Electrical Conductivity	More than 10 mmhos/cms most of the area
Exchangeable Sodium %	Traces to more than 50%.
Order	Inceptisols, Entisols
Sub-Order	Ochrepts, Orthents, Usterts, Psamments, Fluvents
Crops	Cotton, bajra, tobacco, pulses, wheat, paddy, maize, jowar and sugarcane

Area	Kheda District except Borsad and Part of Khambhat Taluka
Rainfall (mm)	625-875
Type of Soil	Sandy loam to sandy soils
Soil Characteristics & Land Use Classification	Most of the area is cultivated
Surface Colour	Dark brown, dark, yellowish brown to yellowish brown
Depth of Soil	Over 90 cm
Predominant Texture	Sandy loam to loam
Soil Slope	1-3%
General Fertility	Nitrogen-poor, phosphorus medium, potash medium
Cation Exchange Capacity	Less than 20 me/100 gm of soil
Electrical Conductivity	Less than 1 mmhos/cm
Exchangeable Sodium %	Traces
Order	Inceptisols, Entisols, Aridisols
Sub-Order	Ochrepts, Orthents, Orthids, Psamments, Fluvents, Paddy, Bajra, Pulse, Cotton, Groundnut
Crops	Tobacco, wheat, jowar, minor millets, vegetables, spices and condiments, oil seeds

Area	Area around the Gulf of Khambhat and Bhal
Rainfall (mm)	625-1000
Type of Soil	Medium black, poorly drained and saline
Soil Characteristics & Land Use Classification	A strip of ~2 km is coastal saline and the rest is under dry land cultivation
Surface Colour	Dark brown to dark, greyish brown
Depth of Soil	Over 90 cm
Predominant Texture	Silty clay loam to silty clay and clay
Soil Slope	0-1%
General Fertility	Nitrogen-poor, phosphorus medium, potash medium
Cation Exchange Capacity	40-50 me/100 gms of soil
Electrical Conductivity	More than 4 mmhos/cm
Exchangeable Sodium %	Greater than 15%
Order	Inceptisols, Entisols, Vertisols
Sub-Order	Aquepts, Orthents, Usterts, Ochrepts, Psamments, Fluvents
Crops	Groundnut, cotton, bajra, dry wheat pulse and jowar

1.4 Ecological Features

The Anand project area is composed of the coastal belt formed by the Gulf of Cambay on one side and the sediments that represent the extension of the main Aravali groups of rocks in Rajasthan on the other side. A part of the project area is rich in water resources and is drained by important rivers viz. Mahi, Goma, Kun, Panam, Karad, Kali, Meshri, Vishvamitri, Vatrak, Shedhi. Among them Mahi is the longest river. The river Vishvamitri is a dividing line between black soil and red loams. There are some isolated hills in certain parts but in general the plain is continuous and uninterrupted.

1.5 Special Ecological Characteristics of Area

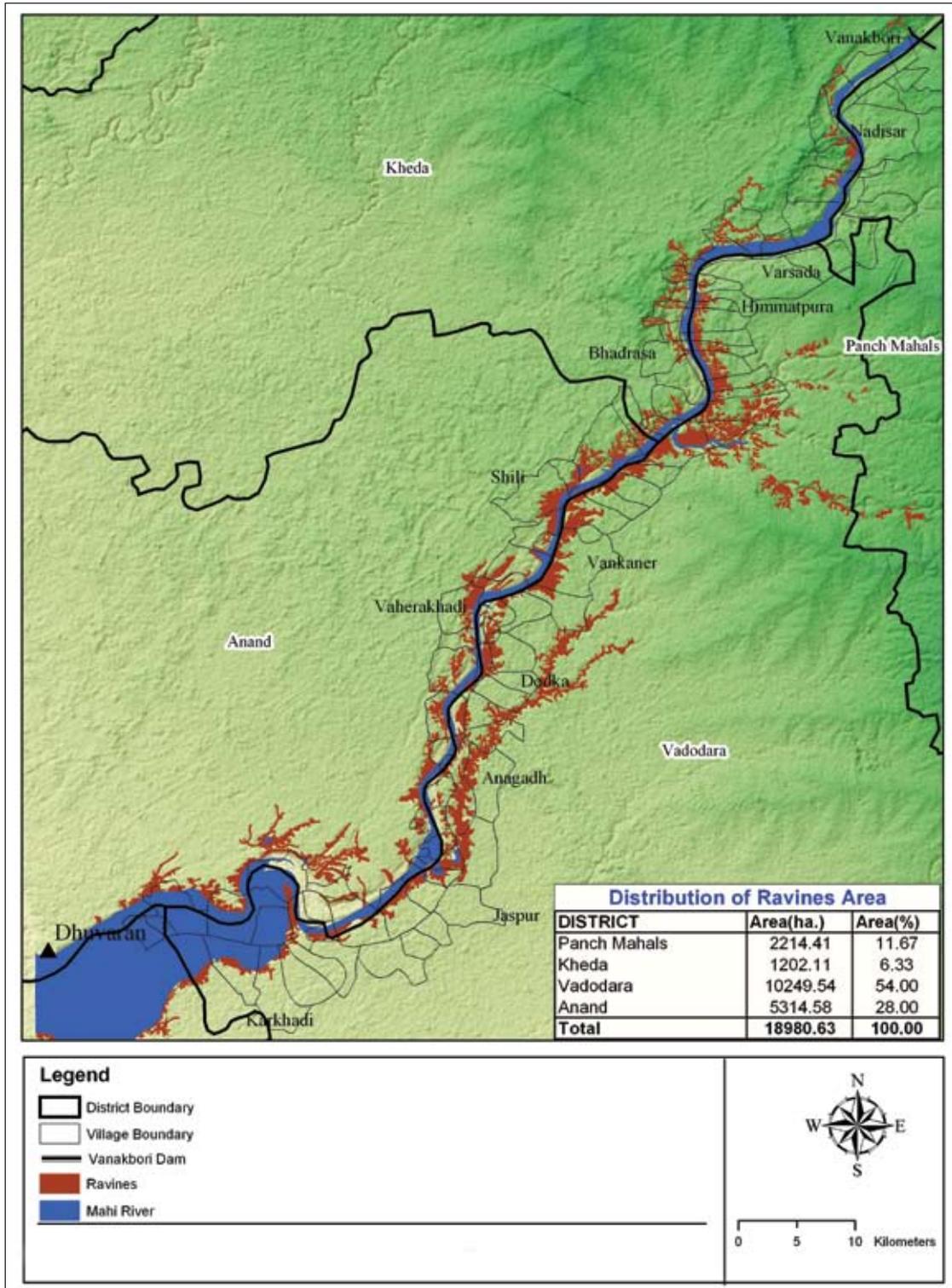
The project area can be categorized into two areas – Ravine and Saline/Bhal wherein parts of the area consist of deeply eroded ravined lands along the banks of the river Mahi, while towards the west is the coastal region of the Gulf of Cambay characterized by large stretches of highly alkaline tidal mudflats. The soils of the region besides the coastal areas vary from grey-brown soils to deep and shallow black soils. Vegetation is largely of the dry deciduous type and agro-climatically the region is a part of the northern plain and central highlands.

Prolonged inundation and impact of back water during high floods result in destruction of protective vegetation and



Ravines along the Mahi river in Kheda district.

DISTRICT-WISE DISTRIBUTION OF MAHI RAVINOUS AREA FROM VANAKBORI TO DHUVARAN



are the main reasons for ravine formation. Depending on the type of soil, geology, degree of vegetation cover, topography, rainfall pattern and the run-off from the catchment area, ravines of different sizes, shapes and depth are formed.

Ravines have an adverse effect on the agro-economy of the area. Conversion of fertile cultivated land into unproductive ravine land is also associated with social problems. Due to lack of effective measures of management and reclamation of these areas, their spread had begun encroaching adjoining good

arable lands and thus, the area under the ravines has increased considerably over the years. It has been estimated that the rate of encroachment of arable lands by ravines ranges from 0.5-1.07% per year in different situations.

The ravine project area lies along river Mahi. The river forms the natural boundary between the Vadodara and the Kheda/Anand districts. Most of Vadodara district lies between Mahi and Narmada and is well known for the black soil that is suitable for production of cotton. The Mahi is characterized by a continuous stretch of deeply eroded, ravinous land found on both its sides. The soil type varies from sandy loam to silt loam. Absence of clay particles in the soil makes the region highly susceptible to soil erosion leading to ravine formation. The mean annual rainfall of the area is 650-700 mm distributed over a period of nearly 43 rainy days.

The western border of Mahi extends to the sea at the Gulf of Cambay characterized by a large stretch of highly alkaline tidal mudflats wherein lies the Saline/Bhal project area. This region is locally called 'Bhal' due to the barrenness, which in turn is influenced by high salinity. The geographical characteristics of Bhal consist of areas affected by high salinization and alkalinity, large creeks and predictably severe temperature variations. It is highly prone to natural disasters like earthquakes, floods, and drought. The region consists of a landmass stretching along the coast from Gulf of Cambay (now Khambhat) in Anand district to the creek of Bhavnagar district. Nine rivers meet at the Bay of Khambhat. Major rivers of Bhal are Sabarmati, Bhogavo, Sukhbhadar, Dhelo and Kalubhar, which terminate in the Gulf of Cambay. Due to low gradient they inundate large portions of landmass during high floods and high tides. Although the average rainfall in this region is 400-500 mm it results in inundation due to its topography. Drought is a common phenomenon in Bhal. Hostile geo-climatic conditions result in poor life supporting systems.

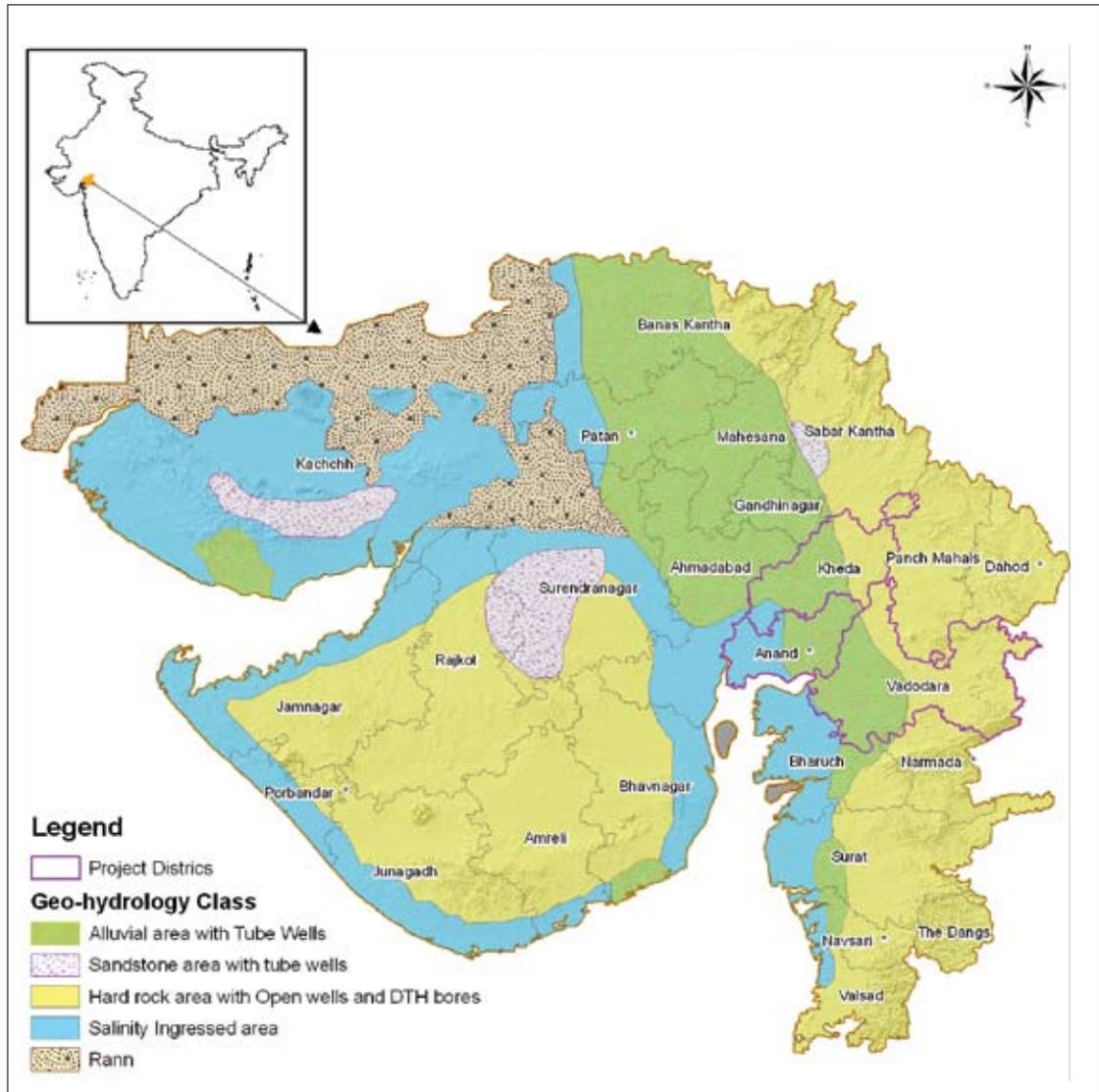
1.6 Physical Factors in the Ravine and Bhal Region

Environmental Variables	Ravine Region	Bhal Region
Mean Minimum Temperature	12° C	7° C
Mean Maximum Temperature	40° C-45° C	44° C
Average Rainfall	770 mm	550-650 mm
Number of Rainy Days	30-45	20-38
Rainy Season	July-September	July-September
Hottest Month	May	May
Coldest Month	January	December
Average Humidity	53%	70%
Average Wind Velocity	11.75 km/hr	10-20 km/hr
Direction of Wind Flow	SW	SW
Depth of Water Table	15 m-40 m	5 m-30 m
Quality of Groundwater	Sweet water	Saline water
Soil Type	Fine sandy loam	Black cotton soil

1.7 Geo-environmental Factors of Anand

The Anand project area envelopes four districts – Anand, Kheda, Vadodara and Panchmahal. As per the division of eco-regions of Gujarat, Panchmahal and eastern Vadodara form the Northern Rocky

GEO-HYDROLOGY MAP OF GUJARAT



Highland while most parts of Kheda, Anand, and Vadodara come under Central Alluvial Plain, except the Khambhat region (Gulf of Cambay) in western Anand, which is a part of the Coastal Zone of Gujarat.

2. Eastern Vadodara and Panchmahal (Eco Region – Northern Rocky Highland)

2.1 Climate

The region experiences characteristic semi-arid climate (aridity index 15-20%); the average annual rainfall is 700-100 mm with 30 to 45 rainy days and has a dependability of 50-60%. Mean annual temperature is 26-27°C with maximum temperature ranging from 46-50°C. The average annual wind speed is 5-15 km/hr. Interestingly, a pocket in Panchmahal experiences high wind velocity (only next to Saurashtra) of more than 15 km/hr. Winds blow from W and SW for a major part of the year. The average relative humidity is 60-65%. The potential evapo-transpiration is about 2250 mm.

2.2 Geology

Structure and stratigraphy

Geologically, the highland is predominantly composed of Precambrian rocks of Aravali and Delhi Supergroups and gneisses and granite basement as well as intrusive type. There are minor occurrences of Mesozoics (Himmatnagar Sandstone) and Deccan Trap. The two Supergroups are made up of different formations/groups of Sirohi, Kumbhalgarh, Gogunda, Champaner, Lunawada and Jharol. They consist of phyllites, schists, gneisses, quartzites, limestones, ambles, dolomites, etc. and are folded and faulted, and extensively invaded by the Post-Delhi magnetism represented by granites (Erinpura and Godhra) and metabasics and volcanics of Malani. The granites are prominently exposed covering vast areas. The lithological composition, structural characters, and tectonic behaviour of the rock formations have governed the pattern of the landscape and drainage.

2.3 Physiography and Drainage

A part of the highland region between Banas and Mahi forms the southern terminal extension of the Aravali range while that between Mahi and Orsang forms the western terminal extension of the Vindhya range. The Aravalis are represented by Jasor and Arasur group of hills and uplands of Idar and Mahikantha. The Vindhyas are represented by the Chhota Udepur and Ratanmal group of hills and the uplands of Panchmahal. The region displays a relief range of 200 m to 1,100 m with steep ground slopes of the range of 1:20 to 1:50. The altitudes range from 300 m to 500 m. The terrain exhibits typical residual landforms of Precambrian rocks, characterized by NE-SW stretching bold ridges of folded metamorphic rocks and prominent granite hills. Topography shows moderate to high ruggedness. The region is drained by rivers Sipu, Banas, Sabarmati, Hathmati, Majam, Watrak, Mahi, Panam and Orsang. The structural and lithological features of the rock formations control the drainage.

2.4 Mineral Resources

Base metal mineralization has been observed at Jabban, Masabar and north and south of Chevad. Clay occurs at Pingli, Satmana and Jhabu. Granite (at Jambughoda, Kalidungri, Shingedi, etc.), quartzite (at Devgarh Baria, Lunawada, Santrampur, Dadana, etc.) and slate (at Jabban and Jhalod) are used as construction material. Graphite occurrences have been reported from Jhabu and Tedhana. Limestone is seen at Umarwen Nani. Manganese, associated with manganiferous phyllite, occurs around Shivrajpura along a 22 km-long Shivrajpura-Pani belt, and its content varies from 22-46%. Phosphatic stromatolite is found within dolomite near Ghanta. Silica sand is recovered from white quartzite/quartz vein at several places in Devgarh Baria and Dahod talukas. Wollastonite is found in the NNER area of Kanjeta.

2.5 Soils and Land Use

Rock outcrops, steep slopes, severe water erosion, shallow soil-depth and low AMC (Antecedent

Moisture Condition) are some constraints of the region's soil resource. The moderate to steeply sloping hills, ridges and isolated hillocks are dominantly occupied with barren rock outcrops associated with extremely shallow (10-50 cm), to shallow, somewhat excessively drained, loamy to loamy-skeletal soils with low AMC (50-100 mm/m). They are neutral in reaction, severely eroded and stony. They have been called Lithic Ustorthents. Large part of the area is barren or covered with sparse vegetation. There is cultivation of rain-fed crops like maize, peri millet and sorghum. In some parts paddy, wheat and cotton are cultivated under irrigated condition. Forests are tropical dry deciduous.

In Panchmahal, loamy, clayey soils occur in the hills and plains. Bouger gravity Anomaly varies from -30 to -50 mgals. The entire district falls in the moderate risk zone of the seismicity. Hot springs are present at Tuva (63°C), Mimbod and Rath Moti. The geomorphic units in the district are alluvial plains, meta-sedimentary and granitic pediplains, Deccan plateau, moderately dissected plateau and dissected hills of volcanic and meta- sedimentary rocks.

2.6 Water Regime

The total water resource potential of the region is on a higher scale, but its un-balanced distribution in space and time has created a paradoxical situation of chronic shortage during summer months.

Surface Water Resources

The upper watershed of the major river basins of Banas, Sabarmati, Mahi and Orsang which extend beyond the area bring in large run-off to the region. The terrain conditions and climatic characteristics are such that 30-40% of the rainfall converts to surface run-off. Thus the area has tremendous surface water potential. Moreover, the physiography of the region provides many ideal sites for its storage and harnessing. These features have been taken advantage of; about 30 major- and medium-sized dam reservoirs are constructed in the region creating about 5,000 million cubic metres of dispersed storage. More than 70% of this storage is being used for irrigation downstream of alluvial plains. Harnessing micro watersheds holds further scope in the region.

Groundwater Resources

In the Precambrian crystalline rocks, groundwater is restricted to the soil and regolith cover and weathered and fissured zones, and occurs under phreatic unconfined conditions up to the depth of 50-100 m. Aquifer yield is 50 to 150 lpm. The average recharge potential is about 8-10% of the annual rainfall. The quality is good except at places where it contains fluorides and nitrates in excess of the permissible potable limits. The fluoride is derived by leaching from the granitic rocks and nitrites come from chemical fertilizers in agriculture.

In Panchmahal, the depth of groundwater table is less than 5 m in the western part and between 5 and 10 m in other areas. Sedimentary pediplain and alluvial plain are excellent aquifers.

District	Annual Replenishable Groundwater Resource					Natural Discharge during Non-monsoon Season	Net Groundwater Availability
	Monsoon Season		Non-monsoon Season		Total		
	Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources			
Panchmahal	25,565	10,047	0	14,947	50,559	2,528	48,031

Units in ha m (1 hectare metre = 10,000 cubic metres)

3. Kheda, Anand and Vadodara (Eco Region – Central Alluvial Plain)

3.1 Climate

The region experiences a semi-arid climate with an aridity index of 15-20% indicating adequate moisture availability in the soils for most parts of the year. Mean relative humidity is 60-65%. The average annual rainfall is 700 to 1,100 mm and rainy days last between 30 and 45 days, with a dependability of 50-60%. Wind direction is SW and average wind speed, 5 to 10 km/hr.

3.2 Temperature (Agro-climatic Zone – Middle Gujarat)

The climatic conditions of the area represent the subtropical conditions with semi-arid features. Monsoon lasts from June to September. In winter the mean monthly minimum temperature varies from 9.4°C to 29.6°C, and summer temperatures vary from 21.0°C to 43.3°C.

3.3 Rainfall (Agro-climatic Zone – Middle Gujarat)

The annual rainfall of the region for the last 30 years is in the range 293 mm to 1658 mm with an average precipitation of 870 mm.

3.4 Soil

Soil of the region and its surroundings is medium black, deep to very deep, poorly drained and salt affected.

3.5 Geology

Stratigraphy and structure

The alluvial deposits belong to the Quaternary period (1.5 million years) and have a history of sedimentation, basin characters and environments of depositions. The deposits vary in their composition and thickness. They occupy the part of the Cambay basin which has been designated as structural depression in the context of the Bharuch, Jambusar and Tarapur blocks. The alluvium shows ample evidences of neotectonism and almost all major drainage courses are governed by structural dislocations and disturbed by neotectonic activities.

The infratrappean lameta sediments near Rahioli in Balasinor taluka are rich in fossils of dinosaurian bones and egg clutches. Discovery of dinosaur egg clutches and bones have brought India on the world map of dinosaur nest sites. Rahioli ridge has a unique distinction of having egg hatcheries and graveyard of the dinosaur bones. It has not only yielded skeletal parts of dinosaur, hitherto unknown in the Upper Cretaceous of India, but is also a well-preserved nursery of numerous dinosaurian eggs.

The study of humeri, femora, teeth and egg fossils has revealed the presence of both Sauropod and Theropod dinosaurs. Sauropod teeth have been correlated with the genus Titanosaurus (and the Theropod teeth are closely comparable with that of Majungasaurus (Megalosaurus)) crenatissimus from the Upper Cretaceous of Madagascar. Both spheroidal and ellipsoidal eggs are found in the area.

3.6 Physiography and Drainage

The region's highest elevation range in the north-east is 100-150 m and dips to about 20 m in the south-west showing a very gentle flat gradient of 1:800 to 1:1,000. The region displays a flat topography with a series of sections cut by deeply incised river channels. The sections are 10-30 m deep and the riverbanks are marked by levee deposits, creating ridge-like banks with elevations higher than normal. The flat topography is dotted with low sandy mounds of stabilized dunes.

The region is drained by Sabarmati, Khari, Meshwo, Majam, Watrak, Mohar, Shedhi, Mahi, Dhadhar, Orsang and Narmada rivers. Rivers with large catchments extending in the eastern and north-eastern highlands carry large discharge of water and sediments, and are prone to floods and land erosion. The flat topography causes monsoon inundation and thus an artificial drain has been provided in the western part of the region. Formation of ravine landscape is common on the river banks due to deep gully erosion.

3.7 Mineral Resource

Vadodara

Base metal (Pb and Zn) mineralization occurs in quartz veins and phyllite at Khandia where reserves of 0.2 Mt containing 4.5% Pb and Zn have been estimated. At Ambadongar a reserve of 11.6 Mt fluorite, containing an average 30% CaF₂, has been established. Graphite occurrences have been reported from Kundal and Muthai. Limestone is excavated in the south-west of Kawant and west of Dodigam. Marble occurs at Motipur. Manganese used to be mined at Pani and south-west of Devhat. Oil and gas reserves are present in Vadodara and Dabka. Talc is reported from (west of) Rangpur.

Kheda and Anand

The main mineral deposits in the district are bauxite, bentonitic clay, limestone, Deccan Traps and petroleum. Bauxite, in the form of narrow belts, capping the Deccan Traps, is found south of Kapadvanj and north of Dakor. Bentonitic clay and yellow calcareous clay of Miocene age are found below the alluvium cover and in the river sections near Mirjapur and Muhammedpura. Deccan Trap is quarried extensively for building material near Kapadvanj and Thasra. Limestone of lameta bed is found near Vadasinor, Khandivav and Rahioli. Petroleum is found west of Khambat, north-west of Mahemdavad and west of Kheda.

3.8 Soil and Land Use

The major soil types of the region are Inceptisols (Ocrepts) and Vertisols (Usterts) characteristic of the alluvial plains and interfluves. They are slightly alkaline to slightly calcareous; some are however saline. They are usually moderately eroded but are severely eroded in dissected plains adjoining river courses. Soils display varying degree of AMC (Antecedent Moisture Condition) from low to high (50 to > 150 mm/m) depending on textural variations. Low lying areas, where there is excessive canal irrigation, tend to have water logged and saline patches.

Pearl millet, sorghum, maize, tobacco, wheat, cotton, pulses, paddy and banana are the major crops. The greater part of the area has irrigation facilities where double crops are harvested. There is limited natural forest in the area. There are man-made forests created under the community forestry programme along roadsides, canal banks, along railways and in village gauchar lands.

Soil Properties of Agro-climatic Zone – Middle Gujarat

Type	Medium black, deep, poorly drained, salt affected
pH	7.2-7.9
Organic Carbon	0.55-0.62
Available N₂	0.46-0.53 kg/ha
Available P₂O₅	88-92 kg/ha
Available K₂O	688-889 kg/ha

There are three types of soils in Kheda and Anand. The soils of alluvial plains consist of deep, well-drained, calcareous, fine to coarse loam, occupying most of the districts. Soil characteristic of hilly plains and interfluvies occur in the northern part. The central fertile part of the districts is highly urbanized. A small marshy wasteland is located in the southern part.

Soils of Vadodara district are loamy, clayey, mixed calcareous and montmorillonitic. Bouger Gravity Anomaly contours vary from -50 to -30 m Gal. The area lies in a moderate (Zone III) seismic zone.

3.9 Water Regime

Central Gujarat has the highest potential of surface water as well as groundwater. Paradoxically, the overuse of this resource in some parts of the region has led to water logging while in other parts there is a conspicuous water level depletion and quality deterioration.

Surface water resource

The region has an abundant surface water potential due to high run-off (run-off index: 40-45% of average rainfall) from the rivers. However, the major sources of surface water are the several dam reservoirs built across the rivers located in the adjoining rocky highlands. The area forms the irrigation command for almost all the dams in the NRH (Northern Rocky Highlands). On the eastern bank of Mahi there is a perennial canal system, which has created an environmental imbalance from over-irrigation. The region is characterized by extensive occurrence of ponds and tanks. Before canal irrigation, the ponds were sources of protective irrigation for Kharif crops.

Groundwater resource

The unconsolidated alluvial formations with extensive lateral extent and thickness over 300 m have provided a rich aquifer system with copious supply. Between Sabarmati and Mahi, the resource is under-utilized due to inexpensive availability of canal waters. As a result the water table in most areas has risen. Quality of water progressively deteriorates depth-wise and also laterally from east to west. The natural recharge index is also high (10-15% of the average rainfall). In the Mahi command area, the rising water tables find outflows into the nearby deep river sections and the water logging conditions to a major extent are naturally controlled by favourable natural drainage conditions, while in the area between Mahi and Narmada, the irrigation needs have over-stressed the groundwater resources; thereby water levels and quality have depleted.

The groundwater level is 5-10 m in the southern part and 10-20 m in the northern region of Anand and Kheda. There are 23 hot water springs around Lasundra (temperature 30°-50° C). The sulphur content in the water increases with temperature. Annual rainfall is about 64 cm.

District	Annual Replenishable Groundwater Resource					Natural Discharge during Non-monsoon Season	Net Groundwater Availability
	Monsoon Season		Non-monsoon Season		Total		
	Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources			
Anand	22,416	22,681	0	18,461	63,558	3,178	60,380
Kheda	35,382	15,985	0	16,960	68,327	3,416	64,911
Vadodara	83,030	8,508	0	13,764	1,05,302	5,265	1,00,037

Units in ha m (1 hectare metre = 10,000 cubic metres)

4. Area around the Gulf of Khambhat (Eco Region – Coastal Zone of Gujarat)

4.1 Climate

The area experiences a semi-arid to sub-humid climate. Aridity indicates status of climate in relation to moisture conditions. According to the aridity index, the evapo-transpiration outweighs the annual precipitation, and the increasing deficiency of moisture. This is characterized by predominant growth of grass and gradual decline of tree density. At a micro level the climate shows significant variation at different levels. Evapo-transpiration is an important climatic factor in the context of agro-ecological conditions.

4.2 Geology

Geology and structure

The area is covered by the alluvial deposits of the Quaternary period. Small exposures of pre-Quaternary rocks in Sundernagar and Bhavnagar districts occur as inliers. The sediments formed a layered sequence of sands and clays deposited under fluvio-marine conditions. During the Quaternary, the sea level has fluctuated about plus 50 m to minus 150 m with reference to the present level. Majority of the present sediments of the area comprising raised mudflats and stabilized coastal and inland ridges represent the last marine transgression when the sea had risen up to about 10 m around six thousand years ago and which is now regressed to the present level. It is envisaged that about 4,000 years ago, the two Gulfs of Khambhat and Kuchh were inter-connected by an arm of the sea and the ancient part of Lothal, and a site of Harappan civilization was located on the mouth of the ancient river of Bhaogavo.

4.3 Landforms

Gulf of Khambhat has distinct landforms in comparison to the rest of the coastal landforms of Gujarat. Extensive mudflats, estuaries, creeks and absence of sand beaches characterize the Khambhat coast. The river mouth areas on the eastern side of the Gulf are composed of cliffs and gullies, while on the western side the river mouth areas are flat with long estuarine inlets. The low level coastal saline stretch towards the north extends along the Nal depression and merges into the south-eastern part of the Little Rann of Kuchh.

The changing pattern of the landforms is observed in the shift of sand bar locations from the inner parts of the Gulf of Khambhat to the river mouth estuaries. This is indicative of the changing balance of fluvio-marine environments in the Gulf, where marine energy dominantly scores over the fluvial energy. Blocking of the river mouths has induced a new pattern of flooding, sediment deposition and land erosion in the estuarine mouth zones. The permanent siltation of old ports such as Khambhat and highly increased sediment load in other ports like Bhavnagar are some examples.

4.4 Physiography and Drainage

The ground elevation of a major part of the project area is below 30 m asl. At places towards Saurashtra, it rises above 50 m asl. Topographically, the areas get broadly divided into two parts along the line of Sabarmati river. The eastern side has a relatively high topography and deeply incised courses of Narmada, Dhadhar and Mahi rivers with wide-open estuarine mouths. The area on the western side is on a relatively lower elevation and traverses through several minor rivers from the north-eastern part of the Saurashtra peninsula. The rivers have shallow courses and narrow estuarine mouths. The area in the northern part – around the line joining the Gulf head and Little Rann through Nal Sarovar – forms a depression with a maximum ground elevation around 15 m. The sloping ground from north Gujarat and that from NE Saurashtra merge here. The drainage is not defined and the area around Nal Sarovar gets

regularly inundated during the monsoon. Similarly the Bhal area south of Nal up to Kalubhar with a flat gradient is also subjected to monsoon inundation.

4.5 Soils and Land Use

Several villages are located near the coastline and some are submerged due to sea ingress. In the remaining villages salinity is a serious problem. Salt deposition on soil surface is common in summer. Agricultural productivity of land is low due to salinity, salt-water ingress, wind erosion and lack of fresh water source. Water logging influenced by black cotton soils adds to the problem. Wheat and paddy are the major crops.

4.6 Water Regime

Surface water resources

All the run-off from the large catchment passes through the project area and discharges into the Gulf. Seasonal availability of large quantity of river flows is hard to be diverted or store for local use due to unfavourable terrain conditions. A large part of the area is thus subjected to frequent floods.

High surface run-off and sediment transport are indicative of the dynamic character of the regional environment. The area is characterized by the presence of a large number of inland water bodies in the form of ponds, tanks and lakes. The locations of the water bodies coincide with sites of the old river meanders, shifting stream course and canals – natural features developed and maintained by the people in the past. In the past they served the fresh water needs of people in Kharif irrigation. Wells located in the bed and on the banks of ponds were good sources of drinking water in the otherwise saline groundwater.

Groundwater resources

The area has plenty of groundwater storages, but most of it being saline, only a small fraction is usable. Hydrogeologically, almost the entire area is formed of unconsolidated alluvial formations. Groundwater occurs in a system of unconfined and confined aquifers formed of the alluvium deposited in the structural depression of the Cambay basin. This segment is a vast tract of coastal saline low land around the Gulf of Khambhat and is distinct in coastal morphology and sea energy conditions. It experiences semi-arid to sub-humid climatic conditions. The average annual precipitation is 600 mm to 800 mm.

The coast between Bhavnagar and Khambhat trending N-S is highly muddy and is made up of a vast open onshore mudflat trenching 40-50 km towards Saurashtra and about 80 km reaching the Nal Sarodvar towards north-west. This low level saline flat land represents a palate mudflat, locally known as the 'Bhal'. The other part of the segment from Khambhat to Bharuch, also trending N-S, shows diverse coastal landforms related to a drowned alluvial coast characterized by steep river mouths. The cliffs abruptly rise to about 20-30 m above the tidal flats. The inter-tidal zone is 3-5 km wide and consists of salty and muddy sediments. The saline coastal land between Mahi and Narmada is locally known as the 'Barra' tract.

Sabarmati, Mahi and Dhadhar and Narmada that flow into the Gulf form broad estuarine river mouths, mud-banks and sand bars. The shoreline is highly indented and is characterized by mudflats, alluvial cliffs, drowned river mouths and palaeo mudflats and alluvial plains.

The sea is characterized by strong tidal currents with low wave energy and very high tidal energy. Tides rise up to 10 m height. The seawater is highly turbid and hypo-saline.

5. Biodiversity



The 40 ha of vegetation developed under the Khorvad Tree Growers' Cooperative Society.



Bauhinia variegata, family Caesalpiniaceae.

Anand is rich in biodiversity. The region serves as a habitat for a variety of plants and animals including several rare and endangered species such as the Guggal tree and the Lesser Florican and Sarus Crane. The project area is endowed with an enormous variety of bird species, reptiles, fish species, amphibians and tree species. Anand district has the largest population of Sarus Crane in Gujarat and also the largest number of Rose-ringed Parakeets in the world. It also has numerous breeding colonies of the Painted Stork. The project area contains 11 varieties of indigenous breeds of livestock of buffaloes and cattle. A tree census carried out by the Gujarat Forest Department in 2004 reported Anand as the greenest district of Gujarat having 65 trees per hectare of land. Environmental factors explain the region's varied plant and animal wealth.

5.1 Flora of the Project Area

The dominant tree species in the project area are:

Anand and Kheda district: Desi Babul (*Acacia nilotica*), Neem (*Azadirachta indica*), Indrakh (*Anogeissus latifolia*), Imli (*Tamarindus indica*), Jungle Jalebi (*Pithecellobium dulce*), Sissoo (*Dalbergia sissoo*), Ganda Babul (*Prosopis juliflora*), Piludi (*Salvadora persica*) – (*Prosopis* and *Salvadora* are found in the areas near the Gulf of Cambay).

Vadodara: Desi Babul (*Acacia nilotica*), Neem (*Azadirachta indica*), Indrakh (*Anogeissus latifolia*), Imli (*Tamarindus indica*), Sissoo (*Dalbergia sissoo*), Ardusa (*Ailanthus excelsa*), Ingora (*Balanites aegyptiaca*), Satavri (*Asparagus racemosa*), Khair (*Acacia catechu*).

Natural revegetation in degraded salt-affected soils of Bhal region is very poor and is formed of stunted and scattered species of *Prosopis juliflora*, *Acacia nilotica*, *Capparis deciduas*, *Prosopis cineraria*, *Salvadora persica*, *Salvadora oleoides*, *Zizyphus nummularia*, *Tamarix ericoides*, *Kochia prostrata*, *Cassia auriculata*, *Cressa cretica* and *Cynodon dactylon*.



Stylosanthes hamatus, family Papilionaceae.

Some important medicinal plants present in this region are Khair, Gum, Behda, Shatavari, Musli, Amla, Kadayo and Harda.

Plant Species in Anand Project Area

Trees

Local Name	Scientific Name	Family
Arduso	<i>Ailanthus excelsa</i>	Simarubaceae
Alan	<i>Elaeodendron glaucum</i>	Celastraceae
Aledi or Aal or Rangori	<i>Morinda tinctoria</i>	Rubiaceae
Ambo	<i>Mangifera indica</i>	Anacardiaceae
Ambedo	<i>Spondias mangifera</i>	Anacardiaceae
Amla	<i>Emblica officinalis</i>	Euphorbiaceae
Amlī	<i>Tamarindus indica</i>	Caesalpiniaceae
Aniyar of Rijiado	<i>Acacia leucophloea</i>	Mimosaceae
Anjan	<i>Hardwickia binata</i>	Caesalpiniaceae
Ankal	<i>Alangium salvifolium</i>	Alangiaceae
Aritha	<i>Sapindus emarginatus</i>	Sapindaceae
Ashotri, Apto	<i>Bauhinia racemosa</i>	Caesalpiniaceae
Banana	<i>Musa paradisiaca</i>	Musaceae
Baval	<i>Acacia nilotica indica</i>	Mimosaceae
Bahedo	<i>Terminalia bellirica</i>	Combretaceae
Bhangaro	<i>Erythrina suberosa</i>	Papilionaceae
Bili	<i>Aegle marmelos</i>	Rutaceae
Biyo	<i>Pterocarpus marsupium</i>	Papilionaceae
Bor	<i>Zizyphus mauritiana</i>	Rhamnaceae
Charoli	<i>Buchanania lanzan</i>	Anacardiaceae
Dantio, Asan	<i>Bridelia retusa</i>	Euphorbiaceae
Dhaman	<i>Grewia tiliacifolia</i>	Tiliaceae
Dhavdo	<i>Anogeissus latifolia</i>	Combretaceae
Dudhi	<i>Wrightia tinctoria</i>	Apocynaceae
Ganiyari	<i>Cochlospermum religiosum</i>	Bixinaceae
Gandobaval	<i>Prosopis juliflora</i>	Mimosaceae
Garmalo	<i>Cassia fistula</i>	Caesalpiniaceae
Ghatbor	<i>Zizyphus xylophyrus</i>	Rhamnaceae
Gol	<i>Trema orientalis</i>	Utricaceae
Gorad	<i>Acacia senegal</i>	Mimosaceae
Gorasamli	<i>Inga dulce</i>	Mimosaceae
Gugal	<i>Boswellia serrata</i>	Burseraceae
Gundi	<i>Cordia dichotoma</i>	Boraginaceae
Haldarvo	<i>Adina cordifolia</i>	Rubiaceae

Local Name	Scientific Name	Family
Hingor	<i>Balanites roxburghii</i>	Simarubaceae
Humbumbh	<i>Milium tomentosum</i>	Annonaceae
Jambu	<i>Syzygium cumini</i>	Myrtaceae
Kadayo	<i>Sterculia urens</i>	Sterculiaceae
Bhamarchal	<i>Hymenodictyon excelsum</i>	Rubiaceae
Kagar	<i>Acacia ferruginea</i>	Mimosaceae
Kaju	<i>Anacardium occidentale</i>	Anacardiaceae
Kakad	<i>Garuga pinnata</i>	Burseraceae
Kakadio	<i>Lagerstroemia parviflora</i>	Lythraceae
Kanaji	<i>Holoptelea integrifolia</i>	Ulmaceae
Karanj	<i>Pongamia glabra</i>	Caesalpiniaceae
Karvali	<i>Streblus asper</i>	Utricaceae
Kashid	<i>Cassia siamea</i>	Caesalpiniaceae
Khair	<i>Acacia chundra (A. catechu)</i>	Mimosaceae
Khakhro or Kesuda	<i>Butea monosperma</i>	Papilionaceae
Khajuri	<i>Phoenix sylvestris</i>	Palmae
Kowth	<i>Feronia elephantum</i>	Rutaceae
Kusum	<i>Schleichera oleosa</i>	Meliaceae
Limdo	<i>Azadirachta indica</i>	Meliaceae
Mahuda	<i>Madhuca latifolia</i>	Sapotaceae
Manvel Bamboo	<i>Dendrocalamus strictus</i>	Gramineae
Mersuing	<i>Dolichandrone falcate</i>	Bignoniaceae
Mindhal	<i>Randia brandissi</i>	Rubiaceae
Moina	<i>Lannea coromandelica</i>	Anacardiaceae
Mokho	<i>Schrebera swietenioides</i>	Oleaceae
Nana Chavdo	<i>Lagerstroemia lanceolata</i>	Lythraceae
Nilgiri	<i>Eucalyptus spp.</i>	Myrtaceae
Pangaro	<i>Erythrina indica</i>	Papilionaceae
Panisadad	<i>Terminalia paniculata</i>	Combretaceae
Passi	<i>Dalbergia paniculata</i>	Papilionaceae
Pipal	<i>Ficus religiosa</i>	Urticaceae
Ratanjot	<i>Jatropha curcas</i>	Euphorbiaceae
Rain Tree	<i>Samania saman</i>	Mimosaceae
Rayan	<i>Manilkara hexandra</i>	Sapotaceae
Sadad	<i>Terminalia crenulata</i>	Combretaceae
Sag	<i>Tectona grandis</i>	Verbenaceae

Local Name	Scientific Name	Family
Saragwo	<i>Moringa oleifera</i>	Moringaceae
Sarasadi	<i>Albizia odoratissima</i>	Mimosaceae
Shamela	<i>Gardenia turgida</i>	Rubiaceae
Shisam	<i>Dalbergia latifolia</i>	Caesalpiniaceae
Shivan	<i>Gmelina arborea</i>	Verbenaceae
Simal	<i>Bombax ceiba</i>	Malvaceae
Siras	<i>Albizzia lebbek</i>	Mimosaceae
Sisso	<i>Dalbergia sissoo</i>	Papilionaceae
Sitafal	<i>Annona squamosa</i>	Annonaceae
Sukhad	<i>Santalum album</i>	Annonaceae
Tad	<i>Borassus flabellifer</i>	Palmae
Timru	<i>Diosypros melanoxyton</i>	Ebenaceae
Umberdo	<i>Ficus racemosa</i>	Utricaceae
Vad	<i>Ficus benghalensis</i>	Utricaceae

Shrubs and Herbs

Local Name	Scientific Name	Family
Adusa	<i>Adhatoda vasica</i>	Acanthaceae
Ankado	<i>Calotropis gigantea</i>	Asclepiadaceae
Awar or Awal	<i>Cassia auriculata</i>	Caesalpiniaceae
Dano	<i>Lantana camera</i>	Verbenaceae
Dhatura	<i>Datura inoxia</i>	Solanaceae
Kaklikanthar	<i>Capparis sepiaria</i>	Capparaceae
Kantharmadith	<i>Dichrostachys cinerea</i>	Mimoseae
Kanski	<i>Abutilon indicum</i>	Malvaceae
Karedo	<i>Capparis deciduas</i>	Capparaceae
Karvi	<i>Carvia callosa</i>	Acanthaceae
Khordu	<i>Cadaba fruticosa</i>	Capparaceae
Kuda, Kalukado	<i>Holarrhena antidysenterica</i>	Apocynaceae
Muradsing	<i>Helicteres isora</i>	Sterculiaceae
Nagod, Nirgund	<i>Vitex nigundo</i>	Verbenaceae
Parijat	<i>Nyctanthes arbor-tristis</i>	Oleaceae
Puwad	<i>Cassia tora</i>	Caesalpiniaceae
Thor	<i>Euphorbia neriifolia</i>	Euphorbiaceae
Vico	<i>Gymnosporia montana</i>	Celastraceae
Zil	<i>Indigofera pulchella</i>	Papilionaceae

Climbers

Local Name	Scientific Name	Family
Amarvel	<i>Cuscuta reflexa</i>	Convolvulaceae
Asan	<i>Cocculus hirsutus</i>	Menispermaceae
Chairo	<i>Dioscorea hirsutus</i>	Dioscoreaceae
Chanoti	<i>Abrus precatorius</i>	Caesalpiniaceae
Dodi	<i>Daemia extensa</i>	Asclepiadaceae
Galo	<i>Tinospora cordifolia</i>	Menispermaceae
Karamdo	<i>Carissa conjesta</i>	Apocynaceae
Khara Jharm	<i>Cressa cretica</i>	Convolvulaceae
Kanch or Kuvech	<i>Mucuna pruriens</i>	Papilionaceae
Malkakani	<i>Celastrus paniculata</i>	Celastraceae
Motikakani	<i>Combretum ovalifolium</i>	Combretaceae
Varsha Dodi	<i>Leptadenia reticulata</i>	Asclepiadaceae

Plants of the Ravine Region

Local Name	Scientific Name	Family
Akdo	<i>Calotropis gigantia</i>	Asclepiadaceae
Ambli	<i>Tamarindus indica</i>	Caesalpiniaceae
Ambo	<i>Mangifera indica</i>	Anacardiaceae
Amla	<i>Embllica officinalis</i>	Euphorbiaceae
Anjan	<i>Stylosanthes hamata</i>	Papilionaceae
Arduso	<i>Ailanthus excelsa</i>	Acanthaceae
Aval	<i>Cassia auriculata</i>	Caesalpiniaceae
Bamboo	<i>Dendrocalamus strictus</i>	Poaceae
Bangali Babul	<i>Acacia auriculoformis</i>	Mimosaceae
Ber	<i>Zizyphus jujuba</i>	Rhamnaceae
Castor	<i>Ricinus communis</i>	Euphorbiaceae
Chandan	<i>Santalum album</i>	Santalaceae
Desi Babul	<i>Acacia nilotica</i>	Mimosaceae
Dhaman	<i>Cenchrus ciliaris</i>	Tiliaceae
Dhamaso	<i>Alhagi camelorum</i>	Papilionaceae
Dharo	<i>Cynodon dactylon</i>	Poaceae
Ganda Babul	<i>Prosopis juliflora</i>	Mimosaceae
Goadio	<i>Acacia senegal</i>	Mimosaceae
Gokhru	<i>Xanthium strumarium</i>	Compositae

Local Name	Scientific Name	Family
Goras Ambli	<i>Pithecellobium dulce</i>	Mimosaceae
Gugal	<i>Commiphora wightii</i>	Burseraceae
Indrakh	<i>Anogeissus pendula</i>	Combretaceae
Ingora	<i>Balanites aegyptiaca</i>	Zygophyllaceae
Jamun	<i>Syzygium cuminii</i>	Myrtaceae
Kanji	<i>Holoptelea integrifolia</i>	Ulmaceae
Karanj	<i>Pongamia pinnata</i>	Papilionaceae
Kapok	<i>Ceiba pentandra</i>	Malvaceae
Kashid	<i>Cassia siamea</i>	Caesalpinaceae
Kerdo	<i>Capparis</i> spp.	Capparaceae
Khair	<i>Acacia catechu</i>	Mimosaceae
Khajur	<i>Phoenix sylvestris</i>	Palmae
Khakhro	<i>Butea monosperma</i>	Papilionaceae
Kothi	<i>Limonia acidissima</i>	Rutaceae
Luni	<i>Cressa critica</i>	Convolvulaceae
Mahua	<i>Madhuca indica</i>	Sapotaceae
Mangroves	<i>Avicennia marina</i>	Acanthaceae
Morud	<i>Suaeda fruticosa</i>	Chenopodiaceae
Nalo	<i>Ipomea</i> spp.	Convolvulaceae
Neem	<i>Azadirachta indica</i>	Meliaceae
Nilgiri	<i>Eucalyptus hybrid</i>	Myrtaceae
Piludi	<i>Salvadora persica</i>	Salvadoraceae
Pipalo	<i>Ficus religiosa</i>	Urticaceae
Ram Babul	<i>Parkinsonia aculeata</i>	Caesalpinaceae
Ratanjot	<i>Jatropha curcas</i>	Euphorbiaceae
Samadi	<i>Acacia leucophloea</i>	Mimosaceae
Sandeshra	<i>Delonix elata</i>	Caesalpinaceae
Sargava	<i>Moringa oleifera</i>	Moringaceae
Saru	<i>Casuarina equisetifolia</i>	Casuarinaceae
Sevan	<i>Gmelina arborea</i>	Verbenaceae
Simlo	<i>Bombax ceiba</i>	Malvaceae
Siris	<i>Albizia lebbek</i>	Mimosaceae
Sissoo	<i>Dalbergia sissoo</i>	Papilionaceae
Sitaphal	<i>Annona squamosa</i>	Annonaceae
Subabul	<i>Leucaena leucocephala</i>	Mimosaceae
Tulsi	<i>Ocimum sanctum</i>	Lamiaceae

Local Name	Scientific Name	Family
Vad	<i>Ficus microcarpa</i>	Urticaceae
Vico	<i>Maytenus emarginata</i>	Celastraceae

Plants of the Bhal/ Saline Region

Local Name	Scientific Name	Family
Anghedo	<i>Achyranthes aspera</i>	Amaranthaceae
Ber	<i>Zizyphus mauritiana</i>	Rhamnaceae
Biladu	<i>Chenopodium murale</i>	Amaranthaceae
Chakla Ponk	<i>Elucine</i> spp.	Poaceae
Del	<i>Aeluropus lagopoides</i>	Poaceae
Dilo	<i>Cyperus rotundus</i>	Cyperaceae
Dudheli	<i>Euphorbia hirta</i>	Euphorbiaceae
Ganda Babul	<i>Prosopis juliflora</i>	Mimosaceae
Ikkad	<i>Sesbania bispinosa</i>	Papilionaceae
Jhinjvo	<i>Dichanthium annulatum</i>	Poaceae
Kalar	<i>Vernonia cinerea</i>	Compositae
Kalavo	<i>Eragrostis</i> spp.	Poaceae
Karanj	<i>Pongamia pinnata</i>	Papilionaceae
Kerdo	<i>Capparis decidua</i>	Capparaceae
Luno	<i>Cressa cretica</i>	Convolvulaceae
Mamejo	<i>Enicostemma littorale</i>	Gentianeae
Morad	<i>Suaeda nudiflora</i>	Chenopodiaceae
Piludi	<i>Salvadora persica</i>	Salvadoraceae
Rayan	<i>Manilkara hexandra</i>	Sapotaceae
Samo	<i>Echinochloa colonum</i>	Poaceae
Saragva	<i>Moringa oleifera</i>	Moringaceae
Saru	<i>Cestrum equisetifolia</i>	Casuarinaceae
Satavri	<i>Asparagus racemosus</i>	Liliaceae
Thor	<i>Euphorbia nivulia</i>	Euphorbiaceae

5.2 Fauna of the Project Area

Birds of Anand Project Area

Common name	Scientific name
Black-headed Ibis	<i>Threskiornis melanocephalus</i>
Black Ibis	<i>Pseudibis papillosa</i>
Black-winged Stilt	<i>Himantopus himantopus</i>
Brahminy Starling	<i>Sturnus pagodarum</i>
Common Hoopoe	<i>Upupa epops</i>
Crested Lark	<i>Galerida cristata</i>
Demoiselle Crane	<i>Grus virgo</i>
Forest Wagtail	<i>Motacilla indica</i>
Great Egret	<i>Casmerodius albus</i>
Greater Flamingo	<i>Phoenicopterus roseus</i>
Great White Pelican	<i>Pelecanus onocrotalus</i>
Green Bee Eater	<i>Merops orientalis</i>
Grey-headed Fishing Eagle	<i>Ichthyophaga ichthyaetus</i>
Grey Heron	<i>Ardea cinerea</i>
Indian Reef Heron	<i>Egretta gularis</i>
Indian Roller	<i>Coracias benghalensis</i>
Little Cormorant	<i>Phalacrocorax niger</i>
Long-tailed Shrike	<i>Lanius schach</i>
Marsh Harrier	<i>Circus aeruginosus</i>
Painted Stork	<i>Mycteria leucocephala</i>
Pied Kingfisher	<i>Ceryle rudis</i>
Purple Heron	<i>Ardea purpurea</i>
Purple Swamp Hen	<i>Porphyrio porphyrio</i>
Red-wattled Lapwing	<i>Vanellus indicus</i>
Rose-ringed Parakeet	<i>Psittacula krameri</i>
Ruddy Shelduck	<i>Tadorna ferruginea</i>
Sarus Crane	<i>Grus antigone</i>
Shoveller	<i>Anas clypeata</i>
Sun-bird (purple)	<i>Nectarinia asiatica</i>
White-breasted Water Hen	<i>Amauornis phoenicurus</i>
White-rumped Vulture	<i>Gyps bengalensis</i>
White-throated Kingfisher	<i>Halcyon smyrnensis</i>
White Wagtail	<i>Motacilla alba</i>
Yellow-headed Wagtail	<i>Motacilla citreola</i>

Wild Animals: Wolf, Hyena, Jackal, Wild Boar, Blue Bull, Antelope, Indian Gazelle.

Fish: Kudnara, Debra, Marel, Padia, Nagra, Rau, Baus, Boi, Singkro, (Fresh water) Sarmai, Belja, Bano, Zinga, Ghalu, Fausta, Zinga-chola, Bamvalo, Biu, Kantia, Palva, Dodi, Magra.

Birds: Grebe, Pelican, Cormorant, Heron, Stork, Ibis, Flamingo, Duck, Hawk, Eagles, Vulture, Falcon, Peafowl, Partridge, Quail, Bustard, Crane, Coot, Bustard, Plover, Gull, Sandgrouse, Owl, Nightjar, Kingfisher, Bee-eater, Swallow, Shrike.



Nilgai (Boselaphus tragocamelus), an antelope, commonly seen in central Gujarat.



Ardea alba, the Large Egret.

Reptiles: Monitor Lizard, Mud Turtle, House Gecko, Chameleon, Marsh Crocodile.

Venomous Snakes: Cobra, Common Krait, Russell's Viper, Saw-scale Viper, Rat Snake.

Non-venomous Snakes: Wolf Snake, Checkered Keelback, Green Keelback, Common Sand Boa, Trinket, Red Sand Boa, Common Kukri, Python.

5.3 Agro-biodiversity of the Project Area

The livestock is composed of cows, buffaloes, sheep and goats.

Major crops in the project area

District	Crop
Anand and Kheda	Wheat (<i>Triticum</i> spp.), Bajri (<i>Pennisetum typhoidis</i>), Jowar (<i>Sorghum vulgare</i>), Rice (<i>Oryza sativa</i>), Gram (<i>Cicer arietinum</i>), Arhar (<i>Cajanus cajan</i>), Cotton (<i>Gossypium hirsutum</i>), Groundnut (<i>Arachis hypogaea</i>), Tobacco (<i>Nicotiana tabacum</i>), Maize (<i>Zea mays</i>), Banana (<i>Musa</i> sp.)
Vadodara	Rice (<i>Oryza sativa</i>), Maize (<i>Zea mays</i>), Wheat (<i>Triticum</i> spp.), Jowar (<i>Sorghum vulgare</i>), Bajri (<i>Pennisetum typhoidis</i>), Gram (<i>Cicer arietinum</i>), Arhar (<i>Cajanus cajan</i>), Cotton (<i>Gossypium hirsutum</i>), Groundnut (<i>Arachis hypogaea</i>), Banana (<i>Musa</i> sp.)



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