Chapter 3

Environmental Background
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ENVIRONMENTAL BACKGROUND

This chapter provides an overview of the present day environmental conditions of Gujarat with special reference to the area under present study.

3.1 Introduction

The environment and its changes play a major role in the formation, development, prosperity, and decline of cultures. It has been observed that the Harappan and the Harappan affiliated chalcolithic communities are distributed over various environmental zones, ranging from dry deciduous climate to wet forests, including marshy lands. Therefore, the skill and adaptability of the Harappans or the Harappan chalcolithic communities into varied environmental niches is very evident. The foremost priorities in choosing a place for settlement are the requirements of good soil and potable water, as well as proximity and accessibility to other raw materials for sustenance.

Gujarat is the westernmost state of the Indian Union. It shares both the land and sea frontiers of the country. The state is located on the Tropic of Cancer falling within the subtropical climatic zone between 35° C and 45°C isotherms. Gujarat is bounded by the Arabian Sea to the west and southwest, and Pakistan to the north. The state of Rajasthan is to the northeast, Madhya Pradesh to the east, and Maharashtra and the Union Territory of Dadra and Nagar Haveli to the south and southeast. Physiographically, Gujarat is divided into three distinct geographical sub-regions, namely, Kachchh, Mainland of Gujarat, and Saurashtra (Figure 3.1).

Kachchh lies on the northwest, and is characterized by four geomorphic land types: (i) The Rann, which forms the vast desert like expanse of salt comprises of the
Great and the Little Rann is only a few meters above sea level. These get inundated for some part of the year especially during the monsoon while for the rest it remains dry. (ii) The low-lying semi-fertile Banni plains that lie between the Great Rann and the rocky mainland. This is a vast sandy loam tract is flat and thinly populated. (iii) The hilly region with the island belt of four rocky projections rising above the Rann and Kachchh mainland. (iv) The southern coastal plains that border the mainland against the Gulf of Kachchh in the south and the Arabian Sea in the west. The climate of Kachchh is arid, with rainfall ranging only from 30 to 40 cm per year. The temperature rises to 46°C in summer while it falls below 5°C or even less during winters. The soil of Kachchh is alluvial only at places, while most of it is covered by wind-blown deposit, or a sandy and loamy soil. Vegetation is exclusively the dry, salt tolerant dry scrub types, excepting a small area of mangrove at the end of the Gulf of Kachchh (Mehr 1995).
Mainland Gujarat consists of the eastern rocky highlands (alt. 300 to 1100m), the extensions of the Sahayadri, Satpura and the Aravallis, including the hilly terrain between the Narmada and Mahi rivers. The Western alluvial plains of the north and central Gujarat comprise of the unconsolidated sediments deposited by fluvial and aeolian agencies mainly during the Quaternary period (Mehr 1995). Across these plains flow the major rivers of Gujarat, viz. Tapi, Narmada, Mahi, Sabarmati and their tributaries. Besides, other rivers such as Rupen, Banas, and Saraswati also contribute to the drainage network. The annual rainfall in the mainland ranges between 800mm to 1500mm per year. Although the eastern highlands receive more than adequate precipitation, it has very little productive potential. The mainland of Gujarat may be further divided into the northern and southern parts. North Gujarat extends in the north up to the southern Rajputana and gradually merges into the alluvial plains of Saurashtra towards the west, and is a semi-arid, sandy plain dotted with fossil sand-dunes. South Gujarat is an alluvial plain developed from the major rivers, as mentioned earlier, and extends south toward Maharashtra, bounded by granite hills of the Sahayadri and Satpura in the east; on the west the Gulf of Khambat and the Arabian Sea bound it. The coastal strip is marked by a covering of dry deciduous forest.

The peninsula of Saurashtra, covering an area of 23,500 sq. miles approximately, is founded on Deccan Trap, fringed by coastal plains. The central part is made up of an undulating plain broken by a range of hills like the Chotila, Gir and Barda. The Gulf of Khambat borders the peninsula on the southeast, the Arabian Sea on the west, the marshes of the Nal Depression on the east and the Gulf of Kachchh on the north. The presence of these features and the comparative altitude of the central plateau suggest that the peninsula may have been, at some point of time in the past, an island separate from the sub-continent. (Bombay Presidency Gazetteer 1879) This is evident from the fact that a large number of lakes and water bodies are present in the Nalkanta region. The entire wasteland, at present, is interspersed with marshes, mangroves, swamps, and lakes. The region around the Gulf of Khambat is marshy and water logged and does not facilitate agriculture, but is known for good grasslands. Rainfall varies from 400mm to 800mm at different places in Saurashtra as the peninsula marks a transition from the regions of -45-.
medium rainfall to drought (Government of Gujarat Census 1965). The drainage pattern of Saurashtra is radial, with rivers flowing to the sea in all directions from the central hilly region. These rivers are not perennial in nature and hence remain dry for most part of year, but get inundated during monsoons. The larger rivers, like the Bhadar, the Shetrunji are perennial and have large tracts of agriculturally rich black soil along their banks.

3.2 The Survey Region and its Environmental Background

The area of present study forms a part of the region of Saurashtra lying between the 400mm to 800mm isohyets. The area mainly falls within the jurisdiction of two adjoining districts of Rajkot and Jamnagar. The focal point of the study, however centers on the site of Jaidak (Pithad) in the Jodiya Taluka of the Jamnagar district and is located on the right bank of the Aji river, which flows into the Gulf of Kachchh. The study area thus extends from Pithad to its surrounding regions in the Jamnagar district as well as covering the Tankara and Morvi Talukas of the Rajkot district. Incidentally, two important Harappan sites – Kuntasi and Bagasra sites are located in the Maliya taluka of the Rajkot district. The extended survey area stretches towards the south up to the Gondal taluka, also in Rajkot district where another Harappan site, Rohdi is located on the banks of the river Bhadar.

The survey region falls in the dry climatic zone where the maximum temperature rises up to 45°C in summers, while dropping to a minimum temperature of 8°C to 10°C in the winter season and has a rather low relative humidity. Various rivers and streams flow in all directions from the central high ground in a radial pattern. However, most of the streams flowing into the Gulf of Kachchh, which form the northern concentration of streams, are comparatively smaller and more or less seasonal. These include the Ruparel, the Kankavati, the Und, the Aji, the Demai, the Machhu, the Godadhro, and the Bambhan. The southern concentration is largely formed by the river Bhadar along with its numerous tributaries.
The area under study covers the Jodiya and Dhrol talukas, besides eastern part of Jamnagar, Lalpur, Jamjodhpur, and parts of the Kalavad talukas of the Jamnagar district. In the Rajkot district, the area stretches covering the Maliya, Morvi, parts of Wankaner, Rajkot and Gondal talukas. The north and northwest are bordered by the Little Rann of Kachchh on the edges of the Maliya taluka, moving into the plains of the rivers; most part of the rest of the region is also plain with somewhat undulating topography. This undulating tract merges into the lowlands in the plains of the trap again drained by the Bhadar river and its tributaries on the southern fringe of the survey region.

3.2.1 Geological and Geomorphological Features

3.2.1a Geological Features:

The Saurashtra region contains only Mesozoic and Cenozoic rocks, and stratigraphically the sequence begins with cretaceous to be followed upward by the Deccan volcanics, Tertiary and Quartermary (Mehr 1995). The Deccan Trap is basaltic in composition, and occupies almost the central part of Saurashtra. There occurs a thick cover of alluvium in the northern part along with the sandy Rann sediments. These trap rocks are made of agglomerate and ash beds while the top is covered by fine to medium-grained basalt. The basalt rock varieties include largely porphyritic olivine and amygdaloidal. Also a large number of other rock varieties such as felspites, granophyres, rhyolites, obsidians, picrutois, limburgite-basalt, trachylyte, etc. are also found in parts of the Jamnagar district. The Morvi and Maliya talukas are situated on the Umia beds constituting of conglomerates, sandstones and shales, which has a total thickness of about 450 meters. The largest stretch of alluvium is represented by sand dunes, consolidated shore sand, tide sand flats raised beaches, and fresh water alluvium soils occur. Several sand dunes are noticed near the Rann of Kachchh. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.2.1b Ground Water:

The alluvium and milliolite formation generally yields moderate quantities of ground water within a shallow depth from the surface for domestic needs as well as
irrigation purposes. Sub-surface water from the Rann region, however, is entirely brackish. The Deccan Trap, on the other hand, are poor containers of water, with only small quantities of usable water found stored in thick soil cover, decomposed rock, flaw lines, joints and fissures. It yields ground water at depths varying from 10m to 25m.

3.2.1c Soils:

The soil in the vicinity of Jaidak and in the area extending from the borders of Kachchh in the north up to the river banks of the Bhadar in the south of the survey region is generally of volcanic origin, derived from the deccan trap. The area is predominately covered by the black or medium black (kali or karal) soil and the alluvial (goradu or gorat) soil. These two soils are distinguishable by their properties, such as, colour and texture. The former is the older alluvium, while the latter is the new alluvium. The black or medium black soil extends over maximum portion of the survey region, i.e. parts of both the Jamnagar and Rajkot districts. The alluvial soil, on the other hand, covers a smaller portion of the region, generally the riverbanks in the Jodiya, Kalyanpur and Jamnagar talukas in the Jamnagar district as well as the riverbanks in the Maliya and Gondal talukas in the Rajkot district. The medium black soil varies from light gray to reddish brown in color, and is rich in minerals and organic matter and is therefore more fertile. The soil is also known for its labor-reducing capacity and of holding moisture, which makes it suitable to all types of crops. This soil particularly favours the cropping of cotton, groundnut, Pearl millet or bajra (Pennisetum typhides) and large millet or jowar (Sorghum bicolar) and wheat (Triticum sp.). The medium black soil may be sub-classed into dharod and rechak (Rajkot District Gazetteer 1965). The dharod soil has a sloppy nature and is devoid of the fine particles of clay, which are eroded away leaving behind the coarse particles and pebbles. Therefore, the soil has a poor depth and needs plenty of irrigation and manuring for producing a good harvest. The chief crops grown in this soil are Pearl millet or bajri, large millet or jowar, green gram or mung and groundnut. A greater portion of the eastern and southeastern parts of the survey region of the Rajkot and Jamnagar districts is under the dharod soil. The rechak (also known as kharach) soil has salt depositions on the surface and therefore cannot bear heavy rain or moisture.
However, crops like cotton, jowar, paddy, and sugarcane can be grown favourably in this soil.

The alluvial soil, locally known as Goradu is formed on the riverbanks or in coastal areas by deposition of sediment. Thus the riverbanks near the Jamnagar and Jodiya talukas are covered by this soil. The coastal alluvium soil is found in some parts of the Maliya taluka. The alluvial soil is highly productive, although somewhat inferior in quality to the black soil. Structurally it is sub-angular and blocky; texturally, the soil is silty-loam to clay, and is neutral to alkaline in reaction. In the coastal areas, the texture varies from sandy-clay-loam to clayey. The goradu soil may be sub-classed into mithi-goradu and khari-goradu, the former being more fertile than the latter. The colour of the soil is generally reddish to brown and the depth varies from 3m to 5m. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.2.1d Geomorphological Features:

The district of Jamnagar demonstrates an uneven topography, broken at places by hills, ranges, with the Rann to the north and east and ranges of sand dunes along the coast to the north and west. The physical aspect of the district, however, varies from one taluka to the other. The central and southern region of the district has a rather plain terrain. The Rajkot district shows similar geographical features – the eastern hills bordering the Jetpur, Rajkot and Wankaner cities, while the fertile alluvial plains drained by the rivers stretch all over the western and south western portions of the district; on the north is again the salty plains of the Rann and the swampy coastline.

The survey region, which covers some parts of both the Jamnagar and Rajkot districts, bears features of similar geomorphology. The Rann of Kachchh borders the Maliya taluka on the north and bounds the Jodiya and Jamnagar talukas in the northwest. The Rann is an alluvial deposit of clay and sand, formed by an inlet of the sea from the Gulf of Kachchh. These salt flats remain dry and arid for most part of the year, except during the rainy season when it becomes a shallow lake. The coast, off Jodiya and
Jamnagar, is a long mud-covered, flat one with mangrove swamps and abounds in reefs, and rocks. This is the terrain covering the southern parts of the Maliya taluka, the western half of the Morvi and Wankaner talukas, the eastern parts of Jodiya and Jamnagar talukas. Dhrol is largely plain, although undulating at places, and has an average height of 150 feet. This undulating area slopes into the alluvial plains again drained by the Bhadar river and its tributaries in the Gondal taluka of Rajkot district. The talukas of Kalavad, Lalpur (in Jamnagar district) and parts of the Rajkot, Gondal and Wankaner talukas (Rajkot district) are partly hilly and partly terrain. The hills, on the east and northeast bordering Jetpur, Rajkot and Wankaner cities, are irregular chains of barren hills and barrow ridges formed from the trap. Thus the survey region basically lies in the narrow stretch of tableland of the Kathiawar peninsula, interspersed with hilly ranges and river valleys supporting appreciable agricultural productivity. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.3 Drainage – River System

The entire stretch of tableland of the survey area is drained by a substantial number of rivers and streams flowing in different directions in a radial pattern. The rivers are not perennial, most of them being small dry channels devoid of any large tributaries. The streams in the northern part of the survey region flows either into the Gulf of Kachchh or disappears into the Little Rann. Of the numerous streams, the Machhu and the Aji are relatively larger. The Machhu originates in highlands, flowing for about 110 km through the town of Morvi and meets the Little Rann. The Aji is smaller than the Machhu in length, originates near Sardhar, flows through Rajkot and empties in the Gulf of Kachchh (Mehr 1995). The major river system in the southern half of the study area is the river Bhadar and its tributaries. The Bhadar river is the longest river in Saurashtra. It has a course of about 260 km, flowing westward from the central highlands and merges into the Arabian Sea. The detail profile of each river in the survey area is as follows:
3.3.1 River Machhu

River Machhu has a course of about 70 miles and flows in the Rajkot district. It rises near the town Anandpur in the northern belt of hills and flows past Wankaner and Morvi. The earlier section of the river course is marked by a rocky channel and rugged precipitous sides. It is almost dry in other seasons, but during the monsoons, it flows in torrents and floods the catchment area. An about one and half mile north of Maliya, the river divides into several streams, before falling into the Rann. Then the water flows to the southwest close to the coast of the Rann and reaches the Vavania creek. Its water becomes brackish about ten miles from its mouth and passes through salt wastes till it loses itself in the salt, sand, and mud of the Gulf of Kachchh. (Rajkot District Gazetteer 1965).

3.3.2 River Aji

River Aji rises north of Sardhar in one of the hills of the northern series of Thanga Hills. It reaches Rajkot flowing past the villages of Tramba and Thorala, through an undulating land scattered with low hills. Smaller streams the Lalpari and the Fulgar meet the Aji at Bedi. The whole course of this section of the river is rocky and precipitous. The volume of water is quite less except in rainy season. Two other streams, Niari and Dondi also join the Aji north of Rajkot, on whose bank stands the town of Paddhari and serves as district boundary for about 2km. It enters Jamnagar at Khakhadabela, about 32km by river form Rajkot. The stream Niari leaves Aji to include within Jamnagar in the village Modpar. River Aji again forms the boundary of the Jamnagar district for nearly 13km of its course. It then flows past the villages, Pithad and Morana and loses itself in the sands 10km from the coast of the Gulf of Kachchh near Balambha village. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.3.3 River Demi

River Demi is a small river originating in the Dema hills near Sansora in Dhamalpur village in the Thanga hills. It flows past the villages Kuvadva and Mitana.
The river is slow and sluggish for most part. Flowing north it enters the district Jamnagar north of the Gunda village. It passes through the village Tankara and empties itself into the Gulf of Kachchh near Navlakhi through many channels. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.3.4 River Und

River Und rises near the village Bedia in Rajkot district at a height of 450 feet. It has a total length of 77km. It flows past the villages Dharaji and Pata Meghpar, on its left and Nana Sagalia, Nana Khijadia and Khokhri on its right. The streams, Moti Phuljar and the Manvar join the Und at Khokhri village. About a kilometer north of the village Hamapur the Und, which is now flowing in the north-south direction, is joined by another small river, the Gal. Further north another river channel, 6km in length joins it before it empties into the Gulf of Kachchh at Dobar creek (Jamnagar District Gazetteer 1970).

3.3.5 River Fuljar

River Fuljar originates in the outliers of the central highlands north-east of the village Devalia Neva in Jamnagar district. It flows past the highlands, about 250 feet in height and enters the plains, passing the villages Babarzar and Rajvad. A small stream rising from the Lasksar hills joins the Fuljar 5km north of Rajvad. It passes the Modpar village flowing east. From Modpar it becomes a perennial river and flows through the Lakhia and Jhakar villages. The total length of the river is about 35km. (Jamnagar District Gazetteer 1970).

3.3.6 River Ruparel

River Ruparel rises in the Khan Khotda hills, an offshoot of the central highlands in the district of Jamnagar. The river flows for a distance of 37km and empties into the Mita Dora creek of the Gulf of Kachchh (Jamnagar District Gazetteer 1970).
3.3.7 River Bhadar

River Bhadar originates in the Mandar hills (Panchal hills), north of Jasdan in Rajkot district and flows westward for a distance of 260 km before meeting the Arabian Sea. About 20 miles from its source flowing westward it is joined by the Katmali river flowing from the hills near the town Sardhar. Then it is joined from left by the Vasavadi river, which flows past Vasvad and from the right by the Gondali river on whose banks stands the town of Gondal. The Bhadar, throughout the course of this river section, has a character of a hill stream flowing with a swift current in the rocky channel between steep banks. From Jetpur, it takes a southwesterly course and the precipitous banks gradually begin to subside. A 15 feet high waterfall is created four miles from Jetpur, where the Bhadar takes a curve for a few miles. From the waterfall it turns to west and enters the plains. The volume of water is increased substantially by the frequent joining of its tributaries. It receives in succession the Utavli passing from the Mengni, the Popal rising from Lodhika, the Moj on whose banks stand the towns Upleta, and Vesini flowing from the hills around Dhraffa. This course is marked by richly cultivated crops. A noteworthy feature of the river is the formation (because of its frequently varying current) of tracts of mud deposits called Bhatha, a fertile land, although liable to be washed away. In the rainy season, however, the river overflows flooding and causing considerable damage to its catchment area. Conversely, the brighter side of its flood may be noticed, as alluvial soil is deposited on its banks, the region has the maximum fertility in the district (Rajkot District Gazetteer 1965).

3.4 Rocks and Minerals

The survey region is quite rich in its mineral resources. A major portion of the district is covered by the Deccan Trap, which being hard, dense and durable are extensively quarried for both constructional purposes as also for road metal. These are fresh, fine grained and compact dolerites. Besides, the region is well endowed with various kinds of building materials. They comprise clays for the manufacture of bricks, sands for mortar and concrete, limestone and kankar for lime making and cement manufacture etc. The famous Wadhwan sandstone exposed near Wadhwan as also near
Jhinkali and Morvi constitute of good building stones, especially for ornamental designs. Some fine-grained varieties are also quarried for grinding stones. Calcite deposits have been also worked out in several talukas of the Jamnagar district, including the Jodiya taluka, near Pithadia and Rajitpur. The semi precious stones occur as geode materials containing chalcedony, moss agate, amethyst, onyx, etc. near Beraja, Navgam, Latipar, Jivapur, Timbdi, Vijarkhi, Bodi, Chapra, Jalasnar and Bhangol. Chalcedony, agate and jasperoid conglomerates of varying sizes are found near Veratia, east of Virpar, Nani Nagajar and on the terraced bank of the Dhudhala Vokala; all in the Jamnagar district. The parts of the Rajkot district within the survey region besides the above mentioned stone beds, has an inter-trappean bed of limestone near northeast of Lakhawad in Jasdan taluka. Also isolated patches of Miliolite limestone are conspicuously present in the Jetpur, Jasdan and Rajkot talukas (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.5 Climate

The area on the whole falls under the dry to semi-arid climatic zone with an annual rainfall ranging between 400mm to 800mm per year. The year may be divided into four seasons – cold season from December to February; hot season from March to May; the southwest monsoon from June to September; the post monsoon during October and November. About 94 percent of the rainfall is received during the southwest monsoon season, July being the month with the highest rainfall. The temperature begins to recede from mid-November and January is the coldest month of the year with the average mean daily maximum temperature at 27.2°C (80.9°F) and minimum at 11.1°C (51.4°F). The period from March till May is one of continuous rise in temperatures. May is the hottest month with an average mean daily temperature at 38.4°C (101.2°F) and the minimum temperature at 24.6°C (76.3°F). The relative humidity during the southwest monsoon is generally over 60 percent, while for the rest of the year the air is neither too dry nor too humid. In association with cyclonic storms or depressions in the Arabian Sea, the region experiences very strong wind and widespread rain with thunderstorms in the post monsoon months. Occasional fog is also found to occur in the winters (Jamnagar
District Gazetteer 1970; Rajkot District Gazetteer 1965). However, some variations in the weather phenomena have been noticed in recent times as a sequel to the increasing pollution and effects of global warming.

3.6 Flora and Fauna

3.6.1 Flora:

The forest cover in the survey region is quite poor in spite of the catchment of several big rivers like the Aji, the Machhu, the Bhadar, etc. Most of the hillocks are barren and open to erosion. The tree growth consists mostly of bad malformed tree clusters and acacia forest or the *babul-kants*. However, areas without tree growth are used as *vidis* or grasslands. *Vidis* are rather more frequent in the region. Some fruit bearing trees are also grown, for example, Mango (*Magnifera indica*), Chikoo (*Manilkara zapota*), Papaya (*Carica papaya*), Bananas (*Musa paradisia* Linn.), *Bor* (*Zizyphus jujube*). Trees like Peepal or *Piplo* (*Ficus religiosa*), and Banyan or *Vad* (*Ficus bengalensis*) are generally found inside the villages. Other varieties of trees include *Desi baval* (*Acacia arabica*), *Awai* (*Cassia auriculata*), *Gando baval* (*Prosopis juliflora*), *Khijdo* (*Prosopis spicigrea*), Babool (*Acacia nilotica*) and few Neem or *Limbdo* (*Azadirachta indica*) trees and other xerophytes. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965) The vegetation cover, however, receives a remarkable boost in growth with sufficient rainfall in the region. The barren and arid land with scrub forest gets covered by an intensive growth of grass and several other plants (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.6.2 Fauna:

The region is inhabited by a large number of both herbivorous and carnivorous wild animals. The herbivore group includes - Blue Bull or *Nilgai* (*Boselaphus tragocamelas* Pallas), Wild Ass (*Equus hemionus*), Mongoose or *Nolio* (*Herpestes auropunctatus* Hodgson), Porcupine or *Shedhadi* (*Hystrix indica* Kerr), Black Buck or Kaliar (*Antelope cervicapra*), Hegde Hog or *Sherva* (*Einaceus collaris*), Rabbits, etc.
The carnivore group includes – Hyaena or Jarakh (Hyaena hyaena Linn.), Wolf or Nar (Canis lupus Linn.), Jackal or Shial (Canis aureus Linn.), Fox or Lonkadi (Vulpus bengalensis Shaw), Wild Cat or Jangli Bilado (Felis chaus Guldenstaedt), Wild Pig or Bhund or Dukkar (Sus scrofa Linn.). Besides these domestic Dog or Kutro (Canis familiaris), and Cat or Bilado (Felis domesticus) are common in the area (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

The avifauna is also quite rich and varied. The most common birds are: Eastern Common Crane or Kunj (Grus grus jerdoni Legge), Jerdon’s Ringed Plover or Titodi (Charadrius dubius jerdoni Legge), the Pamirs Lesser Sand-Plover or Nani Retal Titodi (Charadrius mongolus artifrons Wagler), Grey Plover or Batana Titodi (Squatarola squatarola squatarola Linn.), Gull-billed Tern or Dhomda Dhomdi (Gelochelidon nilotica nilotica Gmelin), White-breasted Kingfisher or Kalkaiyo (Haleyon symrnenis symrnensis Linn.), Grey Heron or Kabut (Ardea eneres Linn.), Black-necked Stork or Kalo iagula (Xenorhynchus asiaticus asiaticus Latham), Ruddy Sheldrake or Brahminy Duck or Batak (Casarca ferruginea Vroeg), Bulbul (Pychonouts spp.), Sandgrouse or Titar (Pterocles exustus Eulanger Neumann), Cotton Teal or Girija (Nettapus coromandelinus Gmelin), Crane or Sarus (Grus leucogeranus), Egret (Bubulcus ibis coromandus Boddaert), Green Bee Eater or Nano Patrangiyo (Merops orientalis Latham), besides other common birds like, fowl, Peacock, house sparrow, pigeons, parrot, dove, cuckoo, vulture, kite, etc. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

Among the reptiles, the Indian Monitor Lizard (Monior Linn.), Blood sucker (Catotoes versicolor), the colourful Skink (Mabuis sp.) and the common House Gecko (Hemidactyles sp.) and fresh water turtles (Lissemys sp.) and tortoises (Tetudo elegars) are found. Snakes of the non-poisonous variety consists of Ajgar or Python (Python molurus), Ratsnake (Ptyas mucosus), etc. The poisonous variety consists of Cobra (Naja naja), Krait (Bungarus coeruleus), and the common Russell’s viper (Vipera russelli), etc. (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).
The aquafauna is not so remarkably varied, yet includes some common varieties such as prawns, zingas, fishes like Palla, mullet, catfish, trichurus, mandeli, etc. besides shank, Pearl-Oysters or Moti-ni-chhip (Pteria vulgaris), and Window-pane Oyster or Kansara moti-ni-chhip (Placenta placenta) are also found (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

3.7 Agriculture

Majority of the village population is engaged in agriculture, as their primary subsistence economy, supplemented by a varying degree of animal husbandry. Agricultural practices in the study area are very similar to the rest of Gujarat characterized by dry farming. Crops grown in the area fall into the two usual categories, viz. monsoon or Kharif and winter or Rabi. The main kharif crops grown are Jowar (Andropgare sorghum), Bajri (Penicillaria typhoideum), groundnut, cotton, til or sesamum, maize. Paddy (Oryza sativa) is grown where adequate irrigation facilities are available. Rabi crops can only be grown with proper irrigation. Wheat (Triticum aestivum) and Gram (Cicer aricitnum) are the two main rabi crops. Jowar and cotton can be grown both as rabi and kharif crops. Cotton and Sugarcane are the most important and extensively grown cash crops in the area. Besides, a number of pulses like mung or green gram, math or kidney bean, urad or black gram, etc, and oilseeds apart from groundnut include sesamum, castor are also grown. Vegetables such as cabbage, cauliflower, peas, brinjals, chilies, beans, fenugreek or methi, garlic, onion, carrot, sweet potato etc are grown in the rabi season, while lady’s finger or bhinda, cluster bean or guwar, cowpea or Lobbia chowli (Vigna unguiculata), etc. are grown in the hot season (Jamnagar District Gazetteer 1970; Rajkot District Gazetteer 1965).

Livestock raising is complementary and inseparable from agriculture in the drought-prone climate of Gujarat. Certain sections of the community such as the Rabaris, and the Bharwads derive income and subsistence from breeding and/or herding cattle, sheep, camel, and buffaloes. The profound nature of seasonality with dry and wet periods in Gujarat results in the movement of these people and their animals (Bhan 2004).
3.8 Palaeoenvironment

The changes in the environment have stimulated the human groups to advance and diversify their exploitation of resources of different environments through the ages. During the latter part of the Pleistocene the pattern of climatic change in South Asia had a recognizable effect on the landscape throughout extensive regions of the subcontinent. During the Holocene the climate does not register major changes, but variations in the monsoonal precipitation influencing human habitation have been recorded in northwest India (Singh et. al. 1990). The reconstruction of the Holocene environment has been mainly based on the palaeoclimatic records retrieved from the lake sediments of Rajasthan. Palynological and geochemical studies of sediments from Lurkaransar, Didwana, Sambhar and Pushkar lakes in Rajasthan have shown that there has been a significant variation in the amount of rainfall from the early Holocene times.

The record from Lake Lunkaransar in the Thar suggests heaviest summer precipitation (about 200mm higher than present) between 10.8 and 10 ka (Bryson and Swain, 1981; Swain et al., 1983), fluctuating lake levels in the early Holocene, a maximum between 7.2 and 5.6 ka, and desiccation around 5.6 ka (Singh et al., 1974, 1990; Enzel et al., 1999). During the early and middle Holocene between 5 and 9 ka corresponds to rapidly fluctuating lake levels (Enzel et al., 1999). A widespread dry phase around 3 ka has been observed from the Aeolian (Kar et al., 1998; Thomas et al., 1999; Jain et al., 2003), speleothem (Yadav and Ramesh, 1999), and the lake (Prasad et al., 1998) records. Thus during the arid phase around 3 ka the streams became defunct and only aeolian dunes are present in the stratigraphic record. Palynological data further indicated increased salinity at 3.7 ka resulting from the increasing aridity (Singh 1971; Singh et. al. 1972).

The cultural significance of this monsoon history is considerable, being applicable to the region occupied by the Harappan Culture between 5000 and 3500 yr B.P., roughly. By 5000 yr B.P. the Harappan Culture was well established in the region, with a large number of upland occupation sites where dominantly rain-fed agriculture would seem to
be indicated. Location of such major cities as Harappa and Mohenjo-Daro on the Indus floodplain suggests to some extent that the culture was essentially riverine (Agrawal, 1971). However, most of the sites are not on floodplains, at least in Rajasthan (Bryson and Swain 1981), and data from the studies of the Lunkaransar suggests not only far more summer rainfall than the present but maximum winter precipitation as well during the Indus Culture interval of 5000-3500 yr B.P. Using the Lunkaransar pollen profile, Singh (1971) interpreted the 5000-3500 yr B.P. period as the wettest in the past 10,000 yr. However, the summer rainfall was not higher than the period preceding the florescence of the Indus Culture. There are two features of the reconstructed monsoon history pertinent to understanding the agricultural base of Indus society. The winter rains appear to have been maximum during Indus time, decreasing the winter desiccation now characterizing the region, and increasing the overall precipitation efficiency (Bryson and Swain 1981). In addition, it was also pointed out that the rapid salinization of the lakes followed by their disappearance coincided with the disappearance of the Harappan culture. This strongly suggests that the collapse of the culture was causally linked to a collapse of their agricultural base associated with climatic change.

Studies in the Sabarmati, Mahi, Orsang and Narmada basins (Tandon et al., 1997; Juyal et al., 2004; Bhandari et al., 2005) point towards the existence of ephemeral river systems and largely semi-arid climate in the Gujarat alluvial plains during most of the Late Pleistocene (Bhandari et al., 2005). Also studies have been undertaken in the Mahi and Sabarmati river sections to analyze the palaeoclimate of the region. During the Early Holocene these rivers show a meandering course which signifies more humid phases resulting in an increase in vegetation and lower sediment deposition (Jain and Tandon 2003). However lack of data on fluvial records of Kachchh and Saurashtra remains a major lacuna in deciphering the Quaternary environmental changes in Gujarat. Therefore, for an understanding of the palaeoclimate of Saurashtra during the Harappan period, data from the study of the sediments from Nal Sarovar is very useful. Nal Sarovar is located on the northeastern margin of Saurashtra and hence its palaeoclimatic records have a better correlation with the past climate of Saurashtra rather than those from Rajasthan.
lakes located hundreds of kilometers away. A high resolution record extending back to 6.6 ka BP could be reconstructed from the core samples from Nal Sarovar showing palaeoenvironmental data slightly different from that of the Rajasthan lake cores (Prasad et al. 1997).

The palaeoclimatic records for the period 6.6-4.8 ka from both the lakes, Didwana and Lunkaransar in Rajasthan showed a higher annual rainfall. Nal Sarovar data on the other hand, for the same period shows a shallow lake level, with periodic drying and short wet spells. The latter data further indicates a wetter climate than the present in the succeeding period, from 4.8 ka to 3 ka. This is comparable with the Rajasthan precipitation data, which also indicated a higher than present rainfall. Termination of this wet phase in the Rajasthan lakes has been dated to about 3.5 ka to 4 ka. Whereas the Nal Sarovar data indicates the beginning of aridity about 3 ka, the deterioration of the climate may have set in a couple of centuries earlier. Data from both the regions shows the onset of present-day conditions around 2 ka (Prasad et al. 1997).

From the studies made in Gujarat by Vishnu-Mitre and Sharma (1979), it is indicated that there is no major difference in the climatic conditions of Harappan phase and today. This proposition was supported by Meadow (1989), Rissman and Chitalwala (1990). This is also evident from the presence of drought resistant summer crops – 'millet', in the Harappan Gujarat as well as today. However, it appears that the scholars are unanimous that there were no major climatic fluctuations during the Harappan period, especially in Gujarat, and the climate did not vary much from the present.

3.9 Concluding Remarks

The survey region thus basically forms a part of central highlands formed from the Deccan traps of the Saurashtra peninsula. The area forms the chief watershed for almost all the rivers of the peninsula. The region is covered by the clayey black soil and has proven congenial to the agricultural operations with variable success, depending on
the amount of rainfall every year. The distribution of the grasslands also supports pastoralist communities to a large extent.

The Harappan settlements in the region as well as in the rest of Saurashtra are found to be located in the areas with a fertile soil and abundant pasturage. Most of the settlements are located along the rivers and their tributaries. Thus the settlement pattern, subsistence strategies and culture change of a region is intimately linked to the climate and other environmental variables.