Chapter 2
Physical Environment

CHAPTER - 2

PHYSICAL ENVIRONMENT

2.1. Location and Extent

The study area lies between 21° 40' to 22° 50' N Latitude and 72° 30 to 73° 50' E Longitude. It is a segment of Bharuch, Narmada, Panchmahal and Vadodara districts in central Gujarat.

Its surface boundaries are constituted by the estuary of River Mahi in the north, Gulf of Khambhat in the west, River Narmada in the south and Narmada Main Canal – 1 in the east.

2.2. Physiography

The entire area is a gentle rolling featureless alluvial flat plain of eroded lava with no exposed geomorphic features or outcrops. The slope varies from 240 feet in the northeast and 20 feet along the coastline to the west. On eastern side of the command area there is a drop of 80 feet in an average of 8 miles between the 240 feet contour (running North-South parallel to main canal) and 160 feet contour (running North-South near Dabhoi – Savli railway line) in upper portion. (areas in Savli and Waghodia Talukas of Vadodara District). There, is therefore giving a gradient of 1:530 in these areas. In the lower portion (areas in Sankheda, Tilakwada and Naswadi Talukas in Vadodara District) there is a drop of 80 feet in an average distance of 14 miles between the above mentioned two contours thereby giving a gradient of1: 930 to this area.

The central and south western portions of the Command Area Phase –I is almost bisected by the river Dhadhar. In the areas North of river Dhadhar (areas in Padra and Vadodara Talukas) there is a drop of 70 feet in an average distance of 14 miles between 160 feet and 90 feet contours whereas in the area south of river Dhadhar (area in Karjan and Bharuch Talukas) there is a drop of 70 feet in an average distance of 20 miles between the above two contours, thereby giving a gradient of 1:1060 in the area north of river Dhadhar and 1:1500 in the areas south of river Dhadhar.

In the south west portion of the command area, in the portion between the 90 feet contour and the 30 feet contour areas (West of Bharuch - Jambusar - Kavi railway line) there is a drop of 60 feet in a distance of about 26 miles, thereby giving a gradient of 1:2300. The area adjoining the Gulf of Khambhat (In Vagra and Jambusar Talukas in Bharuch District) has still flatter gradient. (Figure 2.1)

The slope is retarted due to the greater degree of flatness in the central part extending towards the west. The gradient of the area as a whole is 0.003 % which is quite negligible. It makes the plain well drained in the north-east and the central parts of the study area; but towards the west direction, it makes the plain ill drained, causing inundation during heavy showers of monsoon rains.

The fault line also contributes to the poor drainage. Some flat surfaces are, at places, carved out of minor short run drainage channels, and backwater creeks. These creeks or backwater channels, however play a double role – they spread tidal water inland at the time of tides, and drain out the rainwater during the inter tidal period. These creeks or backwater channels run west to east on the west coast, and south to north from the northern bank of river Dhadhar and Narmada.

Sometimes, great problems arise when the high tide coincides with heavy rains. The three rivers of the area Mahisagar in the north, Dhadhar in the central part and Narmada in the south direction, do not form any system of tributaries in the environs of the study area.

Lack of adequate surface slope and drainage channels leads to sluggish flow of rainwater especially from the central and western parts of the area. However the perennial water logging is seen only in the mud flats, which are closer to the coast and frequently face the tidal ingress.

2.3 Fluvial Activity

Since the three rivers, Mahisagar, Dhadhar and Narmada are the main architects of this plain; it would be worth while to view in some details changes brought about by them in the fluvial geomorphology of the area. (Figure 2.2)

A comparative study of one – inch topographic map (approximately a century old) and the recent 1:50000 toposheet shows interesting features. The earlier sheet shows smooth courses of Mahisagar, Dhadhar and Narmada, and a sharp bluff like coastline making the conjunction of land and the gulf. The shoreline marks the end of the land, and beginning of the water. But the recent sheet as well as the LAND_SAT imagery indicate the following changes (Nayak & Sahay 1983, pp.89-91)

1. River Mahisagar has changed its course southwards after 1972.
2. Two shoals have developed in its mouth as a result of the weakening of its erosional force due to the Kadana dam constructed on the upper reaches of the river. The dam restrains the flood force, which was flushing out the deposited sediments earlier.
3. The gulf water has receded, and discreet deposited features have emerged all along the coast from the estuary of river Mahisagar to that of river Dhadhar (SOI Topographic Sheet of 1:50000). But in the LAND –SAT imagery of this area these features are not quit distinct.
4. The course of Dhadhar is slightly straightened. The outer part of the loop of its meander is eroded away. Prior to this change the meander was the natural line of demarcation between village Dolia of Jambusar Taluka (north) and village Denva of Amod Taluka (south). Now the eroded loop made a new boundary adding part of Denva village land to that of Dolia village. It caused oligarchical problems between two villages.

The mud flats, as seen in the older toposheet, are wide in the lower (southern) part and narrow in the north. A very narrow strip is seen near the river Mahisagar estuary and all along the old shoreline. The river island near Tankari village has increased in number from one in the old sheet to three in the new one. Two more small islands have come up near Dolia village.

The mud flats, as classified by Davis (1972), are of three types (1) High tide flats at the outer fringe; (2) Inter tidal flats in the intermediate part and (3) Low tidal or sub tidal mud flats at the lower part. The paleo-mud flats lie beyond the high tidal mud flats. They are quite different from the new one in their tone, texture and particle arrangements. (Nayak & Sahay 1983)

The coastal morphology is marked by the two estuaries of river Mahisagar, Dhadhar and Narmada, the mud flats and the interwoven short streams in them. Another conspicuous feature is the backwater creeks.

2.4 Geology

The geological frame of the eastern coastal flank of the Gulf of Khambhat is very distinctly divided into two major segments.

1. Mahisagar – Narmada Segment and
2. Tapi - Segment

The study area is the upper most part of the first segment bounded by the River Mahisagar in the north. The central and southwestern portion of the study area is bisected by river Dhadhar and the lower most part of the first segment is bounded by river Narmada in the south. This segment is composed of the fluvial, estuarine and at places, marine materials (marine blue clay) of the Quaternary era. Geologically, it is recognized as "Jambusar formation". Its thickness is estimated to be about 900 metres. Claystone, sandy claystone and sandstone are frequently found in it. Its underlain strata are called as Broach formation, and the topmost layer is known as "Gujarat Alluvium". The thickness of the segment has not been known. Its estimated age is Pleistocene to sub-recent. The Gujarat Alluvium has completely concealed this formation and the sub-surface geology in the Jambusar – Broach block (Patel & Merh 1985). Its top layer i.e. Gujarat Alluvium is composed of eroded cretaceous lava (Gazetteer of Bharuch & Vadodara District) of recent to sub-recent times.

A fault line has been detected, running from the mouth of river Mahisagar to river Narmada off Jambusar and Bharuch. This fault line is supposed to have led to upraising of land on its west and, marks the limit of alluvium. There is evidence also of another fault running approximately along the boundary between region -III and which has caused an upward displacement of the marine blue clay and in consequence shallower alluvial deposits in region - IV.

It has lately been known that this segment has rich reserves of petroleum and natural gas. The O.N.G.C (Oil & Natural Gas Corporation) has recently started extracting oil and natural gas from Degam, Nada, Vanseta and other villages. Explorations are in progress in other coastal and estuarine villages of the study area.

Contour Map of Study Area

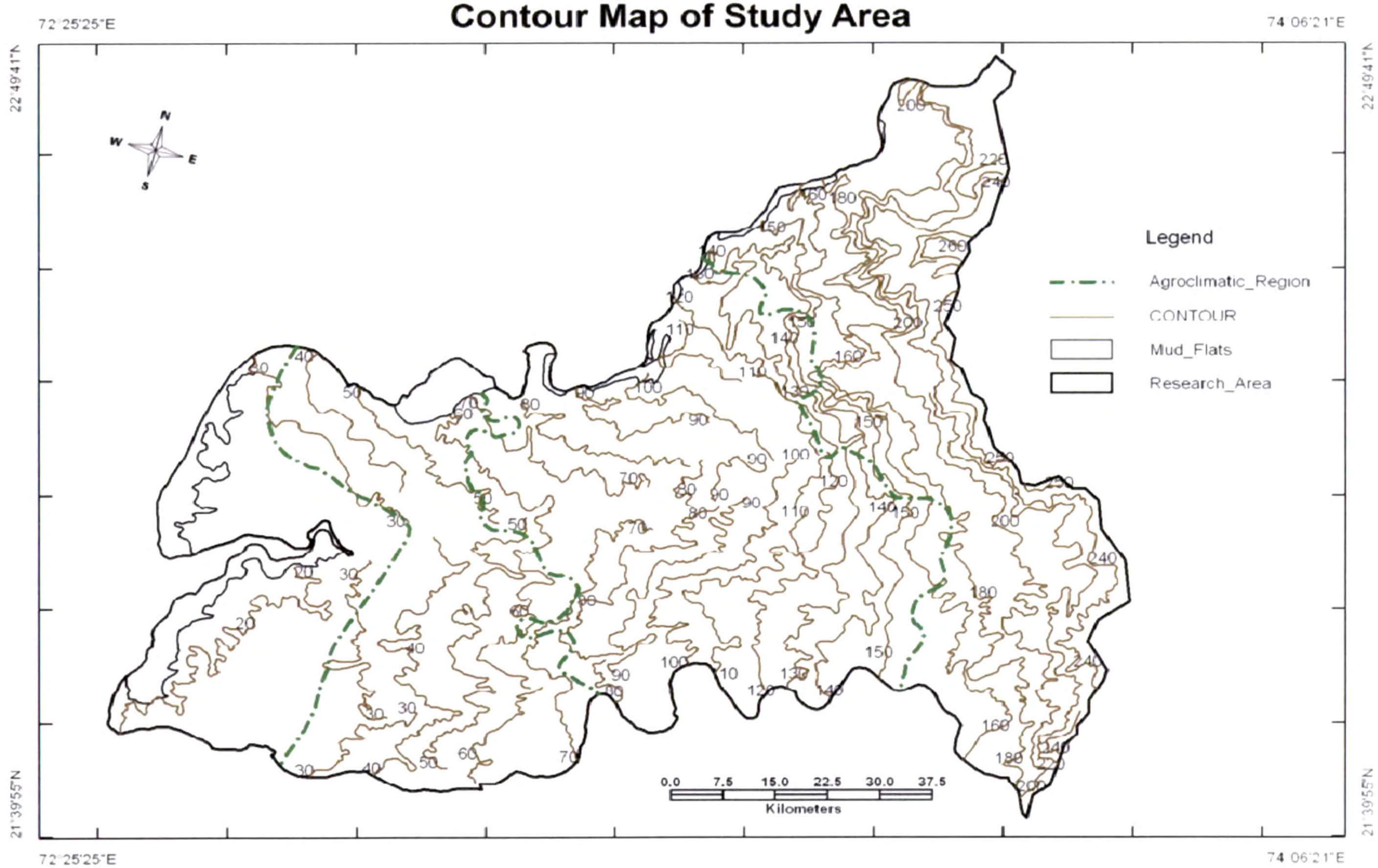

Figure. 2.1

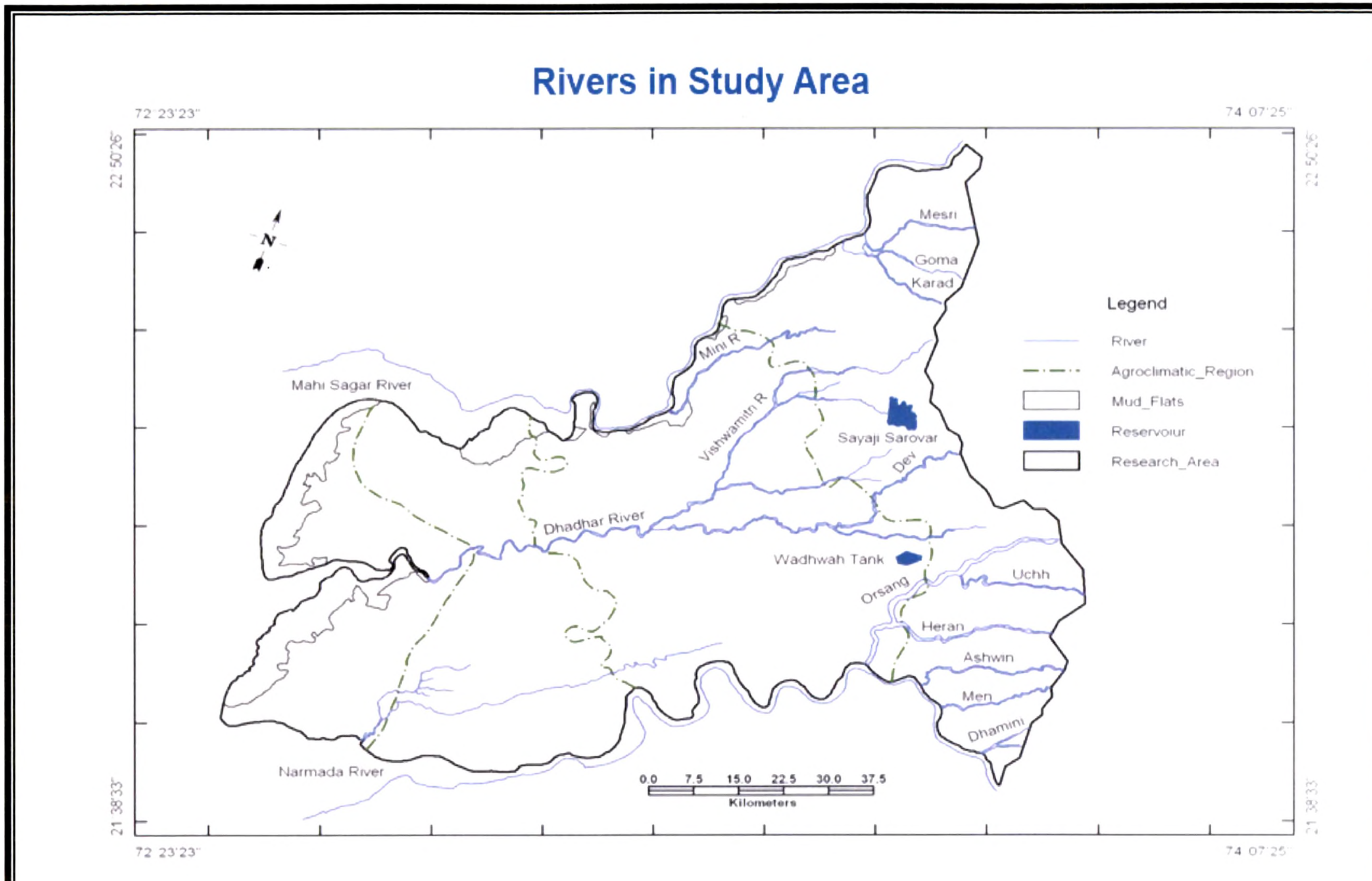
Rivers in Study Area
72 23'23"
74 07'25"
22 50'26"
21 38'33"
N
Mesri
Goma
Karad
Mini R
Mahi Sagar River
Vishwamitri R
Sayaji Sarovar
Dev
Dhadhar River
Wadhwah Tank
Orsang
Uchh
Heran
Ashwin
Men
Dhamini
Narmada River
0.0 7.5 15.0 22.5 30.0 37.5
Kilometers
Legend
River
Agroclimatic_Region
Mud_Flats
Reservoir
Research_Area

Figure. 2.2

2.5 Geomorphic Units

The Reconnaissance Soil Survey of the Government of Gujarat (1974 – 75) has divided the whole study area into the following units:

(1) Mahi and Dhadhar Flood Plain;

(2) Midland Alluvial Plain;

(3) Coastal Lowland.

A close-up view of the geomorphology of the area may lead to further micro divisions of these broad based divisions. It is attempted to split them on the basis of their location, slope and terrain situations. They are:

1. a) Mahi estuarine basin
   b) Dhadhar estuarine basin.
2. a) Upper midland alluvial plain;
   b) Middle midland alluvial plain;
   c) Lower midland alluvial plain;
3. a) Coastal low land.

2.5.1 The Mahi and Dhadhar Flood Plain

The Mahi and Dhadhar flood plain is bifurcated into two micro divisions (a) The Mahi estuarine basin; and (b) Dhadhar estuarine basin. These basins form the northern and southern sub-divisions of the fluvial plain. Since both of the estuarine basins frequently come into contact with the tides of the Gulf of Khambhat, a condition similar to that of the coastal low lands prevail for the most of their extent. However, their basic constituent material is fine silt as both of the rivers, in this area, are in their old age. The overlain material on these basins at the lower sides comprise of marine silt and other materials. Through the creeks intruding inland much of the marine sand and silt as well as the riverine materials are deposited owing to the frequent tidal action along the creeks.

(a). The Mahi estuarine basin

Since the study area is narrow in the north, the Mahi estuarine basin area is quit narrow. It is composed of loamy soils. Floods in Mahi were spreading new silt, but that was more or less checked by the Mahi Dam at Kadana in Panchmahals and Vanakbori in Kheda District. Parts of the basin near the Mahi estuary, and at the mouth of the creeks, have fine fluviomarine silt with higher percentage of salinity. Its gradient ranges between 1 and 3 percent towards the Mahi estuary and the north-eastern coast of the Gulf of Khambhat.

(b) The Dhadhar estuarine basin

It is diametrically on the opposite to that of Mahi at the southern end of the area. This basin is larger in extent than the former. No marked difference is observed in the constituent materials of this basin. However, it is seen that in Mahi basin there are a few patches of loam and clayey loam along with the trappean debris, whereas in this basin they are rare. The colour of soil varies from light to dark black. They are sticky, less permeable, and well drained. Their gradient ranges between 1 and 3 percent tilted towards the Dhadhar River. The level of salinity varies from low to high from the upper to lower parts of the basin.

5.2.2 Midland Alluvial Plain

Bounded by the Mahi and Dhadhar estuarine basins in the north and south respectively and the coastal lowlands from the west, there is an expanse of flat or extremely gently sloping plain composed of fine silt and clay. Though the area lies near the cost in the old age state of the rivers, the soils are composed of the finest particles of silt and clay. There are three prominent types of soils in this sub-division of the area (i) black cotton soil, locally known as 'Kali ', (ii) loamy soil – 'goradu', (iii) less fertile and light black soil – 'besar' soils of the low lying area – 'Kyari' and soils near the creeks and coastal low beds 'Bhata'. This plain, on the basis of its physiographic setting, is divided into three sub-divisions; upper, middle and lower.

a. Upper Midland Plain

The upper midland plain is a narrow strip of land down to the Mahi estuary basin. It is composed of the fine admixture of loamy and trappean soils.

The contours in this part are ranging between 26' (8 Meter) in the west to highest 240' (73 Meter) in the east. The inclination of the sub-division is towards west with comparatively steep slope, posing no problem of inundation. The sub-soil salinity in this sub-division especially in Bara tract starts at a depth of about 5 to 7 feet below the surface. Having the attributes of being well drained due to its proper gradient, this sub-division has the opportunity all the kharif crops and a few rabi crops.

a. The Middle Midland Plain

The middle midland plain has its composition of soils similar to that of the upper midland plain. It has poor gradient, and in the middle part it has concavity, which had been causing inundation during the monsoon in Bara Tract. Now with help of the artificial drainage system, this problem is partly overcome.

2.5.3 The Coastal Lowlands

The coastal littoral extends in the north-south direction from the estuarine basin of Mahisagar to that of Dhadhar. This is the area coming under the influence of marine conditions. The topography is flat at the upper part, and tilted towards the Gulf at the lower parts. There are many creeks, marshland streams, kharlands and saltpans in this area. The contours rise up from 8' at lower parts of the coast to 24' upland. The artificial check dams have been built in this sub-division to restrain the tidal ingress.

2.5 Climate

More then any other factor, the climate plays a dominant role in the development of the pattern and character of land use. The type of bio-mass, the human settlements, the types and pattern of general and cropland use etc, in one or the other way reflect "a major exploitation of climatic resources" (Peacock and Shelly 1974)

The study area is a macro climatic zone in the vast monsoonal realm of the Indian subcontinent. The climate in this area represents the salient characteristics of the south-west monsoon, partly modified by the marine influences, being situated between the estuaries of Mahisagar in the north, Dhadhar to the south of Mahisagar, the Gulf of Khambhat in the west and Narmada in the south. The climate of the study area is moderated by the presence of these water bodies. There are seasonal rhythms but rarely reaching the extremes as experienced in the interior part of the country.

On account of the seasonal rhythms, the year has broadly been divided into three seasons, the winter, the summer and the rainy season. A period of transition intervenes between each outgoing and incoming season.

2.5.1 Winter

The winter season in the Indian sub continent starts from the end of the rainy season. But at different places, due to the spatial influence, the onset period is varying. In the study area the winter does not start just after the end of the rainy season, but some time after mid October, when the evening and night give a feeling of somewhat winter like conditions. This period is the transitional period between the rainy season and the winter season characterized by hot and moist days and moderately cool moist nights. This is the most disease prone period of the year in which the malarial parasites are activated, and cold cough and seasonal fever grip the people. This season lasts till mid November. Thereafter, the winter starts, the mercury dips from 28°C down to 20°C or below. Usually the winters are mild, but sometimes, due to the cold waves brought by the northerly winds become quit severe with mercury dipping down to 15°C or

16° C. During the daytime and 10°C to 12°C during the nights. However, during the two points of time under study this condition has not been observed. The winter normally lasts up to mid February. The actual winter months are mid December to mid February.

During the winter the temperature ranges between 22°C to 24°C and the minimum temperature between 13°C and 15°C In the event of winter rains, locally known as "mavathoon", the diurnal temperature dips down to 17° C to 18°C or even lower. On the whole, the winter may be characterized as the season of warm days with bright sunshine and cool nights.

The winter conditions are normally very suitable for the cotton and also for wheat and rabi oil-seeds. Frost is almost unknown. The rains from the retreating monsoon, or by the cyclones (vavazoda) brighten the prospect of the Rabi crops and if they arrive in the earlier parts of the winter, are very beneficial for the Tur (Pigeon pea) and cotton crop.

Table 2.1 gives the maximum and minimum of temperature of the winter months of 1960 -1961 and 1999-2000.

Table 2.1: Temperature in Degree Centigrade (°C)

MONTH	1960 -1961			1999 - 2000		
	MAX	MIN	RANGE	MAX	MIN	RANGE
NOV	25.2	22.6	2.6	27.6	21.5	6.1
DEC	23.6	17.9	5.7	24.6	20.5	4.1
JAN	24.8	14.6	10.2	23.8	12.3	11.5
FEB	24.7	14.8	9.91	23.5	12.1	11.4

Table 2.2: Relative Humidity

MONTH	1960 -1961			1999 - 2000		
	MAX	MIN	RANGE	MAX	MIN	RANGE
NOV	N.A	N.A	N.A	N.A	N.A	N.A
DEC	66	29	37	69	29	40
JAN	63	29	34	61	26	35
FEB	56	22	34	54	22	32

There has been no significant difference between the monthly maximum and minimum temperatures. However, between the two points of time, when compared, November 1960-61 had 2.4°C more that of the same month of 1999-2000. December had more by 1°C, January had 1°C less and February had less by 1.2°C. This shows less fluctuation, rather more stability in winter temperature. This is highly beneficial, especially to cotton, the principle crop of this area

The average higher percentage of humidity for the three months December, January and February, (for November not available) ranges between 66 and 56 percentage, and lower ranges between 29 to 22 percentage, which provides ideal conditions for cotton crop in particular and other crops in general. The marine conditions prevailing in this area moderates the temperature and increases the humidity and provides the most suitable condition especially for cotton and tur (Pigeon pea).

During winter, gentle continental winds blow from north-east to south-west with an average speed of 2.3 km per hour. However, the velocity varies, sometimes from 4.6 km per hour in November to 5.9 km per hour in February. The north – easterly direction of the wind continuous throughout the winter season because of the presence of high pressure over a vast continental area from around the Himalayas and the corresponding low pressure over the Indo-Gangatic plain particularly during the month of November and December. The increase in velocity of the wind in November and February may be due to the drift of cyclones from the Mediterranean towards the trough of low pressure over the Indo-Gangatic plain. Since it has to cross a long distance the speed decreases and most of the moisture is shed on the way, keeping often a little or nil for this area. That is why the winter rain is not a regular phenomenon, but it is always longed for as it brightens the prospects of winter crops; however, its late arrival is dangerous for tur and cotton crop.

These winds bring the cold wave and cause a dip in the winter temperature, but seldom to freezing point, as the marine conditions moderate and stabilize the temperature and hold them around 25°C (max) and 15°C (min) during the peak of the winter season. Thus, the winters are normally pleasant with bright sunshine and gentle breeze sometimes associated with little rain.

2.5.2 Summer

The summer season is fairly long starting from mid February and staying till the onset of monsoon by mid June. In reality the rainy season is a moderated summer. This season is characterised by warm to hot and scorching conditions during April, May and part of Jun. The early part of the dry summer is the harvesting period of "rabi" crops, and the final plucking of cotton. The bright sunshine and warm winds assist in the ripening of the crops. Cloudiness and rains during this season may spoil the crops and prove disastrous for cotton and tur.

The summer heat is moderated by the marine conditions. The maximum temperature ranges between 25°C in early summer and 37°C (plus) in its later days sometimes even rising above 45°C· The minimum temperature ranges between 18°C and 28°C. During the early summers the difference between maximum and maximum remains around 7°C to 8°C, where as during the later part it is reduced to around 2 to 2.5°C only, making the night warm, sultry and uncomfortable. (Table. 2.3)

Table 2.3 Summer Temperature in Degree Centigrade.

YEAR	**1961**				**2000**			
MONTHS	**MARCH**	**APRIL**	**MAY**	**JUNE**	**MARCH**	**APRIL**	**MAY**	**JUNE**
MAX	24.50	26.60	27.80	30.40	43.6	39.2	42.8	41.8
MIN	17.60	19.80	23.80	28.00	28.5	28.6	31.7	30.7
RANGE	6.90	6.80	4.00	2.40	15.1	10.6	11.1	11.1

The temperature in the study area at both points of time has not remained uniform. The difference between maximum and minimum is gradually decreasing from 7°C to 8°C in March to 2°C to 2.5°C in June. This reveals the moderating effects of the marine conditions. May is the hottest and most sultry month, provided rains do not come early. The late rains make the conditions very much uncomfortable.

The wind blows from south-west to north-east. A very high pressure belt develops over the Arabian sea and, the Gulf o Khambhat, which lies to the west of the study area; and the low pressure belt encompasses the continental part and particularly over Indo-Gangatic plan during the same period. Thus the onshore winds blow with a velocity of 8 km to 12 km per hour from April to June. The same winds accumulating more moisture become rain bearing in June. An unusual and infrequent phenomenon of thunderstorms and light showers occurs in April and May.

The summer is the most difficult season for the area. The water problem arises due to the dried up tanks and ponds. Agricultural work remains suspended after the summer harvest. The fields are criss-crossed with wide cracks breaking the top layer of the soil into innumerable blocks-squares, rectangular and rectilinear. The cracks often go as deep as 5 to 6 metres. These make way for the fast evaporation of moisture from the lower horizone of the soil reducing the sub-soil moisture to a minimum. The little amount of water remaining in the percolation wells becomes brackish.

2.5.3 Monsoon

15th June is considered to be the date of "onset" of monsoon rains, but it rarely comes on this date. It is either earlier or later than this date. Similarly, the departure date is 15th October, but it hardly stays up to this date. The words that can explain the nature of this season's rains are precarious, irregular, unreliable, scanty, erratic, and excessive. The late arrival and early departure prove disastrous and equally disastrous are unabated spells for long durations.

The actual rainy months are the late half of June, July and the first half of August. July is the rainiest month. The force of monsoon starts winding up from mid-August and practically disappears by mid-September. Occasional showers are received during October only in the event of a good season.

A study of the pattern of rainfall for 100 years (1901 – 2000) shows that there have been 53 years of below average rains and only 47 years of average and above average. 1948 was the driest year, which received only 173 mm rainfall. This year is remembered as the year of famine. 1918 was another year of deficient rain, which got only 222 mm 1972 received 257 mm, 1974 received 287 mm and 1999 received 334 mm. These were the years of scarcity of rainfall. The year 1958 received unusually high rainfall of 3066 mm, which is an all time high during this long span of 100 years.

During the bi-decadal period of 1981-2000, there were 12 years of below average rainfall (average 729 mm) and 8 years of above average. However, it is not the average that matters, it is the coming of rains at regular intervals that bears great significance. If the rains come in light to moderately heavy showers at regular intervals of 15 to 20 days, they are more beneficial even if the amount is 450 – 550 m.m in the entire season. This may bring prosperity in agriculture. (Table. 2.4)

The wet spell increases the humidity and decreases the temperature, but this statement would be true only when a prolonged wet spell is experienced.

Table 2.4: Temperature and Rainfall Pattern

YEAR	1961				2000			
MONTH	MAX °C	MIN °C	RAINFALL IN M.M	NO OF RAINY DAYS	MAX °C	MIN °C	RAINFALL IN M.M	NO OF RAINY DAYS
JUNE	30.40	28.0	530.75	07	41.8	30.7	1336.6	13
JULY	29.9	26.7	399.75	10	37.7	28.8	2658.5	22
AUG	28.9	26.3	279.75	15	34.8	26.1	1637.0	15
SEP	28.5	26.7	377.25	10	34.1	24.8	1685.6	19
OCT	28.7	25.8	58.75	04	32.1	30.6	177.2	04

The values in the table show that the longer spell had brought down the August temperature in 1961 as compared to its corresponding period 2000. However the rainfall situation of 2000 as compared to 1961 was better as the required amount of showers came at proper intervals up to October, which was useful for the crops of both seasons. But in 1981, there were heavy showers during the month of July, August and even September and for longer durations, and also there was no rain after October. Given the nature and type of soil of this area, this hampered the agricultural operations because such heavy rains caused the problems of inundation keeping the agriculture work suspended till the drying up of the fields.

2.5.4 Winds

The south-west winds blow with an average speed of 10 -12 Km per hour. The velocity of winds is experienced highest during June, which is taken to be an indicator of monsoon. These winds are usually moisture laden and even if they do not shed the moisture, they increase the atmospheric humidity. The increasing humidity, pressure and the sultry atmosphere indicates the nearness of the setting in of monsoon. Sometimes heavy showers associated with gusty winds cause great havoc for the life and property of the rural folks. During monsoon the humidity rises to more then 90%.

2.5.5 Dynamics of Temperature and Rainfall

The temperature conditions are found to be almost constant. Frost is rare. In spite of the variation in temperature at the two points of time, they are, on the whole, ideal for all crops of this area and particularly for cotton and tur, the principle crops.

Rainfall is more dynamic than the temperature. The degree of inconsistency is high with wide margins of variation. To measure the inconsistency of the rainfall of this area, the method of coefficient of variance has been used (O/M x 100). The period from 1901 – 2000 has been divided into five parts of twenty years each, and then their coefficient of variance (C.V) is calculated. (Table. 2.5)

Table 2.5: Decadal values of S.D and C.V

YEARS	O	C.V
1901-1920	25.35	3.75
1921-1940	27.03	3.51
1941-1960	29.59	3.04
1961-1980	25.51	3.72
1981-2000	25.97	3.66

It is found that (a) and (d) are most inconsistent and (b) and (c) are less inconsistent. The most consistent period is (C), and most inconsistent is (a). The study period 1981-2000 (20 years) is also period of inconsistent rainfall. These results are also proved by the actual data. The percentage deviation of the mean of the period (1640 mm) against the long term mean (1796 mm) Since the rainfall has been irregular and uncertain throughout, but more so during the study period, the cropping pattern has been found highly affected with it; hence irrigation is, a must to utilize the given potentiality of the soil.

A glance over the long-term statistics of rainfall from 1901 to2000 reveals the following interesting facts:

(i) The rains were never consistent.

(ii) The period 1901-1920 received the lowest amount of rainfall.

(iii) The increase after 1921 continued till 1960. This period of 4 decades has received the maximum amount of rains and especially the period between 1941 and 1960 has received the highest amount, 1843 mm. The same period has the distriction f having the lowest rain, 173 mm in 1948 and the highest ever 3066 mm in 1958.

(iv) The cycle takes a turn towards inconsistency and lower amount of rains after 1960, and the period between 1960 -1980 received relatively lower amount of rains with the total of 1369 mm than the preceding period.

(v) However, there have been incidences of below average rains and above average, from 1901-2000 i.e. 100 years. However, it is observed that every third year is found to be the year of below average and every fifth year of above average rains.

2.6 Soils

"Soil is the most valuable natural resource we have in the country and is the basis of all agriculture production". (Rajan and Rao 1978). Though modern technology is developing the scientific measures to grow crops without soil, it seems an illusion in the wider spectrum of the significance of soils for large scale crop raising.

The soils of the study area are part of the broadly classified soils of the 'Kannam' region – the region characterised by its black soils and cotton crop. However, the sub-regional classification of soils shows that there are five types of soils within this broad region, (1) Black Cotton soil; (2) Gorat soil; (3) Bhatha soils; (4) Khyari soil.

2.7 VEGETATION

The area lacks in vegetation. There are no major forests. The Xerophytic types of trees of short stature grow sporadically over the area. In the eastern margin, comparatively more greenery is seen. Towards the coast appearance of barrenness gradually increases.

The official records show an area of 12580 ha under forest cover. It has remained unchanged over a period of two decades. Especially in the Bara track, It is assumed that the sub soil salinity does not allow the trees to send their roots deep to extract more nutrition and water for their growth. They keep them up to a shallow depth and suck the available moisture, which keeps them almost in a semi-dry state making them Xerophytic in their genus. These trees do not contribute significantly to the economy of the area.

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