CHAPTER III

GEO-ENVIRONMENTS OF THE BHADAR BASIN

" Man should learn to live along with the nature, but not on the nature."

GENERAL

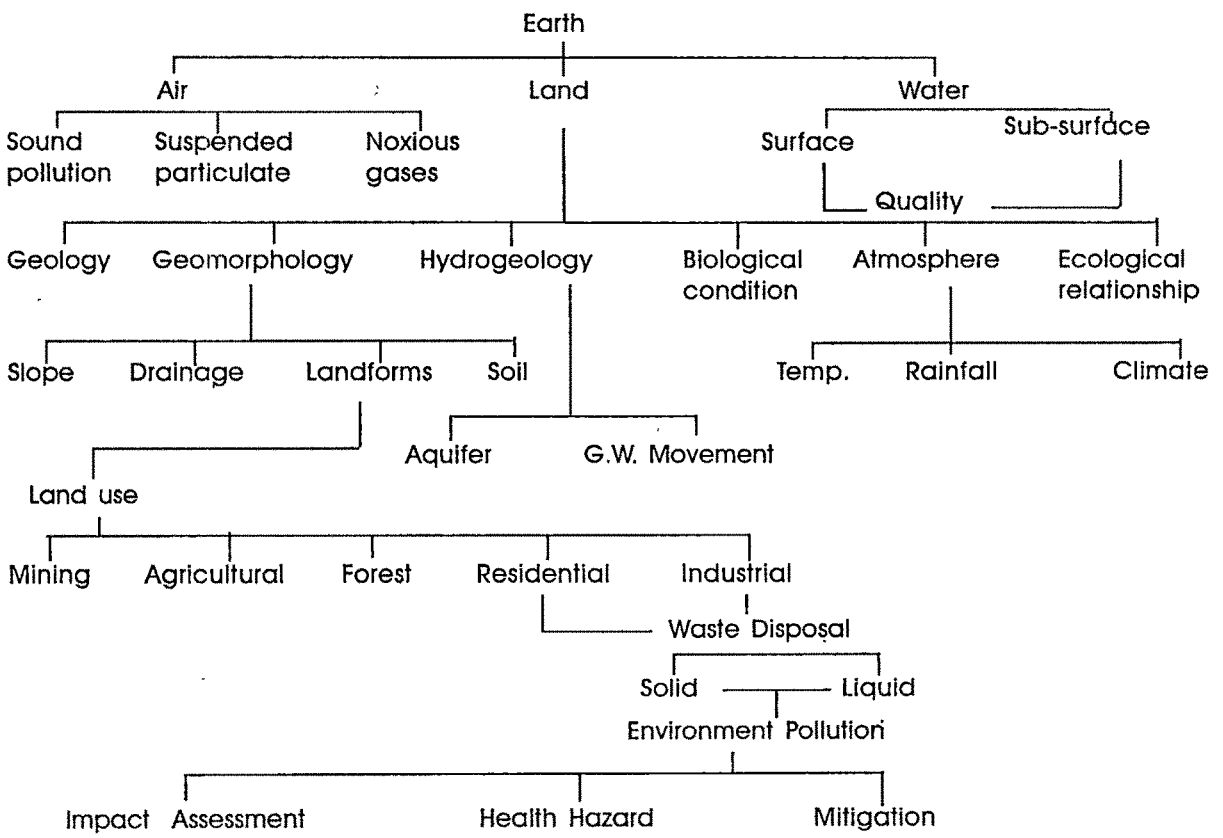
The geo-environment reflects the entire spectrum of human interactions with physical environment. It becomes inevitable for the man to exploit all the available natural resources for upgradation of his existence. Human endeavour, in this direction, has created an imbalance in the natural ecosystem. Environment, thus includes two parts viz.:

i physical conditions such as air, water, gases, landforms, etc. which affect the growth and development of a region and

ii social and cultural aspects such as ethics, economics, aesthetic, etc; which affect the behaviour of the society.

In this thesis, the author, has made an attempt to investigate the geo-environmental conditions of the Bhadar basin. To achieve this, he has assessed the present day environment by following the procedure suggested by Leopold et al. (1971) (Fig. 3.1).

FIG. 3.1 :FLOW CHART- DEPICTING METHODS FOR GEO-ENVIRONMENTAL INVESTIGATIONS



LAND

MINERAL RESOURCES

The rocks exposed on the surface of the study area are Trappean basalts and Miliolitic limestones. These Miliolites occur either as fine grained deposits viz. chalk or medium to coarse gained limestones.

The chalk deposits occur as small pockets within the limestones and cover a total area of 14.25 sq.km. The total reserve is 42.21 million tonnes (source D.G.M. report, 1987). The mines are open cast. The limestones are used in the chemical industry, cement factories and also as construction blocks - locally known as 'Bela stones'; whereas, trappean basalts are used as building materials and road metals. Extensive quarries are situated in Parsanalo, Dhank and Mervadar. The mining activities have led to degradation in various fronts viz.

- the reduction of vegetational cover,
- noise pollution on account of blasting and movement of the heavy vehicles and crushing plants,
- air pollution on account of dust rise in the mining areas and in the vicinity of the crushing plants and
- enhancement in the removal of various elements from the parent rocks.

SOIL

From the point of view of geo-environment, the soil - the weathered products of the rocks, plays an important role in controlling the fauna, flora and ground water conditions. It is most essential, therefore, to evaluate its role within the investigating area.

Based on the secondary data, the author's own observations and published works (Soil Survey Organization, 1979; Soil Drainage and Reclamation Department, 1992; G.A.U., 1994; NBSS & LUP, 1994, and Kalyana Saundaram and Patil, 1995), the soil map of the basin was prepared (Fig. 3.2).

Presently soils are classified on the basis of "Soil taxonomy" as proposed by Soil Survey staff (1978). On this basis, the Gujarat soils have been classified into 10 sub-order association by NBSS & LUP. Of these 'Orthents' and 'Orthids' are represented within the study area. Further, it has been divided into various sub-groups (Fig.3.2). The description and taxonomy of the sub-groups which occur within the basin is given in Table 3.1.

LANDFORMS

Detail description of various landforms developed within the limits of the study area have

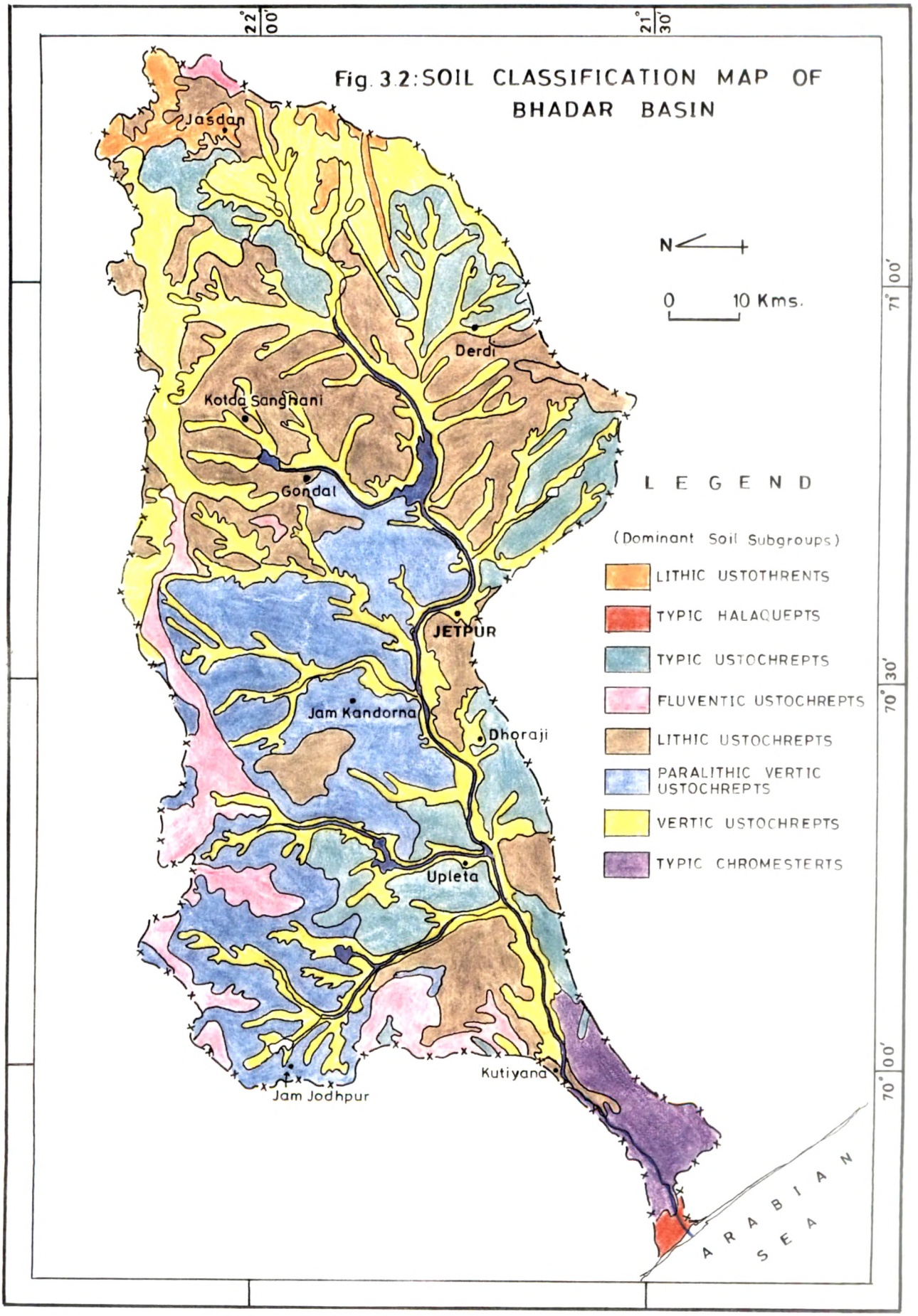


Fig. 3.2: SOIL CLASSIFICATION MAP OF BHADAR BASIN
22° 00'
21° 30'
71° 00'
70° 30'
70° 00'
Jasdan
Derdi
Kotda Sangani
Gondal
JETPUR
Jam Kandorna
Dhoraji
Upleta
Kutiyana
Jam Jodhpur
N
0 10 Kms.
LEGEND
(Dominant Soil Subgroups)
LITHIC USTOTHRENTS
TYPIC HALAQUEPTS
TYPIC USTOCHREPTS
FLUVENTIC USTOCHREPTS
LITHIC USTOCHREPTS
PARALITHIC VERTIC USTOCHREPTS
VERTIC USTOCHREPTS
TYPIC CHROMESTERTS
ARABIAN SEA

TABLE 3.1 : Soil taxonomy of Bhadar basin (modified after NBSS & LUP, 1994)

Colours in the map	Soil Sub groups	Description	Taxonomy
	Typic Ustipsamments	Moderately shallow, excessively drained calcareous, sandy soils on gentle slope, marine ridge with moderate erosion	Mixed (calcareous) isohyperthermic Typic Ustipsamments
	Lithic Ustorthents	Very shallow, well drained, loamy to clayey soil on pediment with severe erosion and moderate stoniness.	Loamy-clayey, mixed, hyperthermic Lithic Ustorthents.
	Typic Halaquepts	Very deep, very poorly drained calcareous, fine soils on nearly level mudflat with very strong affinity and moderate sodicity.	Fine, Montmorillonitic (calcareous), isohyperthermic Typic Halaquepts
	Typic Ustochrepts	Moderately shallow, well drained, calcareous, fine soils on very gently to gently sloping pediment plain (with mounds) with moderate erosion.	Fine, mixed (calcareous) hyperthermic Typic Ustochrepts
	Fluventic Ustochrepts	Rock outcrops: associated with very shallow, well to excessively drained, loamy-clayey skeletal soils on undulating pediment with severe erosion and strong stoniness.	Rock outcrops. Loamy-clayey skeletal mixed hyperthermic Lithic Ustothrents
	Lithic Ustrochrepts	Shallow, well drained, calcareous, clayey soil on gently sloping pediment plain with moderate erosion	Clayey, Montmorillonitic, hyperthermic Lithic Ustrochrepts
	Paralithic Vertic Ustochrepts	Shallow, well drained, calcareous, clayey soil on very gently sloping pediment plain (with mounds) with slight to moderate erosion.	Clayey, Montmorillonitic (calcareous), hyperthermic Paralithic Vertic Ustochrepts.
	Vertic Ustochrepts	Moderately shallow, well drained, calcareous fine soils on very gently sloping pediment plain (with narrow valleys) with slight erosion	Fine, Montmorillonitic (calcareous), hyperthermic Vertic Ustochrepts
	Typic Chromusterts	Moderately to very deep, imperfectly to well drained, calcareous, fine soils on very near level to gently sloping pediment plain (with mounds) with slight erosion and slight to strong salinity and moderate sodicity	Fine, Montmorillonitic (calcareous), hyperthermic Typic Chromusterts.

been discussed in the preceding chapter. Based on the landforms, slope, ground water conditions, the land-use map was prepared (Fig. 3.3). Optimum utilization of the landforms vis-a-vis the existing geo-environmental set-up of the basin has been discussed in detail in the later part of this chapter.

WATER

One of the most vital factors in controlling the geo-environment is the occurrence of surface and sub-surface water and their quality. The main aim of the present investigation is on this aspect, which has been delt with exhaustively in the next three chapters. However, a syneptic over view on its occurrence is given here.

Within the trappean basalts, the ground water is confined to their joints, fractures and weathered zones and its movement is controlled by the fracture patterns. The static water level fluctuates drastically during various seasons. On the other hand, in the Miliolite Formation, the movement of water is controlled by their porosity and it occur within unconfined aquifers.

ATMOSPHERE

QUALITY OF AIR

The parameters responsible for variation of air pollution index, are carbon monoxide, carbon dioxide, oxides of nitrogen and sulphur, hydrocarbon gases and their combinations. Presence of these gases and various other suspended particulates are mainly on account of the exhausts released from vehicular traffic on highways. Gondal, one of the centres of groundnut oil producing industries, are freely emitting the carbon dioxide, sulphur dioxide and combination of hydrocarbon gases. Air pollution is restricted to local areas and that too mainly in the Gondal town, within the basin.

CLIMATE

Owing to the semi-arid climate, the basin experiences hot and dry summer from March to May and cold winter season from December to February. The monsoon period is from June to September and October and November form the post-monsoon season.

RAINFALL

Records of the amount of precipitation observed at the rain gauge stations, distributed in the Bhadar basin, for a period of 11 years, are furnished in Table 3.2. Figure 3.4 shows the isohyet map. It is clear from the map that the amount of rainfall varies from 250 mm to 600 mm; decline in precipitation towards the north east points to the inefficiency of the south westerly monsoonal winds to reach the highlands of Saurashtra Peninsula. On the whole, the average depth of rainfall received in Bhadar basin, as computed from Isohyetal and Thiessen polygonal methods are 497.97 mm and

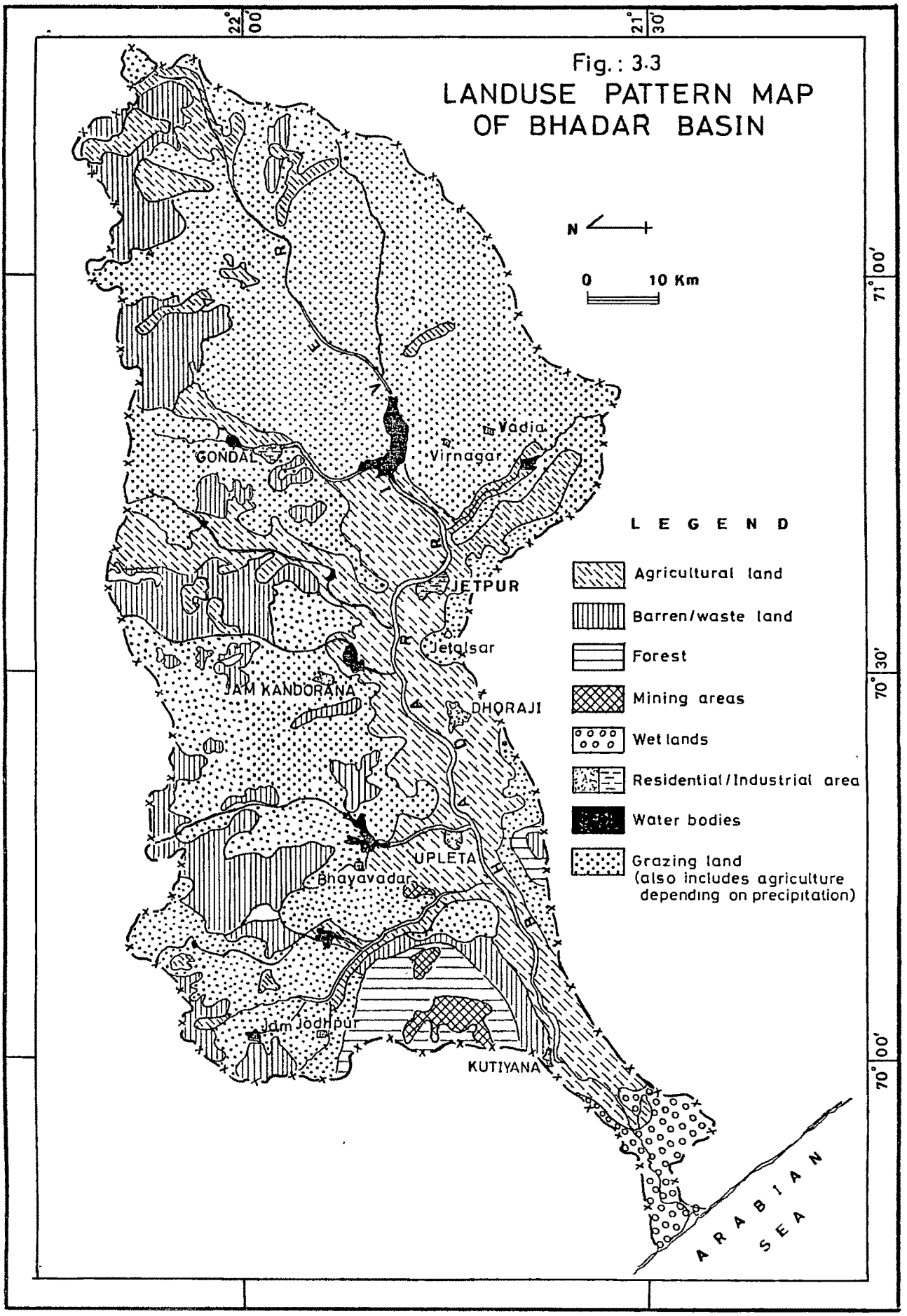


Fig. : 3.3
LANDUSE PATTERN MAP
OF BHADAR BASIN
N
0
10 Km
22° 00'
21° 30'
71° 00'
70° 30'
70° 00'
GONDAL
Vadia
Virnagar
JETPUR
Jetalsar
JAM KANDORANA
DHORAJI
UPLETA
Bhayavadar
Jam Jodhpur
KUTIYANA
ARABIAN SEA
LEGEND
Agricultural land
Barren/waste land
Forest
Mining areas
Wet lands
Residential/Industrial area
Water bodies
Grazing land
(also includes agriculture depending on precipitation)

Table : 3.2 Amount of Precipitation (in mm) in Bhadar basin.

Station No. in Map	Rain gauge Station	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Mean
1	Anandpur	117.20	291.00	93.00	752.50	500.00	322.00	306.20	478.00	-	-	-	357.44
2	Adhiya	115.60	262.30	92.00	808.00	451.00	318.00	241.00	394.00	-	-	-	335.24
3	Amarnagar	242.75	227.30	82.50	840.00	407.00	532.00	416.00	691.00	-	-	-	429.82
4	Bhadar dam	129.00	181.00	172.00	1081.00	554.00	486.00	611.00	726.00	-	-	-	492.56
5	Dharfa	-	-	20.00	1580.00	-	215.00	-	-	-	-	-	605.00
6	Dhoraji	387.00	492.00	80.00	1126.00	582.00	665.00	584.00	584.00	414.00	854.00	503.00	551.18
7	Gondal	402.00	320.00	217.00	792.00	491.00	379.00	332.00	852.00	571.00	1018.00	542.00	537.80
8	Jasdan	272.00	371.00	159.00	957.00	560.00	443.00	337.00	596.00	414.00	770.00	522.00	491.00
9	Jam Kandorna	260.00	354.00	37.00	922.00	490.00	422.00	440.00	765.00	322.00	894.00	459.00	487.73
10	Jam Jodhpur	-	525.40	47.80	921.00	-	250.50	257.00	392.00	-	-	-	398.00
11	Jetpur	269.00	442.00	124.00	1055.00	515.00	670.00	371.00	752.00	550.00	917.00	535.00	563.64
12	Kotda Sanghani	175.00	200.00	138.00	1055.00	616.00	592.00	442.00	696.00	484.00	892.00	557.00	531.54
13	Khanpur	155.00	279.40	123.70	810.00	257.50	237.50	163.00	525.00	-	-	-	299.60
14	Kutiyana	312.20	593.00	98.30	1242.00	696.10	389.00	352.00	890.00	378.00	873.00	567.00	581.00
15	Lodhika	285.00	253.00	79.00	912.00	543.50	345.00	683.00	683.00	265.00	790.00	425.00	448.32
16	Upleta	293.00	495.00	84.00	1161.00	658.00	373.00	867.00	867.00	331.00	836.00	525.00	539.36
17	Vasavad	-	272.00	190.00	629.00	448.50	310.00	624.00	624.00	-	-	-	408.93

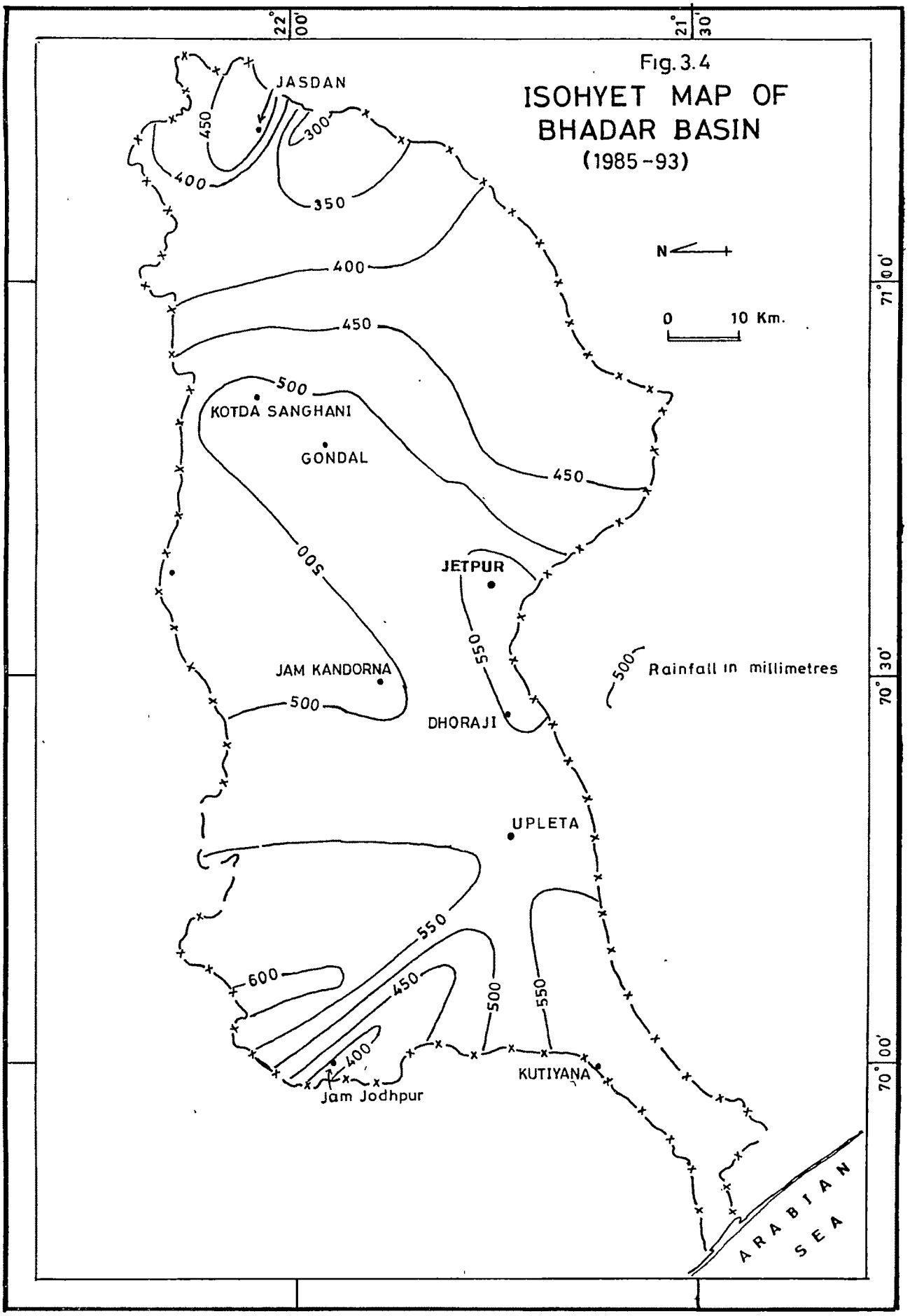


Fig. 3.4
ISOHYET MAP OF
BHADAR BASIN
(1985-93)
22° 00'
21° 30'
71° 00'
70° 30'
70° 00'
N
0 10 Km.
JASDAN
450
300
400
350
400
450
500
KOTDA SANGHANI
GONDAL
450
500
JETPUR
550
500
Rainfall in millimetres
JAM KANDORNA
500
DHORAJI
UPLETA
550
600
450
400
500
550
Jam Jodhpur
KUTIYANA
ARABIAN
SEA

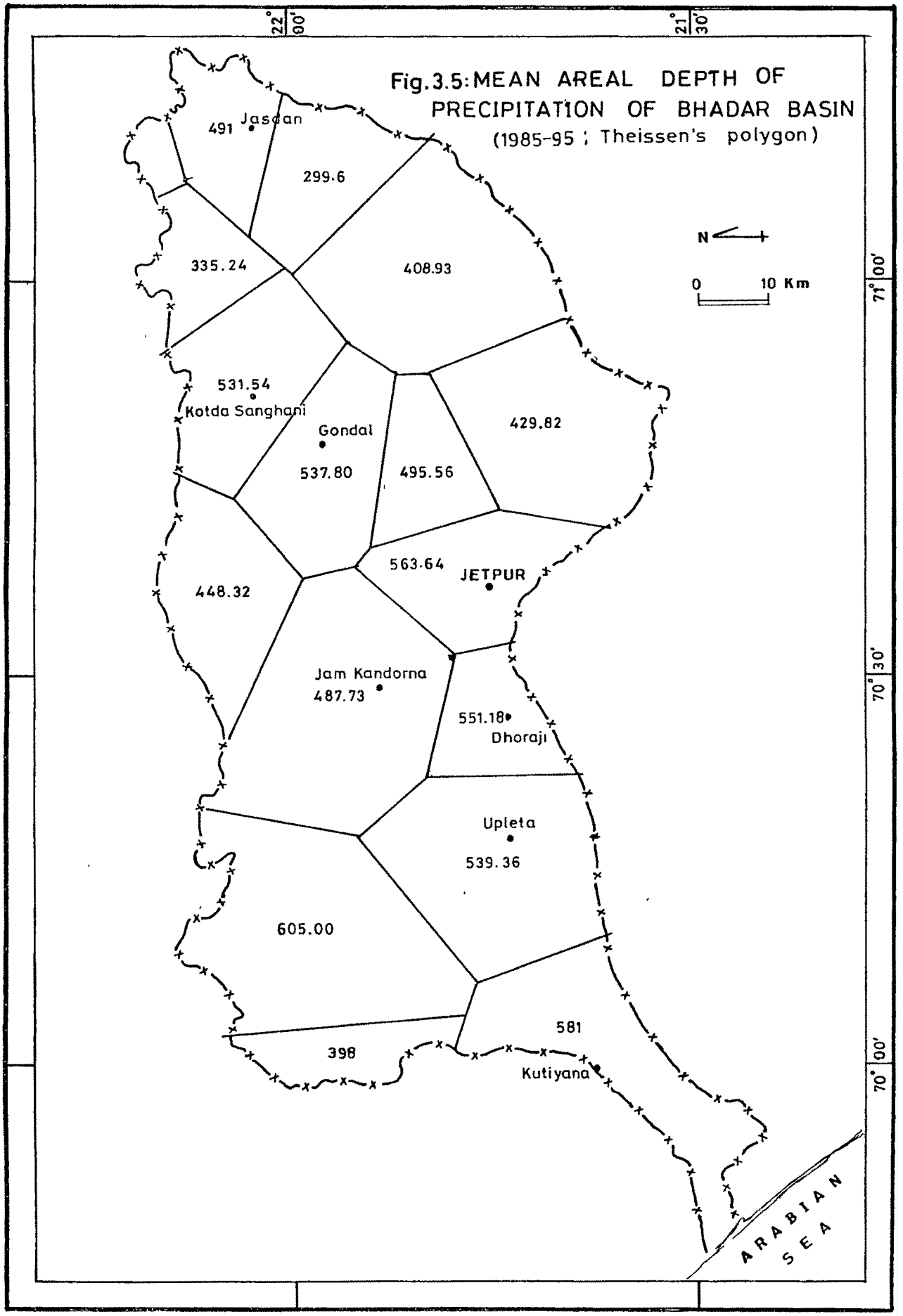


Fig.3.5: MEAN AREAL DEPTH OF PRECIPITATION OF BHADAR BASIN
(1985-95 ; Theissen's polygon)
22° 90'
21° 30'
71° 00'
70° 30'
70° 00'
N
0 10 Km
491
Jasdan
299.6
335.24
408.93
531.54
Kotda Sanghani
Gondal
537.80
495.56
429.82
563.64
JETPUR
448.32
Jam Kandorna
487.73
551.18
Dhoraji
Upleta
539.36
605.00
581
398
Kutiyana
ARABIAN SEA

494.32 mm respectively (Fig. 3.4 and 3.5).

TEMPERATURE

The nearest meteorological observatory from the basin is the one at Rajkot; others are at Keshod and Porbandar. Data collected from these stations (Table 3.3) (Gazetteer, 1965, 1975, and 1982), indicate that their is a continuous rise in temperaure from March to May. May is the hottest month with the mean daily maximum thermometer reading ranging from 40.5°C in highland to 27.0°C in the coastal region. During the month of May and June, the mercury at times soars to as high as 45°C. With the onset of the south-west monsoon by the middle of June, temperature drops, but adds discomfort due to the increase in humidity.

In the post-monsoon, the days are better but nights are cold. After mid-November, both day and night temperature drop down. The month of January is the coldest period, with the mean daily maximum temperature ranging from 28.1°C in the interior of the basin to 27.8°C in the coastal area. The minimum mean daily temperature lowers to 15.4°C and 10.7°C in the inlands and coastal

TABLE : 3.3 Temperature and Relative Humidity.

MONTH	RAJKOT				PORBANDAR			
	Mean daily		Relative Humidity in %		Mean Daily		Relative Humidity in %	
	Maximum Temperature in °C	Minimum Temperature in °C	0830 hours	1730 hours	Maximum Tem. in °C	Minimum Tem. in °C	0830 hours	1730 hours
January	28.1	10.7	51	22	28.5	15.3	67	48
February	30.7	13.1	57	19	30.1	16.8	70	55
March	35.3	17.2	63	17	31.5	20.5	74	62
April	38.8	21.3	66	18	32.3	23.3	79	67
May	40.5	24.7	72	27	32.3	26.5	81	75
June	37.8	26.2	76	48	32.1	28.0	84	79
July	32.6	24.9	85	68	30.1	26.5	88	85
August	31.6	24.0	86	65	29.3	25.6	92	87
September	32.9	22.9	85	57	29.8	25.1	89	80
October	35.4	20.9	70	31	32.5	23.2	80	64
November	33.2	16.5	50	24	33.0	20.0	63	54
December	29.6	12.3	49	25	30.4	16.8	62	49
Annual	33.9	19.6	67	35	31.0	22.3	77	67

Source Gazetteer Rajkot and Junagadh.

regions respectively.

HUMIDITY

Relative humidity during monsoon season is 60% and 80% in the inland and coastal regions respectively. During the rest of the year, the air in the interior parts are quite often dry with humidity ranging from 20% to 40% in the afternoon. The temperature and relative humidities for the Rajkot and Porbandar observvatory stations are furnished in table 3.3.

WINDS

Winds are generally moderate but in summer and south-west monsoon season. In October winds are from directions between west and north-east. In Novemember and December winds are mainly from directions between north and east. In January and February winds are again from directions between west and north-east. In the summer season the winds are predominantly from directions between south-west and north-west.

PROCESSES

It is beyond doubt that during Quaternary time, the interplay of dynamic processes viz; sea-level changes and neo-tectonism have played a major role in shaping the landscape (Merh, 1992). Further, a part of the study area lies on the transitional zone environment, where both marine and fluvial processes act together. The product of these dynamic processes have left their imprints in different landforms, which have already been dealt with.

BIOLOGICAL CONDITIONS

Overall biological conditions existing within the limits of the study area, have been taken into consideration while assessing regional environment. However, the detail study on flora and fauna have not been investigated because it is not coming under the purview of the present research work. A list of natural flora and fauna existing within the basin and which have been collected from the Gazetteers, is provided here.

The natural floral species existing are *Acacia senegal* (Gorad), *Acacia arabica* (Bawal), *Tamarindus indica* (Ambli), *Azadirchta indica* (Limbdo), *Sizhypus mauritaiana* (Bordi), *Prosopois juliflora* (Gando Bawal) and few coconut trees especially near Navibandar.

The fauna existing in the area are Hyena (Striata) locally know as "Zarakh", Wolf (Canispallipes), Jackal (*Cani aures*), Fox (*Vulpes bengatensis*), Badger - local name "Ghorkodia", Pig (*Sus-indicus*), Mongoose (Noila), Bulbul partride - "Titar" (*Erancolinus sp.*), Sarus crane, Egret (*bubulcus ibis cormandus Boddaert*), Snakes, Bats (*Pteropidae* and *Vespertilionidae*), Monkey (*Prestbytis entellus*), Green Bee eater (*Merops orientalis latham*) - "Nano Patrangiyo", Hawk, Rabbit. It is significant to observe that

within the study area, the Panther (*Felis pordus*) population has drastically decreased..

LANDUSE

The term landuse defines the human activity on the land (Clawson and Stewart, 1965). The land in natural form may directly be used for the benefits of human beings. Nevertheless, sometimes man drastically changes the landscape according to his liking, for his own benefits. Otherwise, he prefers to use the land directly with minor changes. Human activities vis-a-vis landuse pattern is mainly depending on the basic factors such as slope of the ground, type of landforms, the thickness of soil, the hydrogeological conditions and activeness of the processes - both endogenic and exogenic. The table 3.4 furnishes the typical land use and impact on the geological conditions.

TABLE : 3.4 Geologic conditions that affect typical land uses.

Geologic conditions	Typical Land Uses						
	Light structure construction	Heavy structure construct -ion	Waste. disposal	Buiding material resources	Ease of excavati -on	Road performa- nce	Agricu -lture
Physical properties of soils and rocks	•	•	•	•	•	•	•
Slope stability	•	•	*	*	*	•	*
Thickness of surfacial materials	•	•	*	•	*	*	*
Depth to ground water	•	•	•	•	*	*	•
Supply of surface water	*	*	*	•	*	*	•
Danger of flooding	•	•	•	•	•	•	•

• Primary importance
* Secondary importance

Source : Turner and Coffman (1973)

From the point of view of geo-environmental investigation of the Bhadar basin, it is most essential to understand the present day landuse pattern; to achieve this, first of all, the author has prepared a landuse map (Fig. 3.3). For preparing this map, the techniques suggested by Anderson et al. (1972), ISRO (1991) and Lillesand and Kiefer (1987) in studying the Land Sat Imagery data have been followed. IRS 1A FCC Band 234 (1: 250,000 scale) was chosen and based on texture and tonal variations, various landforms were classified. While classifying, care was taken to consider the field data, Survey of India toposheet (41/K,O,N,G,J), slope of the area, landforms, ground water condtion

etc. After preparing the map, it was thoroughly checked in the field.

Subsequently, eight types of land use patterns were identified viz. 1) agricultural land, ii) grazing land, iii) barren/waste land, iv) forest, v) mining areas, vi) wet land, vii) residential/industrial area and viii) water bodies.

At times, it is very difficult to separate multi-use landuse pattern into different divisions, for example commercial - cum- residential land. The individual landuse pattern are described in the succeeding paragraphs.

AGRICULTURAL LAND

Figure 3.3 depicts the area under effective agriculture in all the years. It covers an area of 1267.83 sq.km. Agricultural lands occupy mainly flood plains in the lower reaches and burried pediment in the middle and upper reaches. Although the overall climate is semi-arid, recently other seasonal crops such as Rabi (winter) and Kharif (monsoon) crops are also grown. This is facilitated by the canal irrigation from the Bhadar dam, Phophal dam, Champravadi dam, Vinu dam and Moj reservoir. Except the Bhadar which is a medium irrigation dam, others are minor ones. Details are given in a tabular form (Table 3.5).

GRAZING LAND

This is an intermediate landuse area, connecting the pediment and burried pediment. This is one land use area for cattle grazing and live stocks, depending on the monsoon. With good rainfall marginal areas, adjacent to agricultural region becomes agricultural land.

BARREN AND WASTE LAND

These are generally on the north of Bhadar river, occupying the main trappean highland, having moderate to steep slopes, rolling topography. Veneer soil cover and poor ground water availability have made them into a barren land or waste land. However, during monsoon grasses and shrubs grow on it. During summer and winter, they die out, but very scanty herbs are seen at times.

FOREST

It is a natural forest mainly situated north of Kutiyana and south of Upleta, covering an area of 205.10 sq. km. They occupy, generally, the pediment or margins of the pediment. Slopes are moderate to gentle, rainfall is moderate , soil cover is thin to thick varying from fairly dense to dense forest. During recent times, these forests are getting affected by the human interference, by way of illegal cutting of trees. Apart from that the areas of chalk beds are situated in the midst of this forest. Owing to this, cutting of trees is very common to make the temporary roads and also for the purpose of mining activities.

MINING AREAS

Limestones and chalk deposits are mined west of Upleta and north of Kutiyana in Mervadar, Pransla and Dhank. These mines are open cast in nature and mining is carried out by local experts

TABLE 3.5 : Irrigation scheme in the Bhadar basin

Irrigation scheme	Command area		Gross command area in hactare	Cultivable command area in hactare	Average area irrigated			Total length of canal in km	Avg. water perimet-er / in sq.m/
	Taluka	No. of village			Kharif in (Ha)	Rabi in (Ha)	Hot in (Ha)		
Gondli	Gondal/Kotda -Sanghani	05	4050	1417	70	495	170	30.831	2.04/ 0.1007
Moj	Upleta	15	12140	7400	2473	3281	-	85.53	3.10/ 0.2652
Sankroli	Jetpur	04	2890	2113	420	735	-	16.77	2.90/ 0.0486
Champarvadi-I	Gondal	05	1417	1134	120	243	-	19.44	2.14/ 0.0416
Champarvadi-II	Jetpur/Jam Kandorna	09	4048	3917	-	-	-	-	-
Phophal	Jam Kanadorna/ Dhoraji	05	7021	4676	905	1310	840	43.75	2.79/ 0.1221
Bhadar	Jetpur/Dhoraji /Upleta/ Junagadh	46	27518	26720	2970	7377	2490	927.77	2.53/ 2.3473

following old mining system.

.WET LANDS

The low marsh and high marsh at the mouth of Bhadar river constitute wet land area covering 141.82 sq.km. Since these areas are under the influence of tides, they are been mapped as wet land. However, fringes on the land side are under reclamation. But, the reclamation activity has been hampered by the water quality. Therefore, the area is mainly used for one time crop, generally, having high tolerance to salinity which, inturn, depends on monsoonal rainfall. These wet lands can be well utilized if salt works are developed. There are few salt pans which are situated to the north of the Gosa village.

RESIDENTIAL/INDUSTRIAL AREA

There is no significant major industrial complex other than the one at Gondal where ground-nut oil mills exist and are mainly agro-industries. G.I.D.C. complexes are situated in Jasdan and Gondal where engineering works, mainly agro-based products such as harvest related equipments, motors for water pumping, etc are manufactured.

The most important of all the industries is the dyeing and printing of clothes in and around Jetpur. As per the Government rating, it is a small scale cottage industry but there are major printing and dyeing units existing. Earlier to the high court order (1st, August 1995), there were 2500 units out of which 1125 are only registered. But as on today, the number has reduced, 1500 units are functioning. More than 40,000 people work in this sector for their livelihood. Conspicuously, this particular industry has not followed the proper waste disposal management system. Due to this, ample amount of effluent waste are added to the river Bhadar which signaled an alarming situation down the valley. This aspect has been earmarked and dealt in details in the chapter 5 and 6, the reason being, when comparing with other environmental hazard within the study area, this aspect is predominantly alarming.

Residential and industrial areas cannot be separated because all industrial zones in this basin are of small scale and therefore, has been clubbed together. The major town settlement have been marked in the map (Fig. 3.3) whereas small villages and other settlement could not be mapped in smaller scale. Details are furnished in table 3.6.

WATER BODIES

Mainly the man made structure has given rise to minor reservoir viz, Phophal dam, Champarvadi, Vinu, Moj, Sankrola and a medium reservoir Bhadar dam. These reservoir water are used either for agricultural or drinking purpose.

RECREATION

Recreation sites have not been developed in general within the Bhadar basin. However, throughout the year people visits, from all over from Gujarat the temple town Virpur, which falls within the study area. Other recreational activities are the small scale melas arranged by the people

TABLE : 3.6 Settlements and Population.

Taluka	Area in sq.km.	Population				Percentage Decadal variation
		1961	1971	1981	1996 *	1971-1981
Dhoraji	483.50	91774	119357	151681	2891343	+ 27.08
Gondal	1229.20	140247	176463	212665	384455	+ 20.52
Jasdan	1320.20	99893	131792	168621	323600	+ 27.94
Jam Kandorna	607.10	40869	52659	63661	115439	+20.89
Jam Jodhpur	1021.84	75670	97236	110266	187562	+ 13.40
Jetpur	671.60	91985	126544	174040	359035	+ 37.53
Kutiyana	566.00	67981	67981	79722	140234	+ 17.27
Kotda Sangani	444.40	30783	40502	51671	98882	+27.58
Lodhika	364.20	22094	29996	37711	71188	+ 25.85
Upleta	766.40	104209	137793	170609	316872	+ 23.82

Source : Gazetteers * Projected Values

locally.

However, there is a high potential for tourist and heritage welfare, where many old forts and monuments such as in Jasdan, Gondal, Upleta and Dhoraji can be renovated and infrastructure may be provided. It is appreciable that the towns like Gondal, Upleta and Dhoraji are well planned, with broad streets, straight road and urban centres of olden times. However, they are very badly maintained.

ECOLOGICAL RELATIONSHIPS

There is no breakdown in the ecological system, mainly considering the food chain and the habitat. However, the human activity in Jetpur has hampered the existence of live stock in the Bhadar valley on account of influx of the pollutants. Saline ground water in the lower segment of the Bhadar valley has created a warning bell to the habitants. This is due to over exploitation of the ground water. However, the government has made an arrangement to supply drinking water through pipe line from Paswali village.

After understanding the geo-environmental conditions of the Bhadar basin, the author, judged that the waste disposal of Jetpur dyeing and printing industry is the major menace for the people living in the valley. Therefore, he has studied in detail on this aspect and will be describing them in the proceeding chapters.