CHAPTER III. THE PROJECT AREA

III.1 Location and General Features

III.1.1 Geographical Location and Road System

1) Location

The province of Baluchistan located between Latitude 25°N and 32°N, and Longitude 61°E and 71°E, and the Project Area in included in Kachhi plain of the Baluchistan plateau lying between Latitude 28°N to 28°33'N, and Longitude 67°30'E to 69°34'E approximately, and is located about 190 miles (300 km) far from Quetta, the capital of Baluchistan in south-east direction. The South and South-East of the Project Area faces to the commandable area of the Kirthar Branch Canal and irrigation system of the Desert Canal respectively in Sind Province.

2) Road System

There are inadequate to have the infrastructure in the Project Area, and especially, the road systems are under developed at the Project Area inclusive of surrounding area. At present, the national metalled road has been constructed to connect two cities Quetta and Karachi with each other through the Project Area from north-west to south-east.

There are shingled provincial roads to connect the provincial town with each other, namely, Dera Murad Jamali, Jhatpat, Sui, Kashmor, Mirpur Bibiwan etc.

The other hands, there is the national railway running in parallel with the natinal metalled road to connect main city in the country with each other. It is considered that the railway has higher pptentiality to be utilized for the developlment of the province.

In the Project Area, there are some feeder roads and farm roads running along the existing irrigation canals, which are utilized as operation and maintenance roads for the irrigation facilities.

However, the density is low and there is absence of the crossing facilities for the Area. Especially, they are not suitable as the feeder roads during rainy day due to slippery on the surface of the roads.

III.1.2 Population and Living Condtions

1) Population

a) National and Provincial Level

According to the fourth Census in 1981, the population was estimated at 83.782 million in the whole country of Pakistan, and it was estimated at 65.309 million in 1972, and merely 32.500 million in 1947 at the time of independence.

The population of the national level has increased 18.4 million over the eight and half year period between 1972 and 1981. This works out a growth rate of 28.28 percent or an average rate of around 2.98 percent per annum as following table.

Population in 1981 Census (in Thousand)

Province	1981 Census	Percentage Increase Over 1972
Baluchistan	4,305	77.23
N.W.F.P.	10,885	29.77
Punjab	46,116	25.28
Sind	18,966	33.98
Federal Capital	355	42.55
F.A.T.A.	2,175	-
Total	83,782	28.28

The Baluchistan population shown an increase of 77.23 percent over the 1972 census figures, because it was for the first time that a complete physical enumeration of the people in these area was undertaken, and the scientific and correct methodology was adopted.

The density of population per square mile increased from 24 to 31 in 1972 to 1981. The ratio of male and female population has been estimated at 53 percent to the occupation of the male for total population.

b) Project Area

The Project covers a total cultivable commanded are (C.C.A) of 771,300 acres (312,000 has.) in Nasirabad District of Baluchistan Province. Out of this 612,000 acres (248,000 has.) will be under the command of gravity flow canal (Phase-I) and the balance of 159,300 acres (64,000 has.) of upland will be later on commanded by pumping-cum-gravity canal (Phase-II). The Project Area is irrigated by a source of Pat Feeder Canal initiated from the Intake Structure of Guddu Barrage located acress the Indus River in Sind Province. Population in the Project Area is reported at 255,000 persons with a density of 273 persons per sq.mile (105 person per sq.km).

2) Living Condition

a) National Level

i) Source of Drinking Water

Fifty-two percent of the Pakistan Households has been obtained the facilities of drinking water in their houses, and the remaining gets it at the outside of their houses.

Twenty-one percent for the whole population has been supplied the water by the pipeline systems, and 46 percent is used handpumps for the wells, and 21 percent utilized the ponds, and 12 percent remained has been supplied the drinking water by springs, rivers and streams. The details are shown in attached table.

ii) Source of Lighting

Thirty percent of total households have electricity for the lighting and others are utilizing kerosene oil mainly.

iii) Source of Cooking Fuel

Seventy percent of Pakistan's households is used the woods as a main cooking fuel, and other households is utilizing cow-dung (17%), gas (7%) and kerosene oil (6%) respectively.

b) Provincial Level

i) Source of Drinking Water

Fifteen percent of the population is utilizing the pipeline system for teh supplying of the drinking wter, and the user of hand-pump is a very few percent in the province.

On the other hands, 85 percent of the people has supplied the drinking water by the ponds, wells, spring, rivers, and stream etc.

ii) Source of Lighting

In Baluchistan Province, only 14 percent of the households have share in the favours of the electricity, and 86 percent of the remaining is utilizing kerosene oil as a lighting fuel. This electrification level is a half share for the national level.

iii) Source of Cooking Fuel

Eighty-seven percent of Baluchistan's households use wood for cooking fuel, 8 percent use cow-dung, and 5 percent use kerosene oil. Fire wood use households in Baluchistan are much more than 17 percent to the national level.

c) Project Area

According to the results of the socio-economic survey in Nasirabad District Baluchistan in 1980 by the UNICEF, the living condition for the people has described based on sample area survey as follows.

i) Education

There are education system which is classified into three; primary education, secondary education and college in the district.

Regarding the primary education, the report informed that the school-attending population is at about 15 percent of the total schoolable children (5 - 9 years), and it maens 85 percent of population are out of schools. Especially, the facilities for primary education and secondary education for girls are very few.

Living Condition of National & Provincial Level

(Unit: 'ooo households, %)

Items	Pakistan	Baluchistan
Total Households	12,587.6 (100%)	592.8 (100%)
1. Source of Drinking Water		
1) Inside of House		
a) Pipe	1,588.6 (12.6)	38.9 (6.6)
b) Handpump	4,317.3 (34.3)	1.5 (0.2)
c) Well	594.4 (4.7)	3.6 (0.6)
Sub-total	6,500.3 (51.6)	44.0 (7.4)
2) Outside of House		
a) Pipe	791.9 (7.7)	45.4 (7.7)
b) Handpump	1,545.0 (12.3)	2.2 (0.4)
c) Well	1.577.0 (12.5)	213.5 (36.0)
d) Pond	416.9 (3.3)	64.7 (10.9)
e) Spring/River Stream, etc.	1,576.6 (12.6)	223.0 (37.6)
Sub-total	5,907.4 (48.4)	548.8 (92.6)
2. Source of Lighting		
a) Electricity	3,849.1 (30.6)	82.0 (13.8)
b) Kerosene Oil	8,463.5 (67.2)	441.0 (74.4)
c) Other Lighting Source	275.0 (2.2)	69.8 (11.8)
3. Source of Cooking Fuel		
a)Wood	8,810.1 (70.0)	513.0 (86.5)
b) Coal	86.8 (0.7)	8.9 (1.5)
c) Kerosene Oil	780.8 (6.2)	20.1 (3.4)
d) Gas	812.9 (6.5)	4.9 (0.8)
e) Electricity	10.5 (0.1)	0.5 (0.1)
f) Cow-Dung, etc.	2,086.5 (16.5)	45.4 (7.7)

Source: "Housing Census of Pakistan, 1980" Census Bulletin No.6
Population Census Organization.

The popualtion enroled in middle-schools and high-schools students population is 23 percent of the population by the relevent age-group (10 - 14 years old). There is one college with enrolment of 170 students at Usta Mohammad.

ii) Health and Social Welfare

The hospital providing 50 beds are availabel in the whole district. The bed-population ratio was estimated at 1:4,500. In spite of limited number of the beds in hospital, the bed occupancy for 1979 was nearly 70 percent only. The reason of less utilization of the beds might be poor staffing, and lack of equipments and drugs.

The total sanctioned posts of the doctor are nine in the whole district while one is appointed for the urban and two for the rural area. Against nine sanctioned posts of doctors, only 4 doctors are in position, and the doctor-population ratio was estimated at 1:56,000.

iii) Drinking Water

In rural areas of Nasirabad, the main sources of drinking water are canals, ponds and wells. In urban of Jhatpat, Usta Mohammad and Dera Murad, Jamali, piped water supply is available to a limited population. Water reservior of 24,000 and 10,000 gallons are operating at Jhatpat and Usta Mohammad respectively.

iv) Electricity

Three Tehsil and towns have facility of electricity. The total electric connections in urban are 1,460, out of which 45 percent are commercial. The break down of electric connections in towns is given below:

Urban Locality	Electric Connection		
	House Connections	Commercial Connections	Total
Jhatpat	227	96	323
Dera Murad Jamali	113	159	272
Usta Mohammad	465	400	865
Total	805	655	1,460

In the rural area, 57 population clusters (villages) are electrified in the whole district, of which 28 villages in Jhatpat Tehsil, 24 village in Usta MOhammad Tehsil and 5 village in Dera Murad Jamali Tehsil are provided electrified facilities respectively.

III.2.1 Topography

1) Outline of the Province

Physically, Baluchistan Province is divided into the highland and extensive plains approximately. The upper highland known locally as "Khorasan" rise to nearly 12,000 ft. (3,658 m) with the valley floor about 5,000 ft. (1,524 m) above mean sea level, and the lower highlands include the Mekran, Kharan nad Chaghai ranges in the west and Sulaiman, Pab and Kirthar ranges in the east.

The extensive plain is divided into three plains; the Kachhi plain, the plain of Las Bela and the plain of the river Dasht. The northwestern section known as the Chaghai basin, is desert with an area of inland drainage dissipating into "Hamus" - lakes that are generally dry.

On the whole the plateau of Baluchistan presents a scene of rugged, barren and arid land with isolated pathes of green on the plains.

2) Project Area

The Project Area occupes a part of the Kachhi plain, and the north of the area is separated with the Pat Feeder Canal between the Project Area and the desert area, and the western boundary is fixed by the Nari river. The south and the east of the Area is divided with the provincial boundary line between Baluchistan and Sind province near Jhatpat, and with Desert Canal Project of Sind Province and the commandable area of Kirthar Canal.

The Project Araa is of rectangle like shape with the length of about 60 miles (96 km) east to west and 15 to 20 miles (24 to 32 km) north to south.

The land slope varies with gradient in 1 to 2,000 or 1 to 3,000 from north to south gradually, and the area in higher elevation is located along the Pat Feeder Canal at about 200 ft. to 230 ft. (61 - 70 meter), and the lower area extends at about 160 ft. to 180 ft. (49 - 56 meter) in the south of the Project Area.

III.2.2 Climate

1) General

According to the classification of climate by the World Meteorological Organization, that of the Baluchistan province belongs to the arid zone type.

There are four meteorological observation stations, in which three stations, Quetta, Usta Mohammad and Sibi are in Baluchistan province and one station, Jacobabad, is in Sind province. As for representative observation station, Usta Mohammad has selected as the most available observation station among three station for the Project Area, and this station has been operated and maintained by the Surface Water Hydrology Project WAPDA Lahore since December 1965. The location of the station is Latitude 28°11', Longitude 68°04', in Agricultural Seed Farm as shown at location map in Fig. III.2-1.

Main items measured at the station are maximum and minimum Air Temperature, Precipitation, Relative Humidity, Evaporaiton (Pan), Wind Movement and Solar Radiation, and they have been recorded at 0800. Generally, the year has two season, winter (November to April) and summer (May to October) in Baluchistan. HOwever, in case of the Project Area, winter lasts shorter than the aforesaid period (November to March), and the summer seems to begin from April. Based on daily observation data collected for ten years (1966 - 1975) at Usta Mohammad, these data have been rearraged to mean monthly value and evaluated them as following.

a) Precipitation

The Project Area belong to arid zone as mentioned in general discription. However, there are measurable the rainfall in a year because of being affected by the monsoon, and annual amount of rainfall has been observed at 3.43 inches (87.1 mm) as shown in Fig. III.2-2. Through the year, 70 percent of the total amount has occurred in summer season, and it occurred in August and July concentratively. Concerning the daily observation data at Usta Mohammad, the maximum daily rainfall has been recorded about 3.9 inches (99.1 mm) during 10 years (1966 - 1975).

The heavy spot rainfalls have brought the local flood to the Project Area sometimes, and it has given the damage for existing irrigation facilities along Pat Feeeder Caanl. However, it is inadequate as a effective rainfall for the irrigation in the Project Area.

b) Temperature

As mentioned in Fig. III.2-2, the mean monthly temperature in June is the highest through the year, and it stands at 96.9°F (36.1°C), and the lowest one is occurred in January at 55.7°F (13.2°C) respectively. On data recorded at observation station, there are two kind of measurement value as for the mean monthly maximum air temperature and mean monthly minimum air temperature. The mean monthly maximum air temperature has been recorded at 111°F (43.9°C) in June whereas the minimum one is at 40°F (4.4°C) in January. According to the detail information in data collected, the highest air temperature has measured about 122°F (50°C) in June 1981 at Jacobabad station. On the other hands, the lowest one recorded at about 30°F (-0.9°C) in January 1974 at Usta Mohammad station.

c) Relative Humidity

Generally, the high humidity has occurred in July to February and the low one has been recorded in March to June as mentioned in Fig. III.2-2. At the observation station, Relative Humidities has been measured two times in a day, namely, morning (8.0 AM) and evening (5.0 PM) In case of comparison with both value observed, there are much difference, and its difference is about 10 - 20 percent in each month.

According to the data observed from 1968 to 1975, the highest mean monthly relative humidity occurred in September and the lowest in April, and the former was recorded by 87 percrnt in 1974 and latter by 16 percent in 1971.

d) Evaporation

According to the measurement data with Pan-A Method at Usta Mohammad,

mean annual evaporation amount has estimated at 11.65 inches (2,966.5) mm) as shown attached Table III.2-7. In fluctuation of mean monthly evaporation observed in ten years, it has recorded at 18.94 inch (473.5 mm) in May as the highest value and 16,84 inch (421.0 mm) has ranked secondarily in June as mentioned in Fig. III.2-2. Whereas the lowest records has measured at 3.19 inch (79.8 mm) in December. Concerning the monthly amount on evaporation in ten years observation periods, the highest amount has recorded at 23.92 inch (607.6 mm) in May 1973. Meanwhile, the lowest monthly amount has measured at 2.71 inch (68.8 mm) in January 1971. The evaporation value would refer closely to the condition of air temperature and relative humidity, and the relation of said two element (T & H) to humidity is shown clearly by the Fig. III.2-2 attached.

e) Wind Velocity

Mean monthly wind velocities in ten years observation period has indicated in Fig. III.2-2 in the Project Area. However, no there were available data to show the wind direction, maximum and minimum iwnd velocities.

The mean maximum wind velocity have been occurred in the summer and in March as a rare case. There are being sandstorm and occurring in summer season in the Project Area.

f) Sunshine Intensity

The sunshine intensity has been observed at Jacobabad staiton as shown in Table III.2-15. Through the observation period for ten years, the highest intensity has occurred at 82.4 percent in October, and the lowest one in July because of affection of the monsoon.

2) Particular Meteorology

a) Storm

In the province, the most of the rainfall have occurred in association with storms, which are of two types usually as following:

° Tropical storms or summer storms which are responsible for summer or monsoon rainfall.

° Extra-tropical cold weather storms, known in this sub-continent as "Western disturbances", which produce winter precipitation.

i) Summer Storms (Monsoon)

The advance of the monsoon is usually associated with the westward moving depressions from the Bay of Bengal.

These depressions often begin to weaken during their westward march and generally lose much of their activity by the time they reach central India.

Sometimes they recurve northeast or northward from Rajputana and break over the western Himalayas or the Kashmir hills.

On a few occations, they continue to be active and travel into Iran area through Baluchistan. On such occations the province experiences fairly prolonged unsettled weather and rainfall occurs more or less continuously for one or two days.

Otherwise, the precipitation over the area in the summer season is usually in the nature of thundershowers and occurs in the afternoon or early evening.

Occasionally, monsoon depressions cross into Baluchistan from the Arabian Sea and, moving north or northeast, enter the Punjab and then break up over the Punjab hill

According to the old data observed, the monthly distribution of monsoon depressions in the 88 years period was as follows:

May	1
June	5
July	4
August	1
September	2
Year	13

That shows June is the stormiest month in summer. Monsoon depressions in this month cross the province from the Arabian Sea.

The other hands, the speed of movement of monsoon depression varies with the season. They move slowly in teh beginning of the season with an average speeed of 6 - 10 miles per hour in July and to 12 - 15 miles per hour in August and September.

ii) Winter Storms

In winter, the province is affected by disturbance of extra-tropical origin which move form west to east, especially during the months of November to April. These disturbances are known as cold weather storm or more popularly as "Western disturbances". Some of these disturbances induce lows either at sea level or in upper air, which also travel west to east. These lows sometimes induce strong wind currents form the Aravian Sea and become very active.

Although isolated or scattered heavy rainfall may occur over and near the hills, the phenomenon of locally heavy precipitaiton is rare. Winter precipitaitons are more uniform than in summer and the intensities are much lower.

Ocassionally, a winter storm is associated with active warm and cold fronts. Then, severe thundershowers occur with its passage followed by biting cold and strong north-westerly to northerly winds.

iii) Heavy Daily Rainfall

Through observation period at Usta Mohammad, the maximum daily rainfall has been measured at 3.9 inch (99.1 mm) in 1975. Regarding the daily rainfall intensity, (frequency) it has analyzed with the Gumbel Chow formula based on data observed for ten years.

The results of analysis are shown in Table III.2-2, and said value observed (3.9 inch) is equivalent of 25 years return frequency approximately.

iv) Air Temperature

As for the air temperature, the Project Area has been evaluated as the hottest zone in Pakistan and also in the world, and this fact could be approved with the scientific yearbook published in 1978.

Table III.2-1 Rainfall of Annual and Monthly Amount (Inches)
Station ; USTA MOHHAMAD Lat 28°11' Long 68°04'

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Remarks
1966	0.00	0.00	0.00	0.06	0.00	0.00	0.96	0.00	0.00	0.00	0.00	0.00	1.02	
1967	0.00	0.05	2.22 (1.53)	0.13	0.00	0.00	1.17 (0.82)	2.48 (1.03)	1.76	0.85	0.09	2.33 (2.15)	11.08	
1968	0.28	0.01	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.45	
1969	0.00	0.01	0.30	0.00	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.74	
1970	0.07	0.32	0.95 (0.82)	0.32	0.00	0.00	0.53 (0.53)	1.06 (0.60)	0.04	0.00	0.00	0.00	3.29	
1971	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.09	0.00	0.00	0.00	0.00	0.61	
1972	0.50	0.40	0.00	0.00	0.00	0.00	0.30	0.00	N.A	N.A	0.00	N.A.	1.20	
1973	0.00	0.00	0.00	0.00	0.00	0.00	3.03 (2.98)	0.48	0.00	0.00	0.00	0.34	3.85	
1974	0.00	0.00	0.32	0.05	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	
1975	0.12	0.24	0.00	0.12	0.00	0.00	0.42	9.27 (3.90)	0.97	0.00	0.00	0.00	11.14	
Total	0.97	1.03	3.79	0.68	0.50	0.00	7.52	13.38	2.77	0.85	0.09	2.67	34.25	
Average	0.10	0.10	0.38	0.07	0.05	0.00	0.75	1.34	0.28	0.09	0.01	0.27	3.43	
1979	0.00	1.04 (0.50)	1.86 (0.77)	0.00	0.00	0.00	0.62 (0.62)	3.07 (2.05)	0.14	0.17 (0.10)	0.00	0.78 (0.50)	7.68	

* ( ) ; Max Daily Rainfall

* N.A. ; Not Available

Table III.2-2 Probabilities Calculation on the daily Rainfall at Usta Mohammad and Sibi

Station ; Usta Mohammad Formula ; Gumbel - Chow Formula
Observation Period ; 1966 - 1975 ($X = \sigma K + \bar{X}$)
Unit ; inches

Max Daily Rainfall	Order of Xi	Xi - $\bar{X}$	$(Xi - \bar{X})^2$
0.54 (1966)	1. 3.90	2.70	7.29
2.15 (1967)	2. 2.98	1.78	3.17
0.16 (1968)	3. 2.15	0.95	0.90
0.24 (1969)	4. 0.60	-0.60	0.36
0.60 (1970)	5. 0.54	-0.66	0.44
0.45 (1971)	6. 0.50	-0.70	0.49
0.50 (1972)	7. 0.50	-0.70	0.49
2.98 (1973)	8. 0.45	-0.75	0.56
0.50 (1974)	9. 0.24	-0.96	0.92
3.90 (1975)	10. 0.16	-1.04	1.08
	Total 12.02	Total	15.70

Average Daily Rainfall $\bar{X} = 1.20$

$$\sigma = \sqrt{\frac{15.70}{10}} = 1.253$$

Station ; Usta Mohammad		Station ; Sibi	
Probability	X (inch)	Probability	X (inch)
1/5	2.155 (54.7 mm)	1/5	2.040 (51.8 mm)
1/10	2.887 (73.3 ")	1/10	2.470 (62.7 ")
1/20	3.592 (91.2 ")	1/20	2.884 (73.3 ")
1/25	3.813 (96.9 ")	1/25	3.014 (76.6 ")
1/50	4.501(114.3 ")	1/50	3.418 (86.8 ")
1/100	5.184(141.7 ")	1/100	3.819 (97.0 ")

Table III.2-3 Monthly Mean Air - Temperature °F
Station ; USTA MOHAMMAD

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	58.0	67.5	73.0	83.0	93.0	96.5	93.0	91.5	89.0	81.5	66.5	57.5	
1967	53.5	66.5	70.5	82.5	92.0	98.0	95.0	91.5	89.0	80.5	72.5	N.A.	
1968	55.5	55.5	73.0	82.5	91.0	96.0	94.5	90.5	88.0	80.5	70.0	57.5	
1969	56.5	62.0	77.5	84.0	91.5	97.0	94.5	90.0	88.5	82.0	70.5	61.0	
1970	57.5	64.5	71.5	85.0	96.0	96.5	94.0	92.5	88.0	81.5	69.5	60.0	
1971	55.5	62.5	74.0	88.0	94.0	96.5	92.5	90.0	88.0	78.5	71.0	61.0	
1972	57.0	56.0	76.0	84.5	93.5	97.5	N.A.	91.5	N.A.	N.A.	N.A.	N.A.	
1973	53.0	61.0	72.5	84.5	97.5	98.0	93.0	90.5	92.0	82.0	68.0	58.5	
1974	N.A.	N.A.	75.5	85.0	91.0	96.0	97.0	92.0	87.0	77.5	69.5	59.0	
1975	55.0	59.5	70.5	82.5	93.0	97.0	90.0	91.5	86.5	79.5	68.5	58.5	
Average	55.7	61.6	73.4	84.2	93.3	96.9	93.7	91.2	88.4	80.4	69.6	59.1	
	(13.2)	(16.4)	(23.0)	(29.0)	(34.1)	(36.1)	(34.3)	(32.9)	(31.3)	(26.9)	(20.9)	(15.1)	( ) : °C

Table III.2-4 Monthly Mean Maximum Air - Temperature (F°)
Station ; USTA MOHAMMAD

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	75	81	90	98	111	110	105	101	99	96	83	76	
1967	70	82	82	96	108	113	105	100	100	96	87	N.A.	
1968	68	67	89	100	106	111	106	101	101	96	86	73	
1969	73	77	95	100	107	113	106	100	102	98	87	78	
1970	73	81	87	103	113	110	106	102	98	97	87	77	
1971	73	80	91	104	109	108	103	100	101	94	86	78	
1972	72	71	94	102	110	115	N.A.	102	N.A.	N.A.	N.A.	N.A.	
1973	67	75	87	104	112	111	102	100	99	97	87	73	
1974	N.A.	N.A.	92	101	107	110	111	103	99	97	89	75	
1975	71	74	86	99	111	111	101	102	98	97	88	74	
Average	71	76	89	101	109	111	105	101	100	96	87	76	

Table III.2-5 Monthly Mean Minimum Air - Temperature (F°)
Station ; USTA MOHAMMAD

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	41	54	56	68	75	83	81	82	79	67	50	39	
1967	37	51	59	69	76	83	85	83	78	65	58	N.A.	
1968	43	43	57	65	76	81	83	80	75	65	54	42	
1969	40	47	60	68	76	81	83	80	75	66	54	44	
1970	42	48	56	67	79	83	82	83	78	66	52	43	
1971	38	45	57	72	79	85	82	80	75	63	56	44	
1972	42	41	58	67	77	80	N.A.	81	N.A.	N.A.	N.A.	N.A.	
1973	39	47	58	65	83	85	84	81	85	67	49	44	
1974	N.A.	N.A.	59	69	75	82	83	81	75	58	50	43	
1975	39	45	55	66	75	83	79	81	75	62	49	43	
Average	40	47	58	68	77	83	82	81	77	64	52	43	

Table III.2-6 Monthly Mean Relative Humidities (Percent)
Station ; USTA MOHAMMAD

Year \ Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1966	8	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
	5	"	"	"	"	"	"	"	"	"	"	"	"
1967	8	"	"	"	"	"	"	"	"	"	"	"	"
	5	"	"	"	"	"	"	"	"	"	"	"	"
1968	8	N.A.	N.A.	N.A.	N.A.	45	48	63	70	77	63	70	70
	5	N.A.	N.A.	N.A.	N.A.	30	23	40	45	44	40	47	35
1969	8	62	67	62	51	39	55	71	75	71	67	59	72
	5	37	35	30	34	26	24	42	47	41	40	40	46
1970	8	76	67	61	50	45	56	71	80	78	75	78	78
	5	49	34	29	25	22	29	41	60	56	56	60	54
1971	8	76	66	53	35	48	61	68	74	64	64	78	76
	5	50	29	22	16	19	38	39	46	34	40	57	60
1972	8	62	60	52	54	28	42	62	69	N.A.	N.A.	73	N.A.
	5	50	40	19	18	20	25	36	43	N.A.	N.A.	58	N.A.
1973	8	68	74	66	46	46	56	69	78	84	73	66	70
	5	48	47	32	20	41	42	62	75	83	73	64	71
1974	8	58	N.A.	54	N.A.	53	69	81	75	87	76	77	77
	5	62	N.A.	50	N.A.	50	55	72	69	84	79	80	71
1975	8	74	73	68	62	61	49	66	68	80	70	76	76
	5	80	86	74	70	65	39	46	42	80	77	78	74
Average	8	68	68	59	50	46	55	69	74	77	70	72	74
	5	54	45	37	31	34	34	47	53	60	58	61	59

Remarks

8; 8 AM
5; 5 PM

N.A.; Not Available
N.D.; No Observation Data

Table III.2-7 Monthly Evaporation Amount (Inches)
Station ; USTA MOHAMMAD

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Remarks
1966	3.05	3.82	8.21	11.52	17.33	15.37	13.47	11.98	8.84	8.94	5.19	2.92	110.64	
1967	3.41	4.46	5.51	11.41	17.48	N.A.	13.27	9.99	9.23	7.49	5.54	N.A.	-	
1968	N.A.	3.50	9.88	11.58	15.10	15.21	14.18	12.35	10.58	7.42	4.82	3.23	-	
1969	3.66	5.19	9.88	12.65	18.14	17.14	13.63	11.37	10.50	8.65	5.93	3.19	119.93	
1970	3.58	4.16	6.61	11.32	17.88	16.22	14.77	12.93	9.84	7.97	4.72	2.89	112.89	
1971	2.71	4.44	8.53	14.27	19.99	15.91	13.14	12.11	11.10	8.08	4.35	3.20	117.83	
1972	3.26	4.26	8.22	11.64	16.16	16.74	13.97	11.30	N.A.	N.A.	4.36	N.A.	-	
1973	4.19	4.48	8.14	9.74	23.92	17.91	13.15	13.30	11.83	9.68	5.12	2.74	124.21	
1974	4.28	N.A.	10.37	13.05	20.17	17.49	17.40	16.16	11.40	10.59	6.00	3.55	-	
1975	3.40	4.84	11.60	14.37	23.23	19.55	16.95	12.12	8.95	10.30	5.76	3.78	134.85	
Total	-	-	86.95	121.55	189.40	-	143.93	123.61	-	-	51.79	-	-	
Average	3.50 (87.50)	4.35 (108.80)	8.70 (217.50)	12.16 (304.00)	18.94 (473.50)	16.84 (421.00)	14.39 (359.80)	12.36 (309.00)	10.25 (256.30)	8.79 (219.80)	5.18 (129.50)	3.19 (79.80)	118.65 (2,966.50)	

* N.A. ; Not Available
* ( ) ; Milimeter

Table III.2-8 Monthly Mean Solar Radiation (Langley's)
Station ; USTA MOHAMMAD

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	N.D.	N,D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.; No Observation Data
1967	"	"	"	"	"	"	"	"	"	"	"	"	N.A.; Not Available
1968	"	"	"	"	"	"	"	"	"	"	"	"	
1969	353	433	519	531	612	643	575	552	508	472	361	335	
1970	351	406	513	590	599	560	574	501	462	461	384	344	
1971	318	371	399	428	443	393	389	379	382	352	250	198	
1972	181	257	N.A.	N.A.	403	421	411	396	N.A.	N.A.	N.A.	N.A.	
1973	243	240	232	330	405	435	385	348	N.A.	N.A.	N.A.	N.A.	
1974	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	
1975	"	"	"	"	"	"	"	"	"	"	"	"	
Average	289	341	416	470	492	490	467	435	451	428	332	292	

Table III.2-9 Monthly Mean Wind Velocities (miles/day)
Station ; USTA MAHAMMAD

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	15	25	43	47	49	66	68	60	51	34	21	16	(179) Jul.
1967	20	25	38	41	49	67	68	53	42	29	22	N.A.	(115) Jul.
1968	20	29	41	39	58	58	56	N.A.	42	30	15	17	(117) Mar.
1969	19	29	21	45	54	56	61	60	44	35	24	14	(98) Apr.
1970	26	28	37	40	50	68	67	63	47	31	16	12	(115) Jun.
1971	9	19	27	36	46	62	58	56	36	22	14	10	(103) Jun.
1972	11	N.A.	25	43	49	57	37	48	N.A.	N.A.	10	N.A.	(90) Jun.
1973	24	18	37	43	53	62	56	55	25	27	11	16	(212) Mar.
1974	21	21	28	37	49	55	56	52	35	29	14	13	(129) Jun.
1975	20	27	33	42	42	62	60	41	24	19	12	5	(114) Jul.
Average	19	25	33	41	50	61	59	54	38	28	16	13	1 mile = 1,609.3 meter
	(0.35)	(0.47)	(0.61)	(0.76)	(0.93)	(1.14)	(1.10)	(1.01)	(0.71)	(0.52)	(0.30)	(0 24)	( ): m/sec

Table III.2-10 Rainfall of Annual and Monthly Amount (Inches)
Station ; JACOBABAD

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Remarks
1966	0.00	0.27	0.05	0.10	0.00	0.00	0.44	0.00	0.02	0.00	0.00	0.00	0.88	
1967	0.00	0.03	1.58 (0.66)*	0.00	0.01	0.00	1.45 (0.89)	3.27 (1.67)	0.50 (0.33)	0.00	0.00	2.47 (1.80)	9.31	
1968	0.55	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	
1969	0.00	0.00	0.19	0.05	0.00	0.00	0.45	0.00	0.00	1.95	0.00	0.00	2.64	
1970	0.01	1.77 (1.77)*	0.21 (0.15)	0.00	0.00	0.00	0.27 (0.15)	1.62 (0.32)	1.02 (1.00)	0.00	0.00	0.00	4.90	
1971	0.06	0.01	0.00	0.00	0.00	0.00	2.47 (1.95)	0.00	0.00	0.00	0.00	0.10	2.64	
1972	0.37	0.15	0:00	0.06	0.00	0.00	0.16	0.01	0.00	0.00	0.00	0.01	0.76	
1973	0.00	0.03	0.00	0.00	0.03	0.00	1.61	0.08	0.00	0.00	0.00	0.71	2.46	
1974	0.01	0.056	0.508	0.00	0.008	0.00	0.204	0.00	0.00	0.00	0.00	0.00	0.79	
1975	0.252	0.184	0.02	0.052	0.00	0.00	0.456	4.80	3.40	0.00	0.00	0.00	9.17	
Total	1.26	2.68	2.58	0.26	0.05	0.00	7.51	9.78	4.94	1.95	0.00	3.29	34.30	
1979	0.008	1.164	0.132	1.20	0.00	0.00	0.00	1.608	0.26	0.432	0.00	0.26	5.07	

* The Value in Braket ( ) Shows the Heighest-rainfall with in 24 Hours.

Table III.2-11 Monthly Mean Air Temperature °F
Station ; JACOBABAD

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1966	61.8	69.2	75.2	85.0	94.2	97.7	94.8	91.9	88.4	83.4	67.8	59.1	
1967	55.8	68.0	72.6	84.9	92.4	97.8	95.2	91.9	89.9	82.7	73.3	60.7	
1968	57.9	61.2	75.7	86.6	91.3	99.9	96.5	92.1	87.7	81.8	71.9	61.9	
1969	59.5	64.2	79.5	88.0	93.6	99.0	96.4	91.5	89.7	84.4	74.8	63.5	
1970	60.6	65.5	73.8	88.2	97.7	97.1	95.5	93.9	89.0	88.8	71.9	63.0	
1971	58.3	65.2	75.2	90.0	95.1	98.4	93.5	91.2	89.3	81.6	72.5	63.1	
1972	59.9	57.9	76.4	84.5	94.6	99.0	94.9	92.5	87.1	80.2	72.2	61.7	
1973	56.7	66.2	74.1	87.5	96.3	100.8	94.6	92.4	90.5	81.6	70.6	61.1	
1974	59.0 (15.0)	59.9 (15.5)	79.3 (26.3)	88.3 (31.3)	94.8 (34.9)	97.9 (36.6)	95.9 (35.5)	93.0 (33.9)	89.2 (31.8)	79.3 (26.3)	69.3 (20.7)	59.9 (15.5)	( ) ; °C
1975	57.2 (14.0)	61.5 (16.4)	72.5 (22.5)	85.5 (29.7)	95.5 (35.3)	98.1 (36.7)	94.6 (34.8)	91.6 (33.1)	88.3 (31.3)	82.4 (28.0)	66.6 (19.2)	64.0 (17.8)	
Average	58.7 (14.8)	63.9 (17.7)	75.4 (24.1)	86.9 (30.5)	94.6 (34.8)	98.6 (37.0)	95.2 (35.1)	92.2 (33.4)	88.9 (31.6)	82.6 (28.1)	71.1 (21.7)	61.8 (16.6)	

Table III.2-12 Monthly Mean Maximum Air Temperature °F & (°C)
Station ; JACOBABAD

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Max.T.	Remarks ( );°C
1966	77.7	80.5	89.6	98.1	110.3	110.4	105.0	101.5	98.4	96.9	84.8	75.5	118.0 (47.8)	May & Jun.
1967	71.6	82.5	84.3	97.4	107.4	111.0	104.5	100.0	99.8	95.1	85.4	71.0	122.0 (50.0)	Jun.
1968	68.4	72.0	89.7	101.3	105.6	113.9	107.0	102.2	100.4	96.6	87.3	76.4	116.0 (46.7)	Jun.
1969	74.9	78.8	96.4	105.1	108.3	113.9	107.2	103.7	100.8	97.1	89.4	77.9	123.0 (50.6)	Jun.
1970	72.8	79.1	86.4	103.5	112.1	110.8	106.8	103.1	97.8	96.4	86.7	77.3	121.0 (49.4)	May
1971	72.9	80.5	90.9	105.1	109.2	110.2	103.8	90.7	100.1	95.9	86.6	78.1	118.0 (47.8)	May
1972	73.3	70.4	89.3	98.0	108.9	113.1	105.7	102.6	99.6	95.0	87.0	75.0	121.0 (49.4)	Jun.
1973	71.3	80.3	88.8	103.8	110.0	115.9	103.9	100.3	99.8	95.6	85.6	73.6	118.0 (47.8)	May
1974	72.0 (22.2)	73.2 (22.9)	93.2 (34.0)	102.2 (39.0)	108.3 (42.4)	110.8 (43.8)	106.5 (41.4)	102.9 (39.4)	100.4 (38.0)	95.4 (35.2)	84.9 (29.4)	73.4 (23.0)	116.0 (46.7)	Jun.
1975	70.5 (21.4)	74.5 (23.6)	86.9 (30.5)	99.7 (37.6)	111.2 (44.0)	110.8 (43.8)	104.5 (40.3)	99.7 (37.6)	95.9 (35.5)	95.0 (35.0)	85.6 (29.8)	77.5 (25.3)	117.0 (47.2)	Jun.
Average	72.5 (22.5)	77.2 (25.1)	89.6 (32.0)	101.4 (38.6)	109.2 (42.9)	112.1 (44.5)	105.5 (40.8)	100.7 (38.2)	99.3 (37.4)	95.9 (35.5)	86.3 (30.2)	75.6 (24.2)		

Table III.2-13 Monthly Mean Minimum Air Temperature °F & (°C)
Station ; JACOBABAD

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Lowest T.	Remarks ( ); °C
1966	45.9	57.8	60.8	71.8	78.1	85.0	84.5	82.3	78.4	69.9	50.7	42.7	35.0 (1.5)	Dec.
1967	40.0	53.5	60.8	72.4	77.4	84.5	85.9	83.8	79.9	70.3	61.2	50.4	32.0 (0.0)	Jan.
1968	47.3	50.3	61.7	71.8	76.8	85.9	86.0	82.0	75.0	67.0	56.5	47.4	33.0 (0.1)	Dec.
1969	44.0	49.5	62.5	70.8	78.9	84.1	85.5	79.2	78.5	71.7	60.1	49.0	32.0 (0.0)	Jan.
1970	48.3	51.9	61.2	72.8	83.3	83.3	84.2	84.7	80.1	81.2	57.1	48.7	36.0 (2.1)	Jan.
1971	43.6	49.9	59.5	74.9	80.9	86.6	83.2	82.7	78.5	67.3	58.4	48.0	29.0 (-1.50)	Jan.
1972	46.5	45.4	63.5	70.9	80.2	84.8	84.1	82.4	74.5	65.3	57.3	48.4	30.0 (-0.9)	Dec.
1973	42.0	52.0	59.3	71.2	81.6	85.6	85.2	84.4	81.2	67.6	55.5	48.6	30.0 (-0.9)	Jan.
1974	46.0 (7.8)	46.4 (8.0)	65.9 (18.6)	74.3 (23.5)	81.3 (27.4)	84.9 (29.4)	85.1 (29.5)	83.1 (28.4)	77.9 (25.5)	63.1 (17.3)	53.6 (12.0)	46.2 (7.9)	33.0 (0.1)	Jan.
1975	43.7 (6.5)	48.4 (9.1)	58.1 (14.5)	71.2 (21.8)	79.9 (26.6)	85.3 (29.6)	84.6 (29.2)	83.5 (28.6)	80.8 (27.1)	69.8 (21.0)	56.5 (13.6)	50.4 (10.2)	30.0 (-0.9)	Jan.
Average	44.7 (7.1)	50.5 (10.3)	61.3 (16.3)	72.2 (22.3)	79.8 (26.6)	85.0 (29.4)	84.8 (29.3)	82.8 (28.2)	78.5 (25.8)	69.3 (20.7)	56.7 (13.7)	48.0 (8.9)		

Table III.2-14 Monthly Mean Relative Humidity (Percent) in 8.AM. & 5.PM.
Station ; JACOBABAD

Year \ Month	A.M. & P.M.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1966	AM. 8.00	62	70	54	51	38	60	70	76	71	58	48	53
	PM. 5.00	32	38	30	18	16	31	42	48	40	30	25	27
1967	AM. 8.00	51	52	64	48	31	54	71	80	73	60	50	75
	PM. 5.00	24	26	38	27	13	24	47	49	42	30	31	39
1968	AM. 8.00	76	72	58	40	35	56	67	74	74	57	59	56
	PM. 5.00	40	40	29	22	17	23	37	48	48	25	28	29
1969	AM. 8.00	52	58	46	34	35	57	70	75	66	67	56	61
	PM. 5.00	25	24	22	18	18	21	42	47	38	33	28	29
1970	AM. 8.00	69	63	68	40	41	57	65	71	75	69	66	67
	PM. 5.00	37	33	45	21	19	29	35	42	49	45	35	47
1971	AM. 8.00	61	59	51	42	48	60	72	75	63	56	65	72
	PM. 5.00	36	35	29	21	21	28	40	46	34	23	33	44
1972	AM. 8.00	72	63	59	53	34	50	69	64	64	57	62	62
	PM. 5.00	48	42	40	28	20	19	38	38	37	26	30	32
1973	AM. 8.00	51	60	48	38	40	59	69	72	70	69	60	75
	PM. 5.00	24	32	25	16	16	28	42	50	43	32	28	42
1974	AM. 8.00	59	62	53	51	44	52	68	77	73	54	61	75
	PM. 5.00	32	31	28	21	18	19	33	44	41	27	33	52
1975	AM. 8.00	71	69	53	49	49	55	64	73	78	65	57	70
	PM. 5.00	42	50	27	28	21	23	37	53	54	36	28	44
Average	AM. 8.00	62.4	62.8	55.4	44.6	39.5	56.0	68.5	73.7	70.7	61.2	58.4	66.6
	PM. 5.00	34.0	35.1	31.3	22.0	17.9	24.5	39.3	46.5	42.6	30.7	29.9	38.5

Table III.2-15 Monthly Mean Sunshine Intensities (Percent)
Station ; JACOBABAD

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1966	88	65	97	65	69	69	62	73	74	83	98	88	N.A.; Not Available
1967	81	66	55	61	75	68	55	70	81	81	78	73	
1968	78	74	78	81	81	74	61	72	82	79	82	80	
1969	72	72	66	59	64	70	67	70	80	79	85	84	
1970	71	74	79	79	64	57	72	64	74	83	85	78	
1971	75	72	71	54	45	43	54	53	76	84	84	74	
1972	62	77	66	66	65	65	54	55	78	80	78	71	
1973	76	60	67	68	52	65	56	65	75	82	83	N.A.	
1974	70	67	60	71	N.A.	N.A.	68	79	79	87	N.A.	N.A.	
1975	N.A.	N.A.	48	68	75	59	58	57	66	86	84	74	
Average	74.8	69.6	68.7	67.2	65.6	63.3	60.7	65.8	76.5	82.4	75.7	77.8	

Table III.2-16 Annual Rainfall and Monthly Mean Rainfall (Inches)
Station ; SIBI Lat. 29°03' Long 67°53' Elevation 440 ft (M.S.L.)

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Remarks
1966	0.00	0.75 (0.30)	0.00	0.33	0.00	0.72 (0.66)	N.A.	0.31 (0.29)	0.00	0.00	0.00	0.00	2.11	
1967	0.00	0.55 (0.40)	4.38 (1.75)	0.60 (0.20)	0.00	1.08	1.46 (1.08)	0.25	0.06	0.00	0.00	2.79 (1.67)	11.17	
1968	0.27	0.86 (0.60)	0.08	0.00	0.00	0.00	0.67 (0.67)	0.00	0.00	0.00	0.00	0.10	1.98	
1969	0.00	0.82 (0.25)	0.23	0.00	0.00	0.00	3.12 (2.60)	0.00	0.00	0.00	0.00	0.00	4.17	
1970	0.43 (0.25)	0.41 (0.41)	0.70 (0.33)	0.00	0.00	0.00	0.82 (0.70)	1.69 (1.07)	0.04	0.00	0.00	0.00	4.09	
1971	0.01	0.00	0.00	0.00	1.41 (1.29)	0.00	0.99 (0.44)	2.81 (2.66)	0.00	0.00	0.00	0.10	5.22	
1972	0.33 (0.18)	0.08	0.16	0.00	0.10	0.29	0.99 (0.97)	0.00	0.00	0.00	0.00	0.30	2.25	
1973	0.14	0.00	0.00	0.00	0.00	0.00	5.30 (1.81)	0.72 (0.61)	0.00	0.00	0.00	0.91 (0.78)	7.07	
1974	0.16	1.12 (0.81)	0.00	0.24	0.00	0.00	0.50 (0.50)	0.00	0.00	0.00	0.00	0.03	2.05	
1975	0.02	0.50 (0.30)	0.29 (0.15)	0.20	0.00	0.65 (0.65)	3.27 (2.11)	2.78 (2.00)	0.81 (0.70)	0.00	0.00	0.38 (0.38)	8.90	
Average	0.14	0.51	0.58	0.14	0.14	0.27	1.71	0.86	0.09	0.00	0.00	0.46	4.90	

Table III.2-17 Monthly Mean Air - Temperature
Station ; SIBI

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	62.0	66.0	72.5	82.5	95.5	99.5	97.5	94.0	90.5	83.0	66.0	58.5	
1967	51.5	63.5	70.0	81.5	85.0	98.0	96.5	94.5	91.5	83.0	68.0	55.5	
1968	54.5	57.5	71.5	83.0	92.0	101.0	99.5	96.5	90.0	80.0	71.5	61.0	
1969	57.5	59.5	77.5	85.0	92.5	101.0	99.0	95.5	91.5	82.0	69.0	60.0	
1970	55.0	61.5	68.0	85.5	96.5	98.5	96.5	94.5	90.5	82.0	67.5	57.5	
1971	53.5	60.5	72.5	89.0	94.5	99.5	96.5	95.5	88.0	78.5	69.0	60.5	
1972	57.0	53.0	70.0	80.0	92.5	97.0	96.0	98.5	89.5	78.0	71.0	58.5	
1973	56.5	62.5	70.0	85.5	96.5	102.5	96.0	94.5	94.0	80.0	66.5	58.0	
1974	54.5	57.5	77.0	84.0	93.5	98.0	96.0	92.5	91.0	78.0	69.0	58.0	
1975	54.0	58.0	70.5	85.0	93.0	99.0	94.5	86.5	85.5	80.5	66.5	61.0	
Average	55.6 (13.1)	60.0 (15.6)	72.0 (22.2)	84.1 (28.9)	93.2 (34.0)	99.4 (37.4)	96.8 (36.0)	94.3 (34.6)	81.7 (27.6)	80.5 (26.9)	68.4 (20.2)	58.9 (14.9)	( ) : °C

Table III.2-18 Monthly Mean Maximum Air Temparature
Station ; SIBI

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	82.0	80.0	86.0	95.0	111.0	112.0	109.0	105.0	101.0	97.0	85.0	80.0	
1967	69.0	77.0	82.0	93.0	104.0	110.0	106.0	103.0	102.0	97.0	83.0	68.0	
1968	67.0	71.0	83.0	98.0	102.0	114.0	108.0	105.0	102.0	94.0	87.0	75.0	
1969	72.0	74.0	91.0	98.0	105.0	114.0	108.0	104.0	103.0	99.0	88.0	81.0	
1970	72.0	79.0	84.0	104.0	113.0	114.0	109.0	106.0	103.0	99.0	87.0	78.0	
1971	72.0	80.0	91.0	105.0	110.0	112.0	109.0	106.0	104.0	98.0	87.0	79.0	
1972	73.0	69.0	87.0	98.0	109.0	115.0	109.0	111.0	107.0	98.0	90.0	75.0	
1973	70.0	79.0	88.0	104.0	113.0	116.0	106.0	106.0	106.0	98.0	87.0	74.0	
1974	71.0	71.0	94.0	102.0	109.0	114.0	112.0	104.0	107.0	99.0	88.0	75.0	
1975	72.0	74.0	87.0	102.0	113.0	117.0	112.0	101.0	101.0	99.0	86.0	77.0	
Average	72.0	75.4	87.3	99.9	108.9	113.8	108.8	105.1	103.6	97.8	86.8	76.2	

Table III.2-19 Monthly Mean Minimum Air Temperature
Station ; SIBI

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	42.0	52.0	59.0	70.0	80.0	87.0	86.0	83.0	80.0	69.0	47.0	37.0	
1967	34.0	50.0	58.0	70.0	66.0	86.0	87.0	86.0	81.0	69.0	53.0	43.0	
1968	42.0	44.0	60.0	68.0	82.0	88.0	91.0	88.0	78.0	66.0	56.0	47.0	
1969	43.0	45.0	64.0	72.0	80.0	88.0	90.0	87.0	80.0	65.0	50.0	39.0	
1970	38.0	44.0	52.0	67.0	80.0	83.0	84.0	83.0	78.0	65.0	48.0	37.0	
1971	35.0	41.0	54.0	73.0	79.0	87.0	84.0	85.0	72.0	59.0	51.0	42.0	
1972	41.0	37.0	53.0	62.0	76.0	79.0	83.0	86.0	72.0	58.0	52.0	42.0	
1973	43.0	46.0	52.0	67.0	80.0	89.0	80.0	83.0	82.0	62.0	46.0	42.0	
1974	38.0	44.0	60.0	66.0	78.0	82.0	80.0	81.0	75.0	57.0	50.0	41.0	
1975	36.0	42.0	54.0	68.0	73.0	81.0	77.0	72.0	70.0	62.0	47.0	45.0	
Average	39.2	44.5	56.6	68.3	77.4	85.0	84.2	83.4	76.8	63.2	50.0	41.5	

Table III.2-20 Annual and Monthly Evaporation (Inches)
Station ; SIBI

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Remarks
1966	7.71	7.28	13.02	15.80	22.45	22.03	NA	14.05	14.56	12.29	8.05	4.44	N.A.	
1967	5.04	5.77	8.44	13.20	22.48	24.56	19.59	15.52	15.92	12.06	7.94	6.69	157.21	
1968	7.12	5.62	7.65	12.76	21.94	20.46	20.52	18.71	16.11	13.31	10.50	5.10	159.80	
1969	5.59	5.81	9.22	12.54	16.26	21.78	23.82	20.13	16.92	12.05	8.05	4.12	156.29	
1970	3.61	4.99	8.81	16.76	23.72	25.06	21.34	17.68	15.38	13.58	7.17	4.87	162.97	
1971	4.47	7.31	11.53	20.00	24.02	23.42	19.81	17.44	14.89	11.90	6.78	4.32	165.89	
1972	4.60	8.45	10.78	14.59	24.78	23.73	19.91	23.32	20.50	12.61	6.87	5.19	175.33	
1973	6.72	7.66	10.92	20.90	27.84	27.15	18.40	18.29	18.08	12.20	7.33	3.85	179.34	
1974	7.09	8.57	14.57	15.92	22.87	24.95	21.57	23.57	18.09	17.30	6.69	3.96	185.15	
1975	4.14	5.31	11.60	22.62	30.51	35.32	29.48	12.47	15.47	14.82	9.10	6.06	196.90	
Average	5.61	6.68	10.65	16.51	23.69	24.85	22.16	18.12	16.59	13.21	7.85	4.86	170.78	

Table III.2-21 Monthly Mean Wind Velocities (miles/day)
Station ; SIBI

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Remarks
1966	39	81	128	121	134	129	N.A.	128	107	85	N.A.	N.A.	(604) Mar.
1967	59	81	82	100	134	139	132	132	92	97	41	N.A.	(464) Feb.
1968	61	82	130	117	157	126	137	134	75	58	45	58	(500) Mar.
1969	51	72	79	126	128	141	142	128	75	N.A.	54	26	(395) Apr.
1970	47	30	49	70	96	108	110	100	90	63	37	34	(352) Apr.
1971	41	62	55	95	115	116	110	99	68	43	32	19	(292) Feb.
1972	45	113	66	67	115	99	107	89	102	51	32	33	(400) Feb.
1973	74	55	66	94	117	117	115	93	80	60	24	29	(335) May
1974	75	86	74	62	91	99	102	49	63	82	40	34	(361) Jan.
1975	48	45	69	98	124	123	104	90	69	67	52	41	(610) Jun.
Average	54	71	80	95	121	120	118	104	82	67	40	34	
	(1.00)	(1.32)	(1.49)	(1.77)	(2.25)	(2.24)	(2.20)	(1.94)	(1.53)	(1.25)	(0.75)	(0.63)	1 mile=1,609.3 m (m/sec)

Fig III.2-1

LOCATION MAP OF CLIMATOLOGICAL OBSERVATION STATION

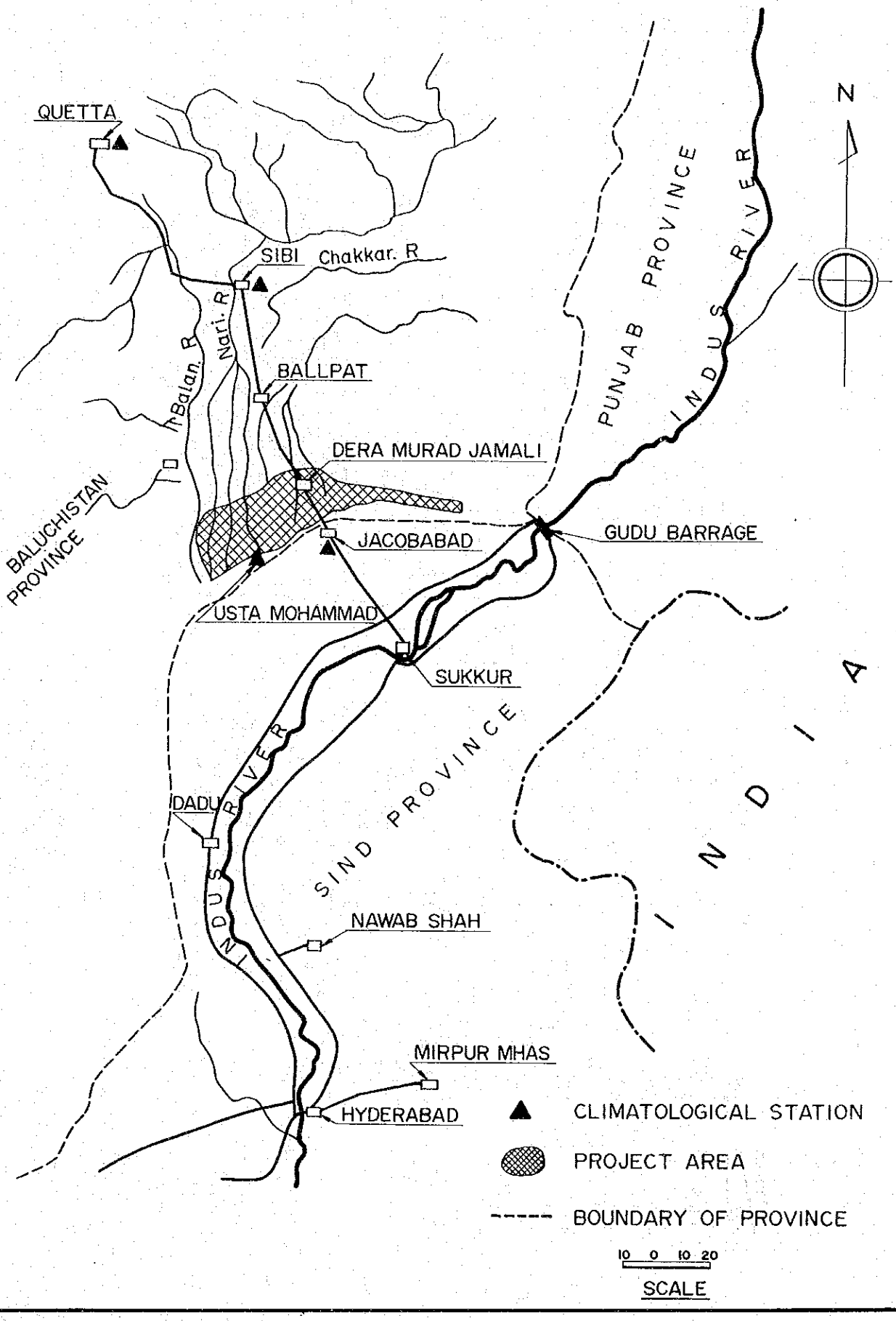
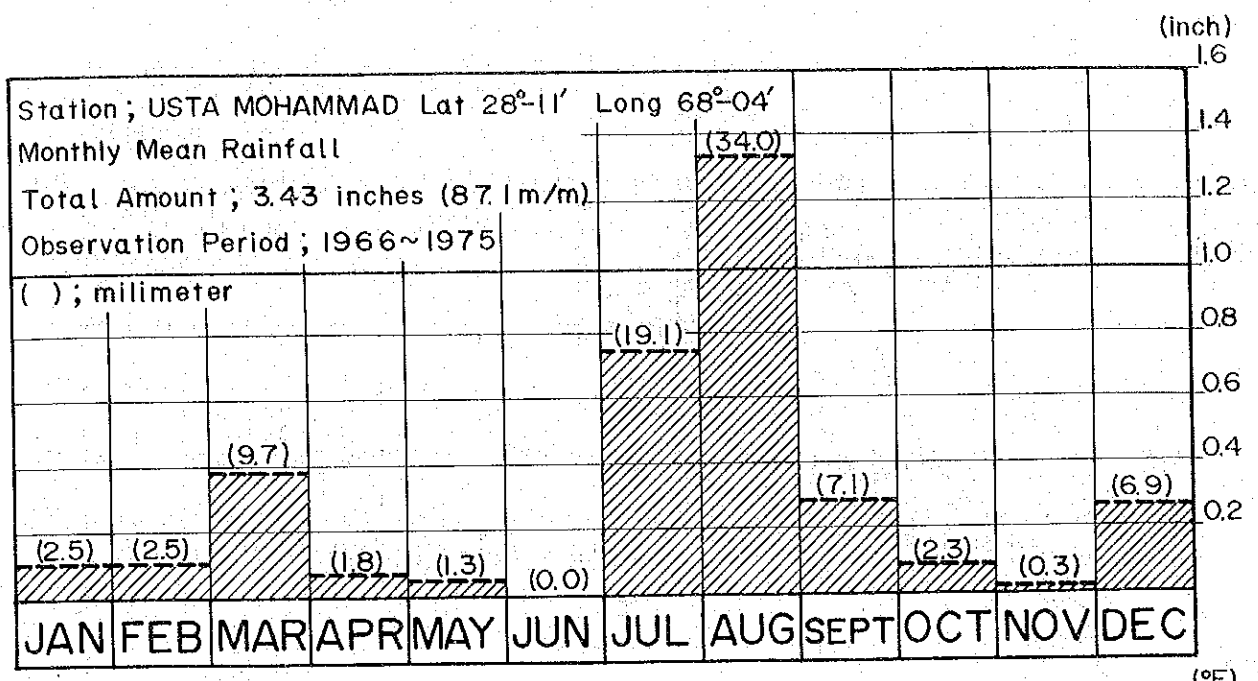
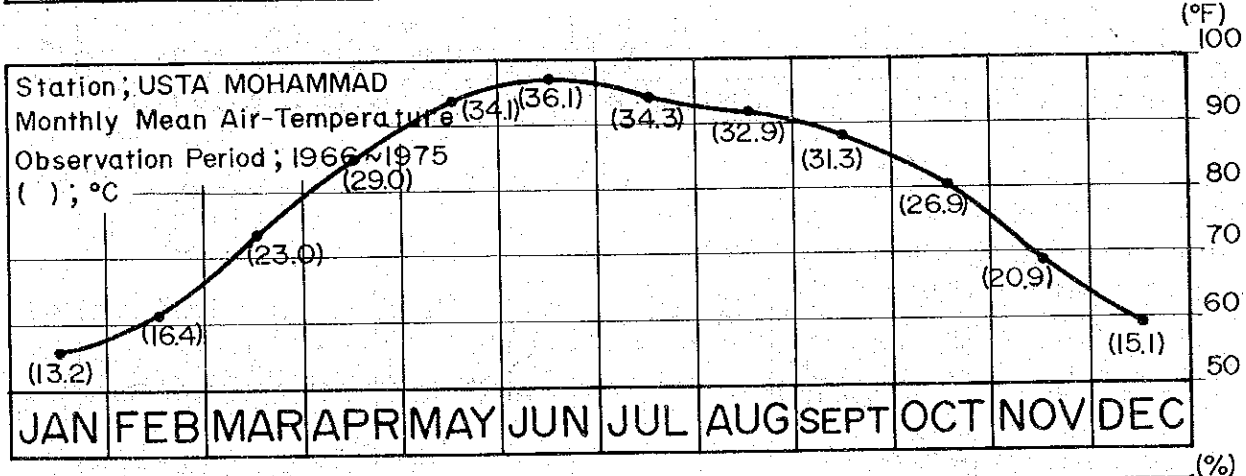


Fig III.2-2

CLIMATIC CONDITION OF THE PROJECT AREA(A)





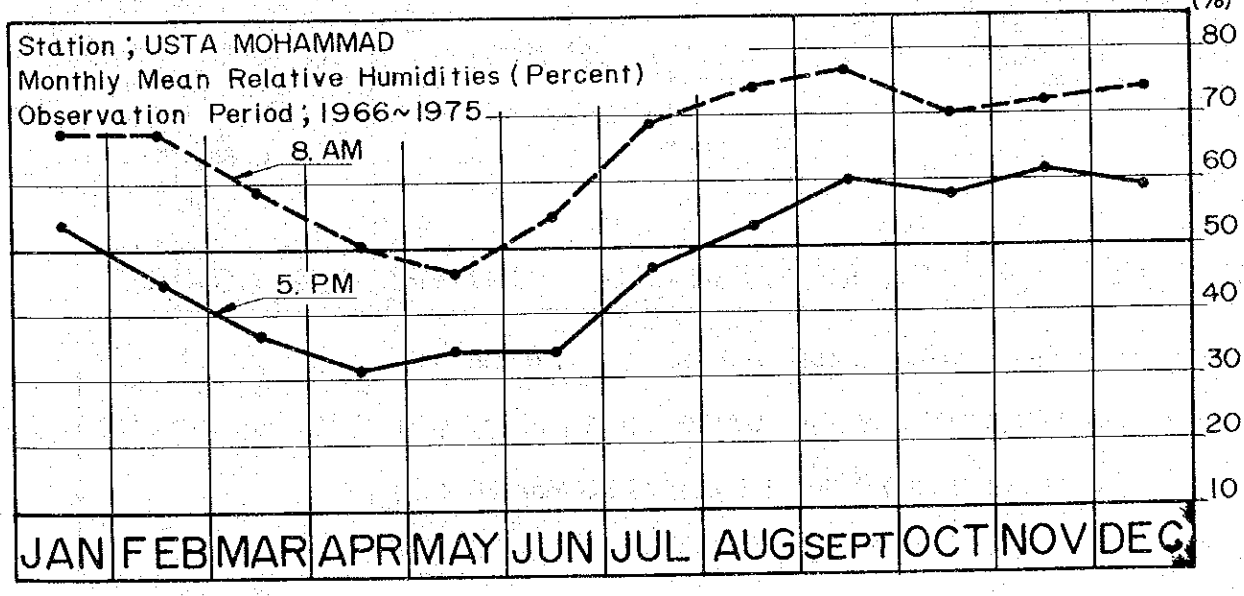
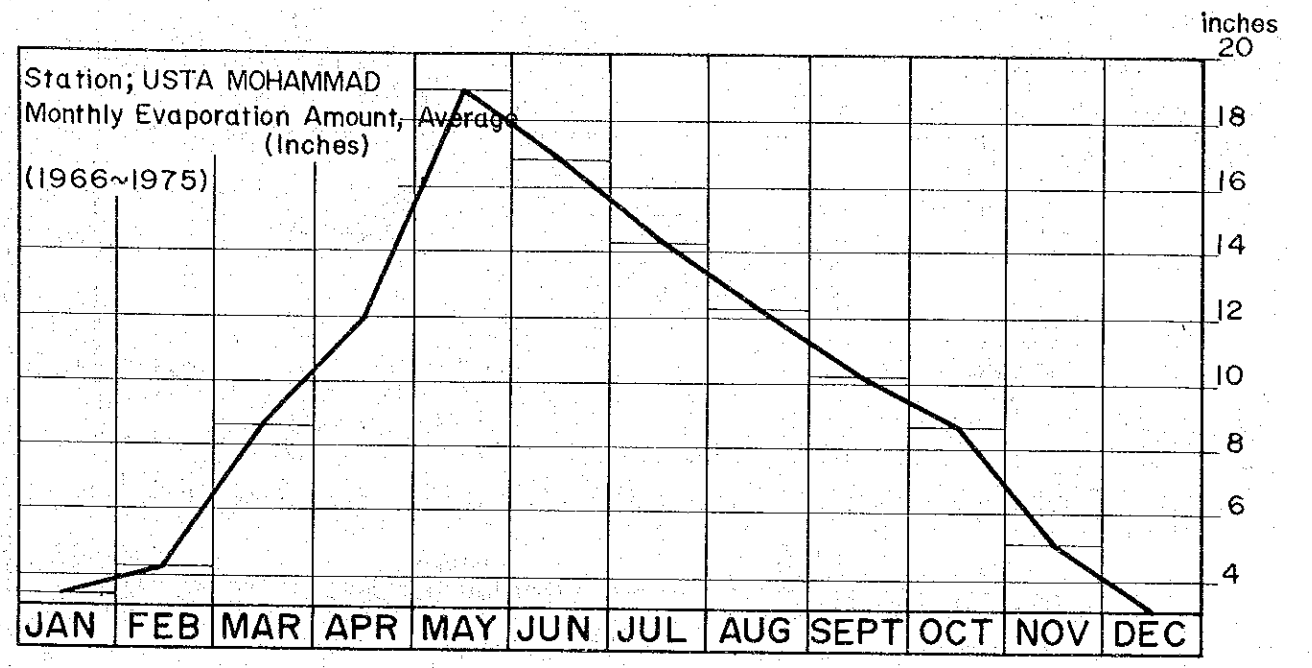
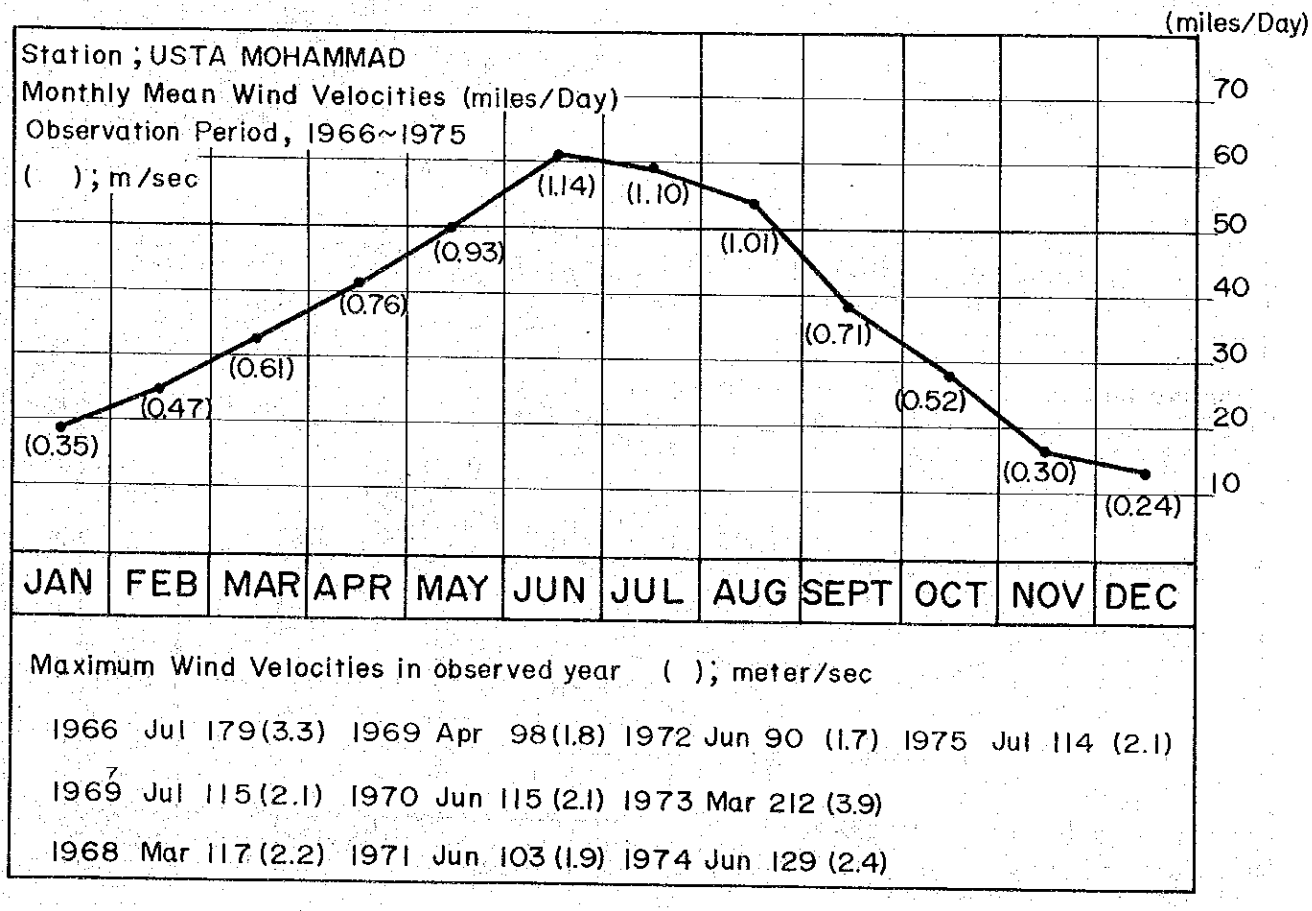


Fig Ⅲ.2-2

CLIMATIC CONDITION OF THE PROJECT AREA (B)





Maximum Wind Velocities in observed year ( ); meter/sec

1966	Jul	179 (3.3)	1969	Apr	98 (1.8)	1972	Jun	90 (1.7)	1975	Jul	114 (2.1)
1969	Jul	115 (2.1)	1970	Jun	115 (2.1)	1973	Mar	212 (3.9)			
1968	Mar	117 (2.2)	1971	Jun	103 (1.9)	1974	Jun	129 (2.4)			

III.2.3 Hydrology

1) Water Resources

a) Discharge of Indus River

The catchment area of the Indus River has been estimated at about 367,000 square miles (950,000 square km), and its length at 1,800 miles (2,900 km) approximately, and it has ranked in 15th as for the length of the river in the world.

There are six main tributary in the Indus River Basin namely, Kabul R, Jhelum R, Chenab R, Ravi R, Sutleg R, and Beas R.

The Kabul River belong to AFGHANISTAN on the origin of the stream, and other tributary's origin located in INDIA. According to the general information published in the report of (Indus Waters Treaty", the mean annual runoff in the Indus River Basin has been estimated at about 168 million acre feet (207,400 M.C.M.), and tributaries have occupied 47 percent for total runoff in the river basin.

However, the runoff pattern of the basin has been changed with the basin development program at downstream since 1967, and particularly, after the construction of the Tarbela Dam, the flow pattern has varied in winter (Jan. to Mar.) since 1979 as shown in Figure III.2-4.

As mentioned in previous chapter, the Indus River is the most important water resources for the Project Area, and the runoff has been controled artificially with the dam group at upstream of the basin due to the demands of the irrigation and the power sources.

Fortunately, daily discharge observed at Guddu Barrage have collected for eleven years (1971 - 1981) with cooperation of the provincial government of Sind Province.

From these data collected, the most available data has selected, and revised based on the purpose of irrigation, and it is tabulated as shown in Table III.2-22.

According to the Table III.2-23, total runoff would be expected to have at about 84 million acre feet (103,614 M.C.M.) at Guddu Barrage, and mothly fluctuation of the runoff shown in attached Figure III.2-3.

b) Intake Discharge at Guddu Barrage

There are three intake structures at Guddu Barrage, one facility constructed at the left bank, and other two facilities have been constructed at the right bank. Namely, Desert Pat Feeder Canal intake and Begari Sind Feeder Canal intake. From data collected at project site, there are provided mean monthly intake discharge amount at each project as shown in Table III.2-22, III.2-23, and III.2-24 respectively.

At present, there are estimated 10 million acre feet as mean yearly total amount intaked from Guddu Barrage, and 3 million A.F. to the Desert Pat Feeder Canal, and 1.05 million A.F. to the Pat Feeder Canal respectively. As for the variation of mean monthly intaked discharge, it has prepared in Figure III.2-3.

c) Consideration of Water Balance at Guddu Barrage after the project

The water demands has been estimated after the project in the Project Area based on proposed cropping pattern and crop's water requirement which are calculated with the meteorological data. In this case, there are provided three kinds of case study to have the most available development plan for the Project Area in view points of economics and water resources at the Indus River Basin.

The other hands, there are being two existing barrage at downstream of Guddu Barrage, and they were constructed near Sukkur and Hyderabed in 1930, 1956 respectvely. As to the estimation of water

demands of Sukkur Barrage scheme, it has been evaluated with the water balance study between Guddu Barrage and Sehwan observation station as shown in Table III.2-25. Furthermore, the water requirement of Hyderabed Barrage estimated with the ratio of acreage of irrigable area for the Pat Feeder Canal Project.

The results of the water balance study have tabulated in Table III.2-26, III.2-27 and III.2-28 respectively. According to the results, Case Study 1 has the highest lack of water supply in Rabi crops from December to February, and Case Study 3 is the most stable in connection with the water supply from the basin. However, there are no consideration to have the maintenance water at downsrream of the Indus River on the water balance study.

Regarding above, the study have included various unknown factor to be cleared in future, and particularly, the operation rules of Tarbela and Mangla Dams should be rivised to be utilized the water resources more effectively in the river basin based on the future development plan, and the arrangement of distribution plan will be carried out by the Indus River Treatment Committee.

2) Sedimentation

a) Data Collection and Analysis

In the Indus River Basin, the Surface Water Hydrology Project WAPDA has carried out to have the observation station and analysis of data observed refer to the sediment since 1960.

According to the information collected, main observation station of sediment are eleven stations in the river basin, ard there were seven stations along the Indus River, and four stations have installed at Tributary of the Indus River as mentioned in Figure III.2-5. However, the observation stations have been installed concentratively into the upstream of the basin except Sehwan because of application for the development plan on dam project. WAPDA has republished the

report in May 1980 as for the results of analysis on data observed at each station, and they have rearranged more clearly and its tabulated as shown in Table III.2-29 and III.2-30.

From these tables, an average sediment concentration by weight were estimated at about 2,500 PPM to 3,600 PPM in main stream of the Indus River and there were measured at about 1,100 PPM to 2,100 PPM in the tributary of the Indus River, but these value have not been included the affection of Tarbela Dam in main stream of Indus River. As mentioned attached Table III.2-29 and III.2-30, the contents of suspended materials have been analyzed at sand, silt, and clay respectively, and the contents of sand is being reducing gradually from upstream to downstream, while the contents of silt and clay are increased in downstream.

The other hand, the collection of sample materials along the Desert Pat Feeder Canals has been carried out and analyzed the contents of the materials as shown in Table III.2-31, and the distribution of contents has indicated that upstream of the canal covered with sandy materials and the silt or clayey materials have deposited at downstream of canals.

b) Evaluation of Sedimentation at Desert Pat Feeder Canal

i) Water Balance of the River Basin

According to the data which were published in May 1980 by WAPDA, the mean annual runoff of the Indus River at Massan for 4 years of record (1972 - 1975) were 89.3 million A.F. The other hands, the mean annual runoff at Guddu Barrage in same period were taken at about 90.5 Million A.F. From this, the tributary of the Indus River has taken at about 1.2 Million A.F. as the mean annual runoff, and its value seems to be smaller in comparison with the catchment area.

In this connection, it could be considered that there were prepared the link canals to connect existing tributaries for the ob-

taining of stable irrigation systems, and the runoff is utilizing more effectively to existing irrigation systems.

ii) Estimation of Average Sediment Yield at Guddu Barrage

Concerning the Sediment Yield at Massan in the Indus River, it has measured at about 304 million ton in mean annual yields. However, after the construction of Tarbela Dam, this value could be assumed to reduced to 10 percent approximately by the example of the investigation of similar project. And also the yield of tributary could be estimated at about 2.96 million ton (1,480.2 M.C.M. x 0.002) so that, total mean annual yield at Guddu Barrage should be at 33.36 million ton. Form this value, average Sediment Concentration at Guddu Barrage could be evaluated at about 320 PPM (0.032% by weight) by the mean annual runoff at the Barrage.

iii) Average Sediment Yield of Desert Pat Feeder Canal

From the case study at previous chapter, Case 3 would be applied as a final development plan for the project, and Case 3 should be required to have 5.70 Million A.F. (7,031 M.C.M.) in both project at the Desert Canal.

In case of above, the mean annual sediment yield has been estimated at about 2.25 million ton from intake structures to distribution point at both project. As mentioned Table 3-30, the contents of suspended sediment (percent) could be divided into 3 class due to grain size, and the sandy materials would be the most suitable one which is silted in the canal. The contents of sandy materials have been measured at about 30 percent for the total value based on observation data in the Indus Basin.

As a results of said evaluation, the sandy materials is 0.675 million ton (675,000/2.60 ≒ 260,000 CM) as total sediment yield in the Desert Pat Feeder Canal.

3) Water Quality

During the investigation at the project site, there were collected the water sample from the Desert Pat Feeder Canal, and analyzed it at Water and Soil Laboratory of Hydrogeology Directorate WAPDA, Quetta. The results of analysis has been tabulated in the Table III.2-32, and there were no problems for the irrigation, in the Project Area.

Table III.2-22 Mean 10 days Discharge of Indus River at Guddu Barrage (1979 ~ 1981)
Mean 10 days Intake Discharge at Desert Pat Feeder Canals (1979 ~ 1981)

Station		January			February			March			Sub-total
		1	2	3	1	2	3	1	2	3	
Guddu Barrage	Cusec	26,606	34,304	44,988	43,637	39,384	41,410	53,015	65,475	51,722	
	A.F.(10^3)	528	680	892	866	781	821	1,052	1,299	1,026	7,945
Desert Pat Feeder C.	Cusec	2,494	6,092	2,283	1,248	1,338	1,264	1,475	754	217	
	A.F.(10^3)	49	121	45	25	27	25	29	15	4	340

Station		April			May			June			Sub-total
		1	2	3	1	2	3	1	2	3	
Guddu Barrage	Cusec	67,175	61,464	74,017	115,715	137,964	157,277	148,638	156,001	173,920	
	A.F.(10^3)	1,332	1,219	1,468	2,295	2,736	3,120	2,948	3,094	3,450	21,662
Desert Pat Feeder C.	Cusec	100	92	167	335	617	2,406	5,990	8,272	9,260	
	A.F.(10^3)	2	2	3	7	12	48	119	164	184	541

Station		July			August			September			Sub-total
		1	2	3	1	2	3	1	2	3	
Guddu Barrage	Cusec	260,675	230,857	326,041	449,639	401,725	271,524	142,610	117,343	112,945	
	A.F.(10^3)	5,170	4,579	6,467	8,918	7,968	5,386	2,829	2,327	2,240	45,884
Desert Pat Feeder C.	Cusec	11,610	11,527	9,244	7,227	8,628	8,707	8,955	8,850	8,736	
	A.F.(10^3)	230	229	183	143	171	173	178	175	173	1,655

Station		October			November			December			Sub-total
		1	2	3	1	2	3	1	2	3	
Guddu Barrage	Cusec	89,250	67,925	49,277	42,172	38,839	38,401	35,936	37,925	37,626	
	A.F.(10^3)	1,770	1,347	977	836	770	762	713	752	746	8,673
Desert Pat Feeder C.	Cusec	6,918	4,011	2,577	2,146	1,764	1,565	1,632	1,493	1,615	
	A.F.(10^3)	137	80	51	43	35	31	32	30	32	471

Total	
84,164	
3,007	

Note ; 1) Cusec is estimated as average discharge of 10 days in 1979 to 1981.
2) A.F. : Acre Feet (10^3).
3) Data Source : Guddu Barrage O & M Office in Sind Province.

Table III.2-23 Mean 10 days Intake Discharge at Guddu Barrage (1979 ~ 1981)

Month / Year	Jan.			Feb.			Mar.		
	1	2	3	1	2	3	1	2	3
1979	7,830	13,226	9,536	4,290	4,718	2,880	5,234	5,467	4,996
1980	7,421	14,064	11,597	1,504	556	1,713	3,973	4,023	2,713
1981	5,160	16,951	10,372	2,839	1,846	2,111	3,422	2,775	1,977
Average	6,804	14,747	10,502	2,878	2,373	2,235	4,210	4,088	3,229

Month / Year	Apr.			May			Jun.		
	1	2	3	1	2	3	1	2	3
1979	-	-	1,370	3,353	5,540	10,622	20,762	26,338	34,673
1980	60	165	600	4,499	7,594	12,589	19,372	28,952	35,566
1981	-	-	-	1,058	4,300	14,518	23,955	30,132	29,792
Average	20	55	657	2,970	5,811	12,576	21,363	28,474	33,344

Month / Year	Jul.			Aug.			Sept.		
	1	2	3	1	2	3	1	2	3
1979	40,919	39,827	40,201	22,398	28,703	32,257	25,040	28,706	26,195
1980	37,641	40,171	36,743	29,856	29,152	32,215	28,883	27,243	25,452
1981	37,923	37,963	22,032	30,365	28,638	26,396	28,857	26,872	24,692
Average	38,828	39,320	32,992	27,540	28,831	30,289	27,593	27,607	25,446

Month / Year	Oct.			Nov.			Dec.		
	1	2	3	1	2	3	1	2	3
1979	22,635	12,831	8,828	8,197	7,503	5,373	4,016	2,726	3,764
1980	21,596	14,525	10,314	4,969	5,347	4,846	4,755	4,071	2,897
1981	19,240	10,562	7,411	6,449	4,552	3,926	3,351	2,566	2,320
Average	21,157	12,639	8,851	6,538	5,801	4,715	4,041	3,121	2,994

Note : Mean Yearly Total Intake Amount is 10 million A.F.

Table III.2-24 Monthly Mean Discharge of Pat Feeder at R.D 109 (1972 - 1982)

(Unit: Cusec)

Year \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1972	-	-	-	-	-	1,108	2,245	2,650	2,857	-	-	-
1973	-	-	-	-	-	917	2,048	2,200	2,616	-	-	-
1974	-	-	-	-	-	889	380	2,196	2,152	-	-	-
1975	-	-	-	-	-	1,593	2,884	1,830	2,121			-
1976	-	-	-	-	-	1,670	2,641	2,043	1,672	2,008		-
1977	984		319	-	-	918	2,626	2,056	2,389	2,982		-
1978	1,909	780	-	-	814	1,488	1,631	1,860	2,867	2,920	1,846	841
1979	1,996	514	158	-	-	1,257	2,974	2,513	2,713	2,406	2,087	971
1980	589	760	-	70	227	1,500	2,951	3,051	3,135	2,550	1,313	1,279
1981	1,265	1,464	559	-	305	1,643	2,486	1,821	2,410	2,321	1,743	1,393
1982	1,256	792	316	-	-	-	-	-	-	-	-	-
Average (1978~ ~1981)	1,440	880	179	18	337	1,472	2,511	2,311	2,781	2,549	1,747	1,121

Note : 1) Total Amount of Intake Discharge (1972 - 1981) is 7.4 Million A.F.
2) Mean Yearly Total Amount (1978 - 1981) is 1.05 Million A.F.

Table III.2-25 WATER BALANCE OF DOWN-STREAM OF INDUS RIVER (1979)

(Unit : Cusec)

	Jan.		Feb.		Mar.		Percent of Irrigated Area
	Average Discharge	Percent	Average Discharge	Percent	Average Discharge	Percent	
Indus River	27,830	(100)	45,122	(100)	91,042	(100)	(100)
Intake Discharge of Guddu, B	10,200	(37)	3,963	(9)	5,232	(6)	(21)
" of Sukkur, B	3,700	(13)	28,859	(64)	25,410	(28)	(71)
Sehwan (Hyderabad, B)	13,930	(50)	12,300	(27)	60,400	(66)	(8)

	Apr.		May		Jun.		
Indus River	91,641	(100)	123,243	(100)	140,842	(100)	(100)
Intake Discharge of Guddu, B	456	(1)	6,505	(5)	27,258	(19)	(21)
" of Sukkur, B	31,485	(34)	36,305	(29)	53,217	(38)	(71)
Sehwan (Hyderabad, B)	59,700	(65)	80,433	(66)	60,367	(43)	(8)

	Jul.		Aug.		Sept.		
Indus River	282,048	(100)	326,632	(100)	107,738	(100)	(100)
Intake Discharge of Guddu, B	40,316	(14)	27,786	(9)	26,647	(25)	(21)
" of Sukkur, B	71,365	(25)	72,979	(22)	23,724	(22)	(71)
Sehwan (Hyderabad, B)	170,367	(61)	225,867	(69)	57,367	(53)	(8)

	Oct.		Nov.		Dec.		
Indus River	68,643	(100)	42,621	(100)	36,680	(100)	(100)
Intake Discharge of Guddu, B	14,765	(22)	7,024	(16)	3,502	(10)	(21)
" of Sukkur, B	22,711	(33)	22,597	(53)	25,378	(69)	(71)
Sehwan (Hyderabad, B)	31,167	(45)	13,000	(31)	7,800	(21)	(8)

Remarks

Irrigable Area in each Barrage.

I. Guddu Barrage

1 Desert Pat Feeder
1,074,688 Acre

1) Baluchistan
612,189
(122,400)

2) Sind 462,499

2 Begari Sind Feeder
1,001,910

3 Ghotki Feeder
857,517

Total 2,934,115

(21%)(2,444,326)

II. Sukkur Barrage
(71%) 8,300,000 Acre

III. Hyderabad Barrage
(8%) 889,549 Acre

All Total
12,123,664 Acre

(11,633,875)

Note: ( ) Irrigated Area at Present

Table III.2-26 WATER BALANCE OF GUDDU BARRAGE OF INDUS RIVER
in CASE 1 (Qmax = 8,200 cusec, K = 60, R = 95)

(Unit : cusec)

Items / Month	WATER DEMAND (Proposal) Guddu Barrage ① D.C.	② Other Project	③ Pat Feeder	④ Sub-Total	⑤ Sukkur Barrage Mean Monthly	⑥ Hyderabad Barrage (3 x 0.99)	⑦ = ④ + ⑤ + ⑥ Total	SUPPLY ⑧ Indus River	
1-1	1,145	4,310	5,283	10,738	3,700	5,230	19,668	26,606	Rabi Crops (95)
1-2	4,743	8,655	5,350	18,748	3,700	5,297	27,745	34,304	
1-3	934	8,219	5,369	14,522	3,700	5,315	23,537	44,988	
2-1	544	1,630	6,717	8,891	28,900	6,650	44,441	*43,637	
2-2	634	1,035	6,103	7,772	28,900	6,042	42,714	*39,384	
2-3	560	971	5,214	6,745	28,900	5,162	40,807	41,410	
3-1	1,268	2,735	4,189	8,192	25,400	4,147	37,739	53,015	
3-2	547	3,334	4,804	8,685	25,400	4,756	38,841	65,475	
3-3	10	3,012	2,761	5,783	25,400	2,733	33,916	51,722	
4-1	86	-	1,936	2,022	31,500	1,943	35,465	67,175	
4-2	78	-	1,047	1,125	31,500	1,037	33,662	61,464	
4-3	153	490	774	1,417	31,500	766	33,683	74,017	
5-1	66	2,635	1,047	3,748	36,300	1,037	41,085	115,715	
5-2	348	5,194	1,184	6,726	36,300	1,172	44,198	137,964	
5-3	2,137	10,170	1,271	13,578	36,300	1,258	51,136	157,277	
6-1	4,692	15,373	2,482	22,547	53,200	2,457	78,204	148,638	Kharif Crops (60)
6-2	6,974	20,202	5,078	32,254	53,200	5,027	90,481	156,001	
6-3	7,964	24,084	7,400	39,448	53,200	7,326	99,974	173,920	
7-1	9,323	27,218	8,425	44,966	71,400	8,341	124,707	260,675	
7-2	9,240	27,793	8,903	45,936	71,400	8,814	126,150	230,857	
7-3	6,957	23,748	8,598	39,303	71,400	8,512	119,215	326,041	
8-1	5,005	20,313	7,946	33,264	73,000	7,867	114,131	449,639	
8-2	6,406	20,203	8,903	35,512	73,000	8,814	117,326	401,725	
8-3	6,485	21,582	9,903	37,970	73,000	9,804	120,774	271,524	
9-1	6,462	18,638	9,176	34,276	23,700	9,084	67,060	142,610	
9-2	6,357	18,757	9,517	34,631	23,700	9,422	67,753	117,343	
9-3	6,243	16,710	10,200	33,153	23,700	10,098	66,951	112,945	
10-1	4,387	14,239	9,449	28,075	22,700	9,355	60,130	89,250	
10-2	1,480	8,628	9,654	19,762	22,700	9,577	52,019	67,925	
10-3	46	6,724	9,903	16,223	22,700	9,804	48,727	49,277	
11-1	748	4,392	6,443	11,583	22,600	6,379	40,562	42,172	
11-2	366	4,037	6,253	10,656	22,600	6,190	39,446	*38,839	
11-3	167	3,150	6,375	9,692	22,600	6,311	38,603	*38,401	
12-1	735	2,409	4,178	7,322	25,400	4,136	36,858	*35,936	
12-2	596	1,628	4,233	6,457	25,400	4,191	36,048	37,925	
12-3	718	1,379	4,624	6,721	25,400	4,578	36,699	37,626	
Total	104,604	353,147	210,692	668,443	1,253,400	208,612	2,130,455	4,243,422	
(Million AF)			(4.18)	(13,26)		(4.14)	(42.26)	(84.17)	

Remarks : 1) $\frac{890}{900}$ = 0.99, 2) 5 estimated with the measurement discharge data at Sehwan in 1979.

Note : * Supplies is inadequate. Total volume inadequate is 0.12 M.A.F.

Table III.2-27 WATER BALANCE OF GUDDU BARRAGE OF INDUS RIVER in CASE 2 (Qmax = 6,700 cusec, K = 50, R = 80)

(Unit : cusec)

Items / Month	WATER DEMAND (Proposal) Guddu Barrage ① D.C.	② Other Project	③ Pat Feeder	④ Sub-Total	⑤ Sukkur Barrage Mean Monthly	⑥ Hyderabad Barrage ③ x 0.99	⑦ = ④+⑤+⑥ Total	SUPPLY ⑧ Indus River
1-1	1,145	4,310	4,716	10,171	3,700	4,669	18,540	26,606
1-2	4,743	8,655	4,788	18,186	3,700	4,740	26,626	34,304
1-3	934	8,219	4,619	13,772	3,700	4,573	22,045	44,988
2-1	544	1,630	5,929	8,103	28,900	5,870	42,873	43,637
2-2	634	1,035	5,358	7,027	28,900	5,304	41,231	*39,384
2-3	560	971	4,538	6,069	28,900	4,493	39,462	41,410
3-1	1,268	2,735	6,143	10,146	25,400	6,082	41,628	53,015
3-2	547	3,334	4,075	7,956	25,400	4,034	37,390	65,475
3-3	10	3,012	2,415	5,437	25,400	2,391	33,228	51,722
4-1	86	-	1,579	1,665	31,500	1,563	34,728	67,175
4-2	78	-	866	944	31,500	857	33,301	61,464
4-3	153	490	652	1,295	31,500	645	33,440	74,017
5-1	66	2,635	866	3,567	36,300	857	40,724	115,715
5-2	348	5,194	1,009	6,551	36,300	999	43,850	137,964
5-3	2,137	10,170	1,118	13,425	36,300	1,107	50,832	157,277
6-1	4,692	15,373	2,149	22,214	53,200	2,128	77,542	148,638
6-2	6,974	20,202	4,432	31,608	53,200	4,388	89,196	156,001
6-3	7,964	24,084	6,499	38,547	53,200	6,434	98,181	173,920
7-1	9,323	27,218	7,283	43,824	71,400	7,210	122,434	260,675
7-2	9,240	27,793	7,782	44,815	71,400	7,704	123,919	230,857
7-3	6,957	23,748	7,472	38,177	71,400	7,397	116,974	326,041
8-1	5,005	20,313	6,785	32,103	73,000	6,717	111,820	449,639
8-2	6,406	20,203	7,772	34,321	73,000	7,635	114,956	401,725
8-3	6,485	21,582	8,573	36,640	73,000	8,487	118,127	271,524
9-1	6,462	18,638	7,853	32,953	23,700	7,774	64,427	142,610
9-2	6,357	18,757	8,210	33,324	23,700	8,128	65,152	117,343
9-3	6,243	16,710	8,700	31,653	23,700	8,613	63,966	112,945
10-1	4,387	14,239	8,139	26,765	22,700	8,058	57,523	89,250
10-2	1,480	8,628	8,282	18,390	22,700	8,199	49,289	67,925
10-3	46	6,274	8,700	15,020	22,700	8,613	46,333	49,277
11-1	748	4,392	5,715	10,855	22,600	5,658	39,113	42,172
11-2	366	4,037	5,429	9,832	22,600	5,375	37,807	38,839
11-3	167	3,150	5,643	8,960	22,600	5,587	37,147	38,401
12-1	735	2,409	3,718	6,862	25,400	3,681	35,943	*35,936
12-2	596	1,628	3,718	5,942	25,400	3,681	35,023	37,925
12-3	718	1,379	4,036	6,133	25,400	3,966	35,529	37,626
Total	104,604	353,147	185,501	643,252	1,253,400	183,647	2,080,239	4,243,422
(Million AF)			(3.68)	(12.76)		(3.64)	(41.26)	(84.17)

Rabi Crops (80)

Kharif Crops (50)

Remarks : 1) $\frac{890}{900} = 0.99$,

2) 5 estimated with the measurement discharge data at Sehwan in 1979.

Note : *Supplies is inadequate. Total volume inadequate is 0.040 M.A.F.

Table III.2-28 WATER BALANCE OF GUDDU BARRAGE OF INDUS RIVER
in CASE 3 (Qmax = 8,200 cusec, K = 60, R = 60)

(Unit : cusec)

Items / Month	WATER DEMAND (Proposal) Guddu Barrage ① D.C.	② Other Project	③ Pat Feeder	④ Sub-Total	⑤ Sukkur Barrage Mean Monthly	⑥ Hyderabad Barrage ③ x 0.99	⑦ = ④+⑤+⑥ Total	SUPPLY ⑧ Indus River
1-1	1,145	4,310	3,370	8,825	3,700	3,336	15,861	26,606
1-2	4,743	8,655	3,507	16,905	3,700	3,472	24,077	34,304
1-3	934	8,219	3,444	12,597	3,700	3,410	19,707	44,988
2-1	544	1,630	4,326	6,500	28,900	4,283	39,683	43,637
2-2	634	1,035	3,849	5,518	28,900	3,811	38,229	39,384
2-3	560	971	3,507	5,038	28,900	3,472	37,410	41,410
3-1	1,268	2,735	4,532	8,535	25,400	4,487	38,422	53,015
3-2	547	3,334	3,096	6,977	25,400	3,065	35,442	65,475
3-3	10	3,012	1,830	4,852	25,400	1,812	32,064	51,722
4-1	86	-	1,389	1,475	31,500	1,375	34,350	67,175
4-2	78	-	911	989	31,500	902	33,391	61,464
4-3	153	490	705	1,348	31,500	698	33,546	74,017
5-1	66	2,635	1,047	3,748	36,300	1,037	41,085	115,715
5-2	348	5,194	1,184	6,726	36,300	1,172	44,198	137,964
5-3	2,137	10,170	1,271	13,578	36,300	1,258	51,136	157,277
6-1	4,692	15,373	2,482	22,547	53,200	2,457	78,204	148,638
6-2	6,974	20,202	5,078	32,254	53,200	5,027	90,481	156,001
6-3	7,964	24,084	7,400	39,448	53,200	7,326	99,974	173,920
7-1	9,323	27,218	8,425	44,966	71,400	8,341	124,707	260,675
7-2	9,240	27,793	8,834	45,867	71,400	8,746	126,013	230,857
7-3	6,957	23,748	8,660	39,365	71,400	8,573	119,338	326,041
8-1	5,005	20,313	7,879	33,197	73,000	7,800	113,997	449,639
8-2	6,406	20,203	8,834	35,443	73,000	8,746	117,189	401,725
8-3	6,485	21,582	9,840	37,907	73,000	9,742	120,649	271,524
9-1	6,462	18,638	9,108	34,208	23,700	9,017	66,925	142,610
9-2	6,357	18,757	9,517	34,631	23,700	9,422	67,753	117,343
9-3	6,243	16,710	10,200	33,153	23,700	10,098	66,951	112,945
10-1	4,387	14,239	8,766	27,392	22,700	8,678	58,770	89,250
10-2	1,480	8,628	8,562	18,670	22,700	8,476	49,846	67,925
10-3	46	6,274	8,537	14,857	22,700	8,452	46,009	49,277
11-1	748	4,392	5,009	10,149	22,600	4,959	37,708	42,172
11-2	366	4,037	4,463	8,866	22,600	4,418	35,884	38,839
11-3	167	3,150	4,395	7,712	22,600	4,351	34,663	38,401
12-1	735	2,409	2,824	5,968	25,400	2,796	34,164	35,936
12-2	596	1,628	2,755	4,979	25,400	2,727	33,106	37,925
12-3	718	1,379	2,948	5,045	25,400	2,919	33,364	37,626
Total	104,604	353,147	182,484	640,235	1,253,400	180,661	2,074,296	4,243,422
(Million AF)			(3.62)	(12.70)		(3.58)	(41.14)	(84.17)

Rabi Crops (60)

Kharif Crops (60)

Reamrks : 1) $\frac{890}{900} = 0.99$

2) 5 estimated with the measurement discharge data at Sehwan in 1979.

Table III.2-29 ANALYSIS OF SUSPENDED SEDIMENT IN INDUS RIVER

Items / Stations	Drainage Area Sq.Miles ($10^3 KM^2$)	Mileage Miles (KM)	Observation Periods (years)	Mean Annual Run-off $10^3 A \cdot F$ (M.C.M)	Average Sediment Yield for the Year of Record Jan.to Dec. m.t.	Jun.to Sept. m.t.	Average Sediment Concentration by Weight %(PPM)	Contents of Suspended Sediment(percent) Sand	Silt	Clay
① Indus R. at Kachurd	43,500 (113)	1,149.7 (1,850)	1970~1975 (6)	24,500 (30,221)	87.1 (100%)	78.6 (90%)	0.287 (2,870)	62	31	7
② Indus R. at Partab Bridge	55,100 (143)	1,076.4 (1,732)	1963~1975 (13)	45,100 (55,631)	161.4 (100%)	156.9 (97%)	0.291 (2,910)	53	27	20
③ Indus R. at Besham Qila	62,700 (162)	929.8 (1,496)	1969~1975 (7)	60,100 (74,133)	229.5 (100%)	224.0 (98%)	0.303 (3,030)	64	30	6
④ Indus R. at Darband	64,100 (166)	883.2 (1,421)	1960~1972 (13)	62,000 (76,477)	300.2 (100%)	228.6 (76%)	0.368 (3,680)	59	34	7
⑤ Indus R. at Attock	102,000 (264)	856.6 (1,379)	1963~1975 (13)	88,000 (108,548)	288.4 (100%)	190.5 (66%)	0.255 (2,550)	44	41	15
⑥ Indus R. at Massan	111,000 (287)	773.3 (1,244)	1972~1975 (4)	89,300 (110,152)	303.8 (100%)	197.7 (65%)	0.264 (2,640)	38	45	17
⑦ Indus R. at Sehwan	- (-)	146.7 (236)	1968~1975 (8)	48,300 (59,578)	192.3 (100%)	167.8 (87%)	0.311 (3,110)	15	55	30

DATA SOURCE ; Sediment Appraisal of PAKISTAN RIVERS (1960 ~ 1975) by SWHP of WAPDA (May 1980)

Table III.2-30 ANALYSIS OF SUSPENDED SEDIMENT IN TRIBUTARY OF INDUS RIVER

Items / Stations	Drainage Area Sq.Miles ($10^3 KM^2$)	Mileage Miles 1/ (KM)	Observation Periods (years)	Mean Annual Run-off 10^3A.F (M.C.M)	Average Sediment Yield for the Year of Record Jan.to Dec. m.t.	Jan.to Sept. m.t.	Average Sediment Concentration by Weight %(PPM)	Contents of Suspended Sediment(percent) Sand	Silt	Clay
① Gilgit R. at Gilgit	4,670 (12.1)	20.0 (32.2)	1963~1972 (10)	7,330 (9,042)	13.6 (100%)	13.2 (97%)	0.148 (1,480)	34	45	21
② Kabul R. at Nowshera	34,200 (88.6)	20.0 (32.2)	1961~1975 (15)	23,000 (28,371)	34.8 (100%)	33.7 (97%)	0.114 (1,140)	16	53	31
③ Soan R. at Dhok Pathan	2,500 (6.5)	40.0 (64.4)	1964~1975 (12)	999 (1,232)	17.6 (100%)	15.8 (90%)	0.144 (1,440)	14	45	41
④ Chenab R. at Alexandria Bridge	12,600 (32.6)	360.0 (579.3)	1961~1968 (8)	15,600 (19,243)	42.7 (100%)	33.1 (77.5%)	0.212 (2,120)	28	59	13

Note ; 1/ Miles are distance from conjunction with the Indus River to observation station.

Table III.2-31 Results of Sieved Analysis on Bed Material of the Main Canals
(Desert Pat Feeder & Pat Feeder Canal)

Location of Sample - (R.D)	Wt of Total Sample Materials (gm)	% Wt Retained by Sieve of Mesh								%Wt Passed through Mesh 270	Specific Density
		16 (1.00) (mm)	32 (0.55) (mm)	60 (0.25) (mm)	80 (0.177) (mm)	100 (0.149) (mm)	150 (0.105) (mm)	200 (0.074) (mm)	270 (0.053) (mm)		
Indus.R Bed	100	-	0.2	0.2	-	-	0.1	0.3	0.9	98.3	2.64
Desert P.F. Canal 37.5	100	-	-	0.2	2.2	10.8	46.2	33.2	4.2	3.2	2.61
R.D 109	100	-	0.05	0.7	2.45	12.6	55.6	25.2	1.6	1.8	2.58
R.D 238	100	-	0.4	43.2	35.1	12.3	4.4	2.9	0.2	1.5	2.61
R.D 324	100	-	-	0.2	1.4	11.3	27.1	44.0	10.2	5.8	2.57
R.D 418	100	-	-	0.2	0.5	1.3	8.5	46.3	24.3	18.9	2.48
R.D 558	100	-	0.4	1.2	0.2	0.2	0.3	1.1	3.3	93.3	2.26
Bari Distry Q. (505)	100	-	-	0.1	0.3	1.5	11.5	48.4	24.3	13.9	2.45
Jhudher Distry 19~20 (418)	100	-	-	0.05	0.1	18.1	21.6	0.05	1.5	58.6	2.29
		Coarse Sand		Medium Sand		Fine Sand		V. Fine Sand		Silt & Clay	

Note; [ ] More than 10 percent 1/ } Bed Materials affected with the erosion of
[ ] More than 20 percent 2/ } embankment along the canal.

Table III.2-32 ANALYSIS OF WATER QUALITY AT GUDDU BARRAGE (Mar., 1982)

MILLIEQUIVALENTS PER LITER											Parts per Million					
Ca	Mg	Na	K	Total Cations	CO_3	HCO_3	Cl	SO_4	F	Total Anions	Fe	B	D.S. (by-Evap)	pH	SAR	Exc. 10^6/cm at 25°C
1.90	1.45	2.18	-	5.53	-	2.77	1.62	1.14	-	5.53	-	-	387	7.6	1.68	530

Note : Water sample has been analyzed by WATER and SOIL LABORATORY of Hydrogeology Directorate WAPDA, QUETTA.

D.S. ; Dissolved Salts

Fig III.2-3 Mean 10 Days Discharge of Indus River (As average in 1979 to 1981)
Mean 10 Days Intake Discharge at Desert Pat Feeder Canal

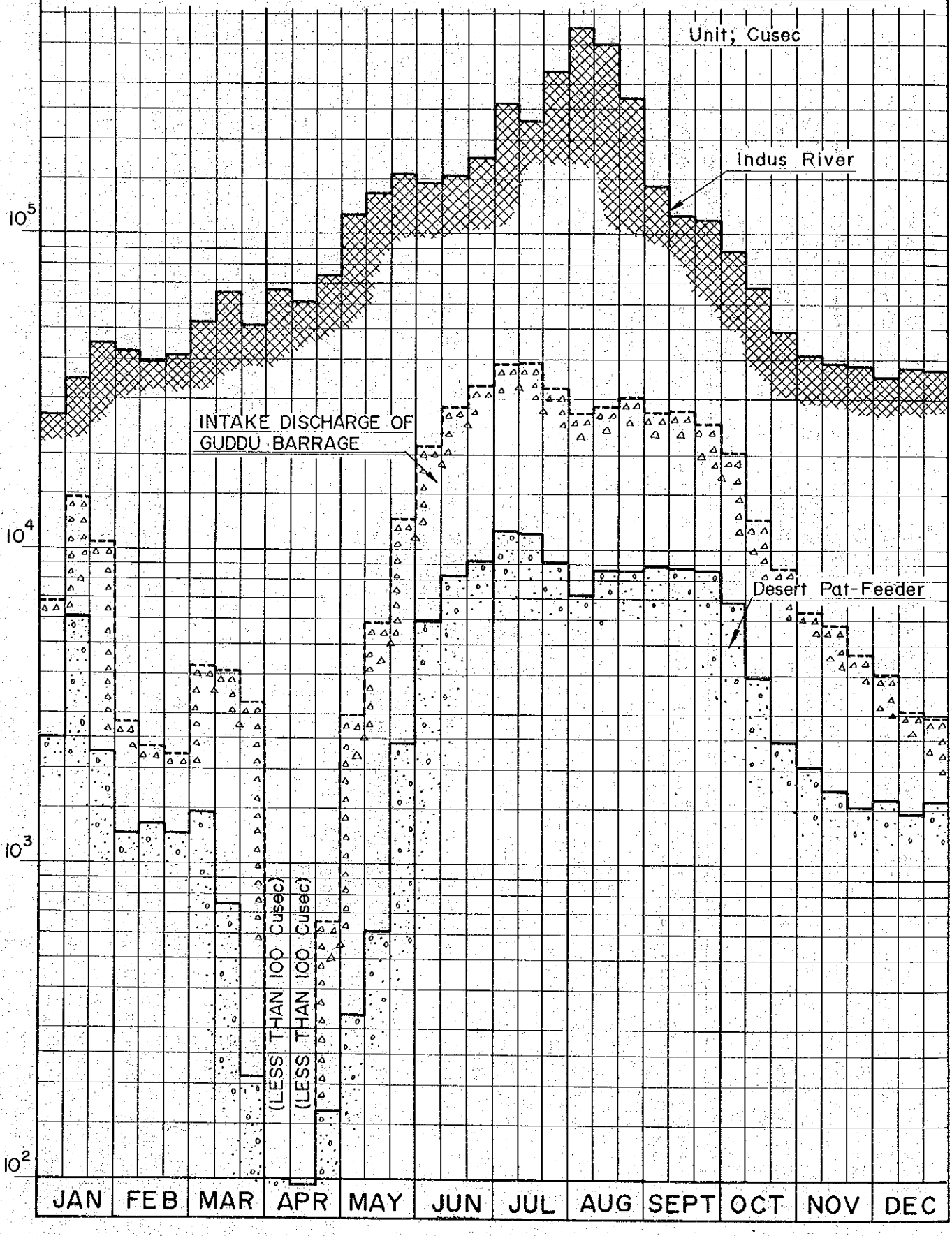


Fig III.2-4 HYDROGRAPH FOR INDUS RIVER AT SEHWAN IN 1969, 1972, 1974, AND 1979

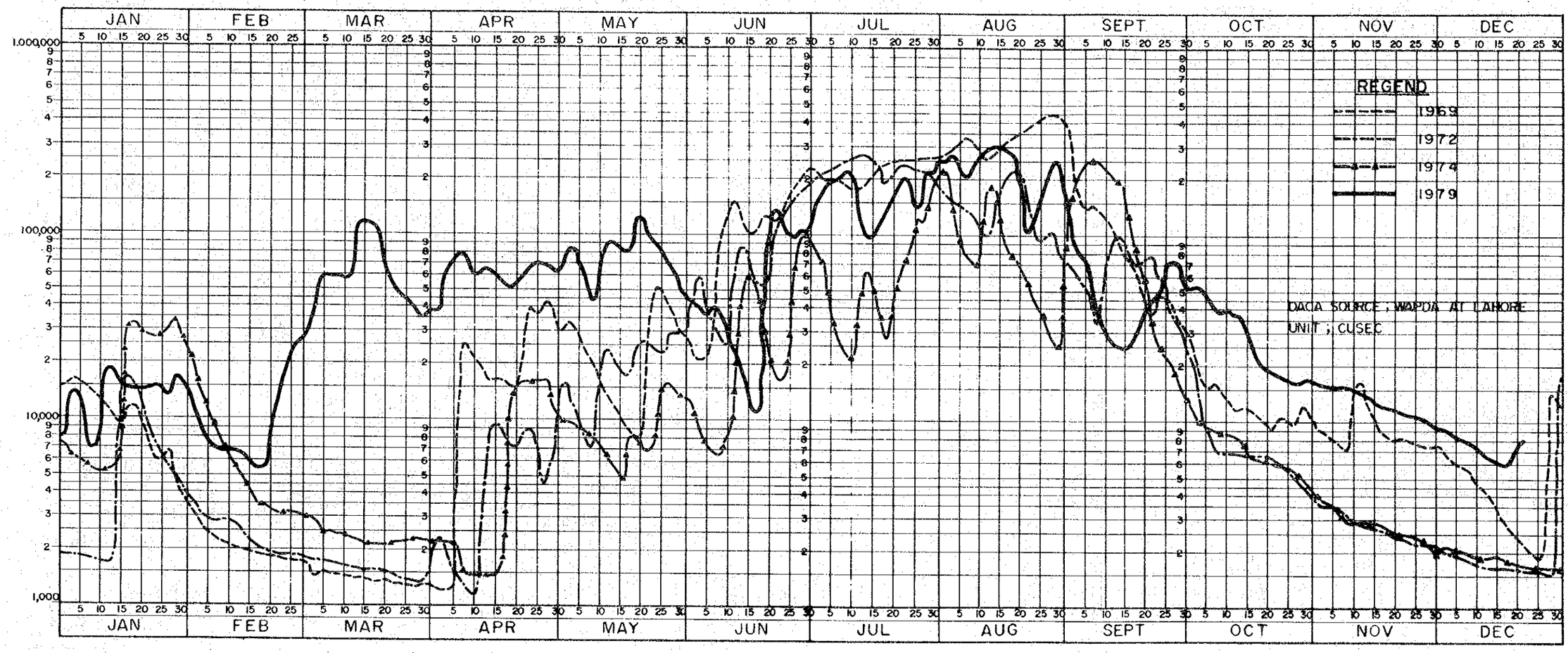


Fig III.2-5

LOCATION OF SEDIMENT OBSERVATION STATION IN INDUS RIVER