PLANNING STRATEGY FOR SETTLEMENTS– INDIRA GANDHI CANAL REGION–RAJASTHAN

A DISSERTATION

submitted in partial fulfilment of the

requirements for the award of the degree

of

MASTER OF URBAN AND RURAL PLANNING

By

SATISH CHANDRA GAUR

DEPARTMENT OF ARCHITECTURE AND PLANNING
UNIVERSITY OF ROORKEE
ROORKEE–247 667 (INDIA)

APRIL, 1987

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled 'PLANNING STRATEGY FOR SETTLEMENTS - INDIRA GANDHI CANAL REGION-RAJASTHAN', in partial fulfilment of the requirement for the award of the Degree of 'Master of Urban and Rural Planning', submitted in the Department of Architecture and Planning of the University is an authentic record of my own work carried out during a period of eight months from August, 1986, to March, 1987 under the supervision of Mr. Rakesh Chandra, Reader, Department of Architecture and Planning, University of Roorkee, Roorkee.

The matter embodied in this dissertation has not been submitted by me for the award of any other degree.

Dated : 11.04.87 (SATISH CHANDRA GAUR)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Dated : 11.04.1987

(RAKESH CHANDRA)
Reader,
Deptt. of Architecture
and Planning,
University of Roorkee,
ROORKEE.

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Date : 11.04.87

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(SATISH CHANDRA GAUR)

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CHAPTER 1. INTRODUCTION

Ever since the dawn of human civilization, there has been a constant tug of war between human being and nature. Nevertheless, man, with his creative mind and determination has always been able to make his environment adaptable to him. Even before 3000 B.C., man was able to reclaim the sandy deserts of Egypt and Mesopotamia. The Western Rajasthan is the extension of 'North Subtropical Desert Belt' starting from north-west Africa. The area was, once, quite flourishing and full of human habitation. The present arid landscape is mainly natural and partly man made. The desert has been created by the extreme aridity of the area with its extremes of temperature and lack of humidity which, over a long period, have resulted in the weathering of rocks. The process was further helped by man by his improvident methods of exploitation of the environment.

This desert is potentially fertile but this vast tract of the land is lying barren and waste only due to scarcity of water. Since water is a major limiting factor for development.of the area, itt is natural to presume that such area would cease to be a problem if water could be brought in to it for irrigation and domestic use. The construction of Indira Gandhi Canal is an attempt to develop hitherto neglected regian. It is really a sight

to see the life giving water being lifted at pumping stations and flowing through such inhospitable desert, whose inhabitants, for generations have accepted scarcity and famine as their mode of living.

1.1 INDIRA GANDHI CANAL PROJECT

The Indira Gandhi Canal Project, earlier known as Rajasthan Canal Project has its Origin in Indus Water Treaty of 1947, which established the division of the Indus Water between India and Pakistan. Subsequently division of Indian share between participating states in 1955 allocated 9,900 million-cubic meters of water annually to Rajasthan. Survey was first conducted by central water commission in 1951; followed by a detailed survey by Rajasthan Govt. The formal inaugration of the project was done on March the 31st, 1958 by Late Govind Ballabh Pant, the then home minister of India.

The Canal takes off from the Harrike Barrage constructed at the confluence of river Bease and Sutlej in Punjab state. The total length of the Canal is 649 Kms. first 204 Km is called the feeder canal and water is not drawn from this portion of the canal. The remaining 445 Km length is called main canal. The main canal project is divided into two stages. Stage I includes 189 Km. long main canal with its distribution system of 3000 Km.

CANAL IRRIGATION SYSTEM

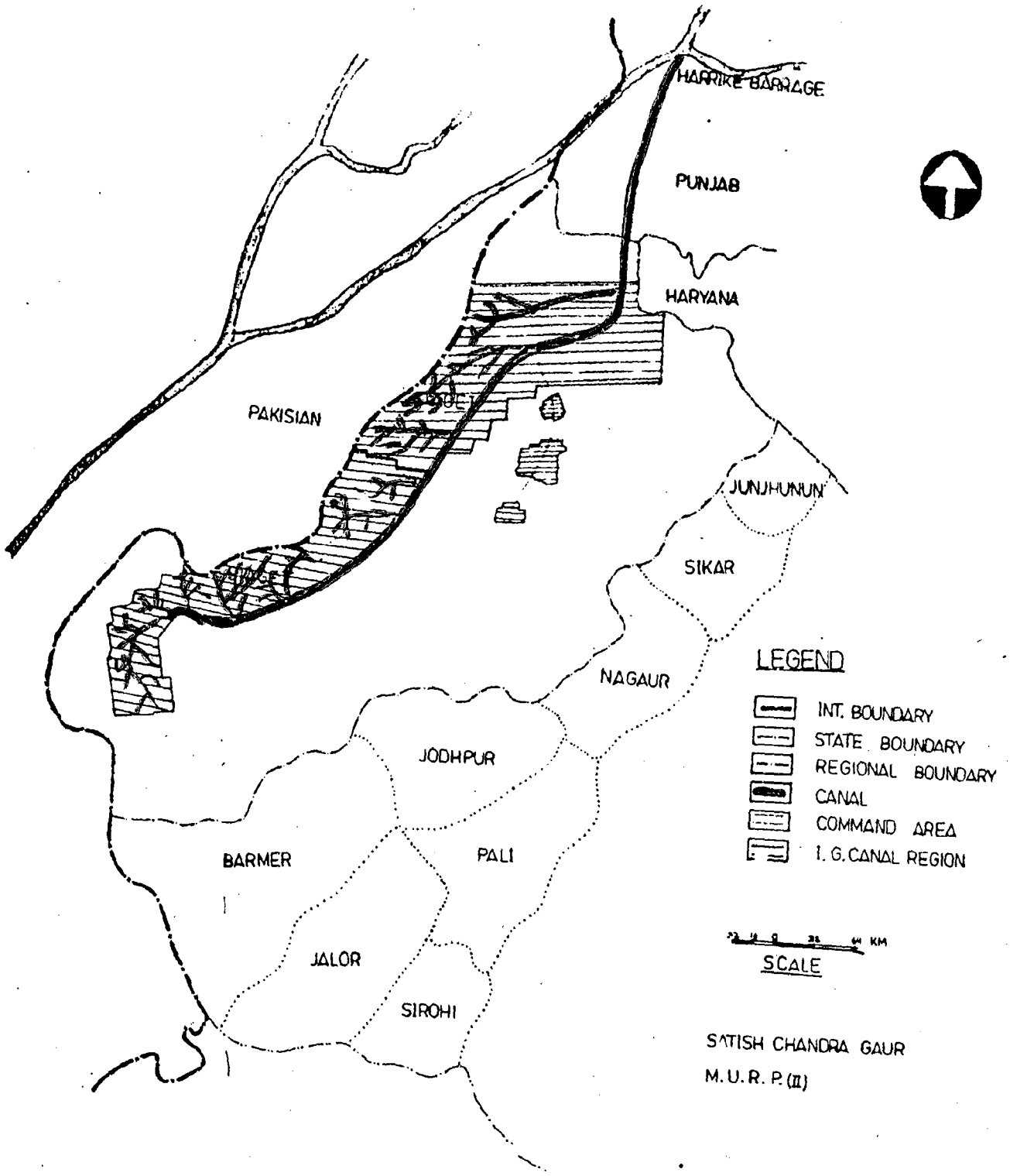

FIG.1

Stage II consists of main canal from 184 Km to its end with 4000 Km of branches and distributaries. The cultivable area in stageI and stage II is 5.4 lakh ha. and 6.1 lakh ha. respectively. The construction of the main canal was completed on 31st Dec., 1986. The distribution system on stage I has already been completed and that on stage II is under the way. The 1958 estimate of the project was of the tune of Rs. 664.6 million but due to increased scope of the project and price escalation, the cost of the project is going on increasing. Till the end of 1986 the total investments on project was Rs. 5850 million, and Rs. 1000 million more is needed to complete the work.

1.2 DELINEATION OF INDIRA GANDHI CANAL REGION

The region has already been delineated by the Rajasthan State Town Planning Dept. The region delineated for the exercise of planning function must have sufficient geographic, economic and social units to permit effective common foresight and policy in handling the important problems of the region. Such an area must have a diversified and complementary resource base to facilitate integrated development.

The canal command area has its distinctiveness due to canal irrigation and the associated crop economy.

TABLE 1

INDIRA GANDHI CANAL REGION

Administrative Unit	Population (1981)	Area (Sq.Km.)
Distt.Ganganagar	20,29,968	20,634
Distt.Bikaner	8,48,749	27,244
Distt.Jaisalmer	2,43,082	38,401
Distt.Churu	11,79,466	16,830
Distt.Nagaur		
(a) Nagaur Tehsil	2,74,281	4,661
(b) Jayal Tehsil	1,21,548	2,056
Distt.Jodhpur		
(a) Phalodi Tehsil	2,55,395	7,524
TOTAL	49,52,489	11,73,350

Source : District Census Handbook (1981) of District Ganganagar, Bikaner, Jaisalmer, Churu, Nagaur and Jodhpur.

If the planning is confined to the irrigated area only, then the development will take place in linear fashion which is not economical and good from planning point of view. Moreover, the canal tract is free from minerals and other natural resources, which can contribute to diversified economic base. Important minerals like gypsum, lignite lime stone, fuller's earth etc. occur on periphery of canal tracts. Other factors influencing the delineation of the region are:-

(i) Entire Western Rajasthan is a desert, of which canal tract covers only 1/10th part. Therefore some part of this desert to which the benefits of the canal could be extended conveniently are taken in the region so that the maximum possible area of the desert is reclaimed and put to productive use.

(ii) The areas where the geographic conditions are same have common problems of development. Thus, the areas where climate and other natural conditions are found as same have been included in the region.

(iii) While delineating the region it has been taken care of that two widely different groups are not brought together. Homogeneity in them would make the development more convenient.

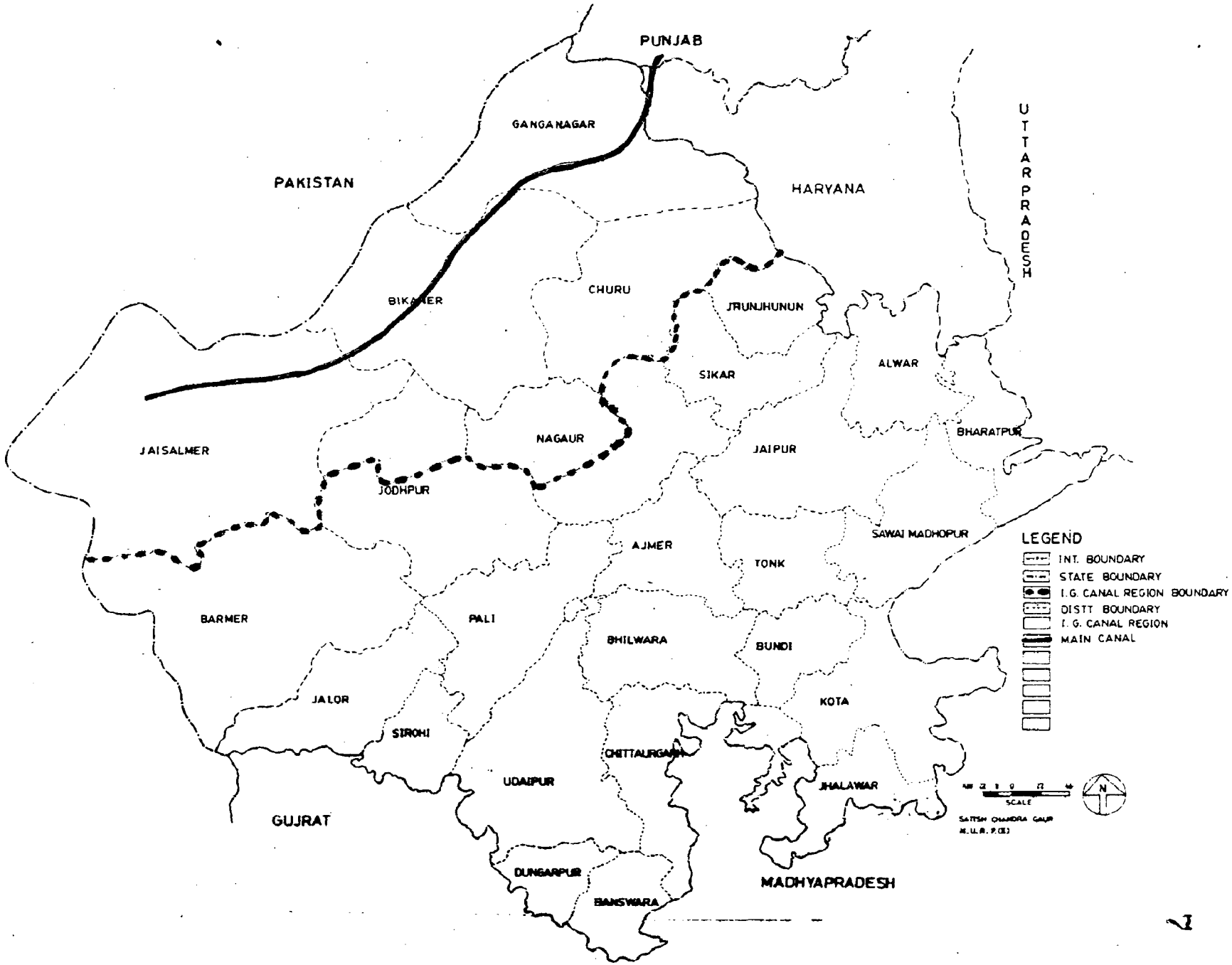
PUNJAB
GANGANAGAR
PAKISTAN
HARYANA
UTTARPRADESH
BIKANER
CHURU
JHUNJHUNUN
SIKAR
ALWAR
NAGAUR
JAISALMER
JODHPUR
JAIPUR
BHARATPUR
SAWAI MADHOPUR
AJMER
TONK
BARMER
PALI
BHILWARA
BUNDI
JALOR
SIROHI
KOTA
CHITTAURGARH
UDAIPUR
JHALAWAR
GUJRAT
DUNGARPUR
BANSWARA
MADHYAPRADESH
LEGEND
INT. BOUNDARY
STATE BOUNDARY
I.G. CANAL REGION BOUNDARY
DISTT BOUNDARY
I. G. CANAL REGION
MAIN CANAL
SCALE
SATISH CHANDRA GAUR

FIG. 2

AREA UNDER STUDY

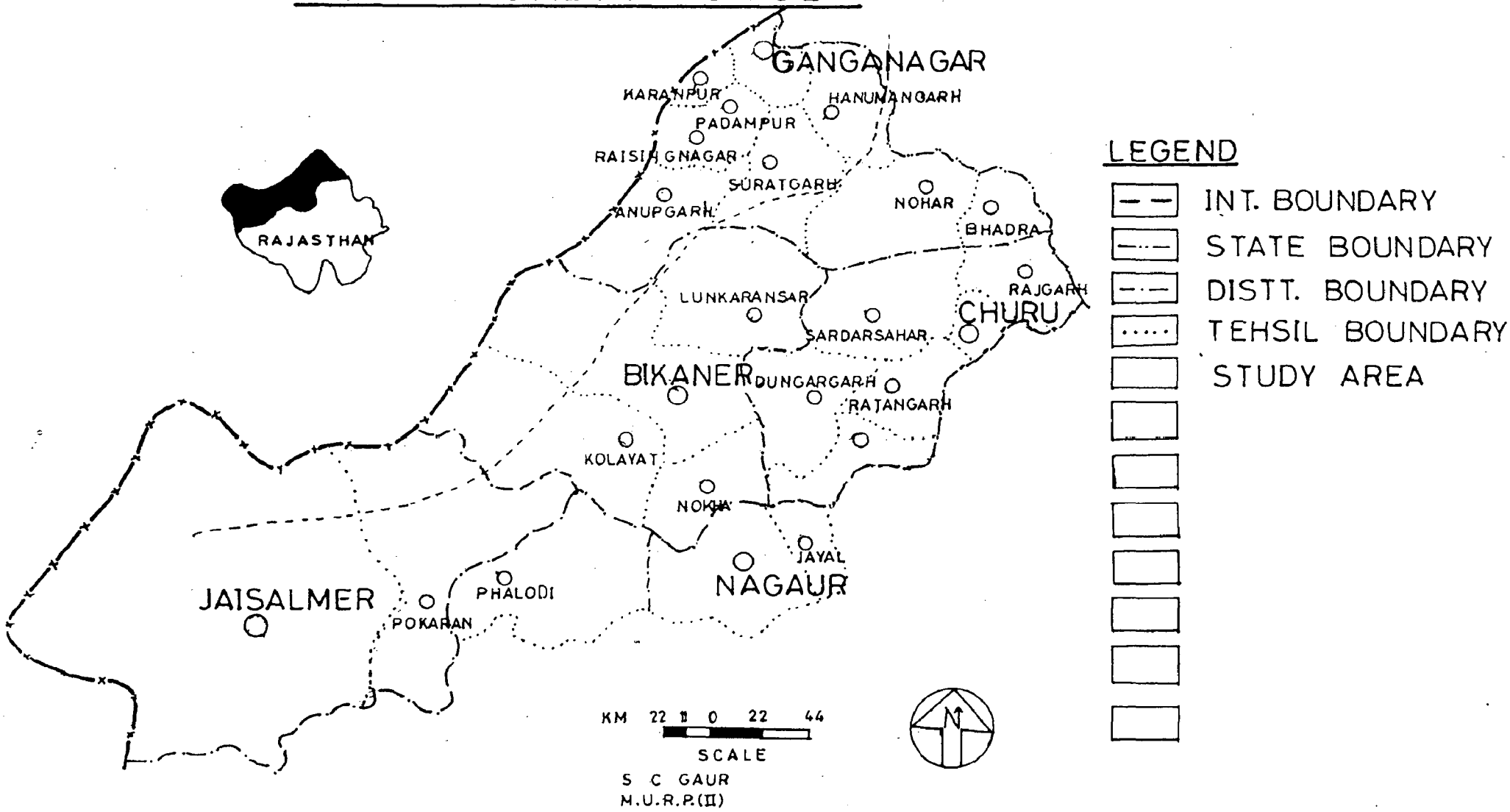

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FIG. 3

(iv) Areas influenced by the central force like Delhi, Jaipur, Narbada Valley etc. are excluded from the region.

(v) While demarcating the region it also has been seen that how best the existing administrative system is used without bringing much changes in it. Thus, the international border with Pakistan and border with Punjab and Haryana become firm western and northern boundaries of the region. The eastern and southern boundaries of the region are formed by district and tehsil boundaries. The smallest administrative unit in the region in kept as a tehsil.

On the basis of the criterian mentioned above, the regian has been delineated and includes four complete districts namely Ganganagar, Bikaner, Churu and Jaisalmer, and parts of Jodhpur and Nagaur districts. (Refer Table 1)

1.3 OBJECTIVE AND SCOPE OF THE STUDY

Indira Gandhi Canal project is one of the pioneering projects in the world, involving huge expenditure but with high expectations to come. The economically backward state like Rajasthan has devoted Rs. 50 Crores in the

outlay of 1986-87 budget which is 8.67% of the total outlay. This contribution could be made only at the cost of other important programmes. Therefore, in order to obtain optimum results from the project a cautious and comprehensive planning approach is necessary. For proper utilization of the resources, mass scale human settlements are required and it is a must to give attention to the location of settlements, their size and interlinkages.

Author is a resident of the region and has faced such problems. It is his personal experience which tempted him to take up this study. The study aims to evaluate positive and negative potential of the region, the capacity of the potential to absorb population and their spatial disposition. Moreover, the activities in Indira Gandhi Canal region in last few decades will be analysed and attempt would be made to identify the salient problems of the region in respect of the physical, climatic, economic and demographic characteristics. The study also intends to find out existing settlement hierarchy in the region, because in absence of preplanned settlement hierarchy it would be difficult to decide about the amenities and facilities to be provided in each settlement, as each settlement has its respective claim for various facilities. After analysing the existing conditions

author aims to give proposal for hierarchy of settlements in irrigated area and industrial development on the basis of indigeneous resources. And finally general suggestion and directives for the development of the region.

1.4 LIMITATIONS

Indira Gandhi Canal region includes four complete districts, namely, Ganganagar, Bikaner, Jaisalmer and Churu and parts of two districts of Jodhpur and Nagaur. Due to limited time available the study is restricted to three districts, Ganganagar, Bikaner and Jaisalmer, which constitutes 70% of the total area. The study is mainly based on the secondary data collected from various Govt. departments. The contempleted hierarchy of settlements in irrigated area has only been applied to area under Pugal distribution system. The microclimate of the region has not been dealt with due to scarcity of the time.

CHAPTER 2. PHYSICAL AND CLIMATIC CHARACTERISTICS OF THE REGION

2.1 LOCATION

The Indira Gandhi Canal region is part of Western Rajasthan. It extents between latitude 27°N to 30°N and longitude 70°E to 75°E. The region consists of an area of about 11,7350 Sq. Km. To its north lies the state of Punjab and towards West it is bounded by Pakistan. District Jhunjhunun, Sikar, Nagaur, Jodhpur and Barmer forms eastern boundary of the region.

2.2 TOPOGRAPHY

The region has desert topography, fully covered with sand dunes and represents the most arid part of the country. The region, in general has a east-west slope of 1 in 500. The study of the behaviour of the sand dunes, the most common feature of the region will help in finding out the ways and means as to how best their existence in the area can be avoided or utilised for planning purposes. The types of sand dunes spread over the region can be categorized in to following three types:

(i) Longitudinal Sand Dunes
(ii) Barchands
(iii) Transverse Sand Dunes

TABLE 2

MEAN MONTHLY AND ANNUAL RAINFALL (Cm)

District	J	F	M	A	M	J	J	A	S	O	N	D	Av. Annual Rainfall	No. of rainy days per year
Ganganagar	.7	1.1	0.5	0.5	0.6	3.0	6.6	7.0	0.7	0.2	0.0	0.5	21.5	16
Bikaner	0.7	0.7	0.6	0.5	1.5	3.0	8.4	8.5	3.3	0.5	0.5	0.5	28.8	17
Jaisalmer	0.4	0.5	0.4	0.3	0.8	1.5	5.2	6.2	2.2	0.1	0.1	0.2	17.2	8

Source: Central Arid Zone Research Institute (CAZRI), Jodhpur.

EXTENT OF SAND DUNES

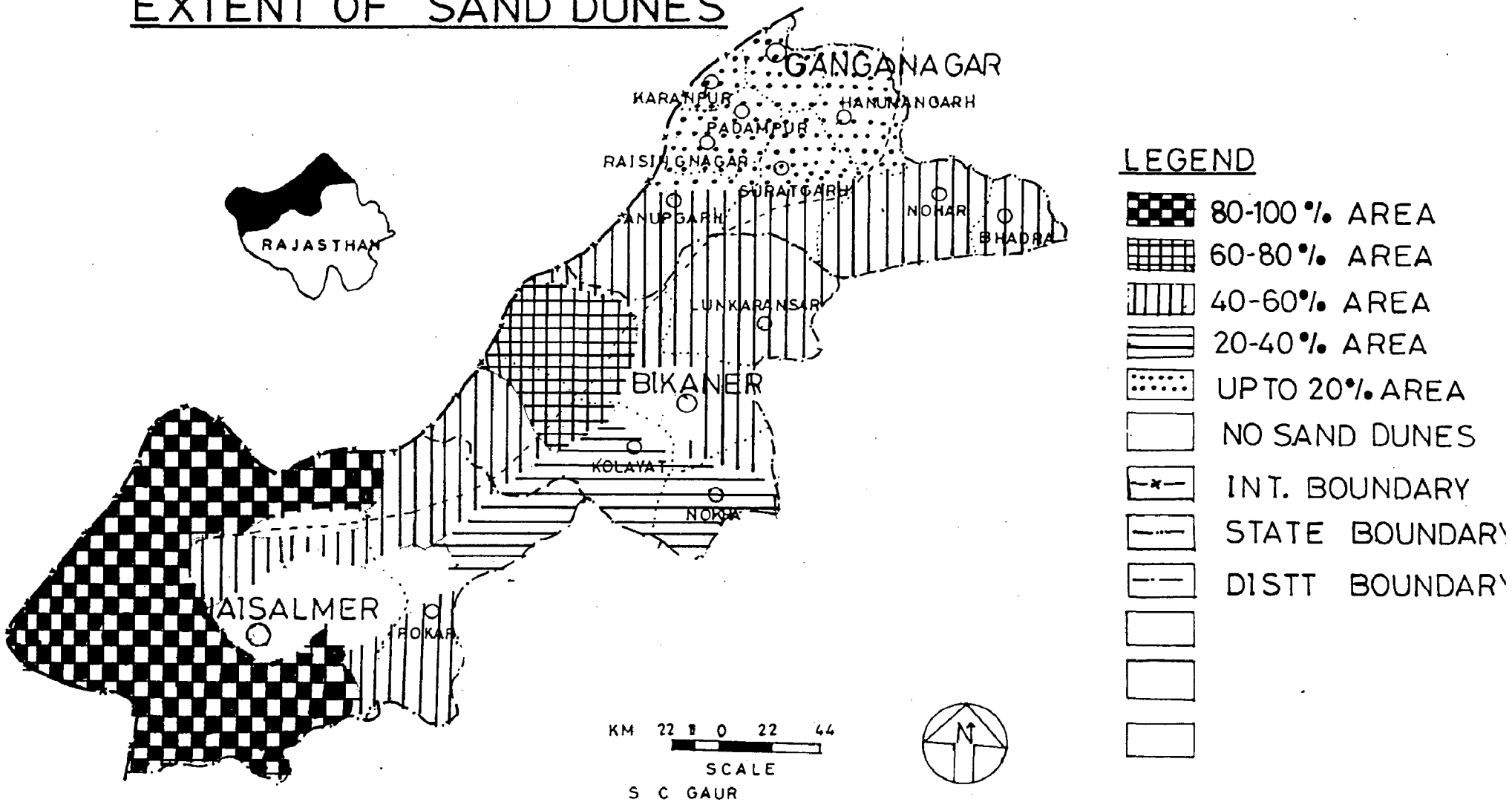


FIG. 4

The Longitudinal dunes run parallel to the prevailing wind direction (Prevailing wind direction in the region is South-West). In such dunes longer axis is parallel to the direction of the wind. The Barchands are crescent shaped dunes with their concave interior sides facing the wind direction. The transverse dunes are formed across the wind direction and longer axis is usually at right angles to the direction of the wind, The transverse sand dunes are stagnant in their formation, on the contrary, the longitudinal dunes are of shifting nature. The nature of shifting sand dune is very typical and they move along one and same direction in which they had been moving all the while in the past. Therefore longitudinal sand dunes are more dangerous and require more care.

2.3 RAINFALL

The average annual rainfall in the region is very low. It is 28.8 cm at Bikaner, 21.5 cm at Ganganagar and 17.2 cm at Jaisalmer. This is the lowest average annual rainfall received in any part of the country. The general trend of the isohytel lines is from north east to south-west. The main peak in the annual rainfall distribution is in July and August. These are Monsoon months of the year and nearly 90% of the rainfal

is received during this period. The number of rainy days receiving rainfall of 2.5 cm or more is least in Jaisalmer (8 days). This number increases from West to East and South to North. They are generally between 13 and 20 in the whole region. The heaviest rainfall ever recorded in a day has been 10 cm at Ganganagar and 14 cm at Bikaner. The possibility of agriculture on the basis of such a scanty rainfall is very gloomy. On an average, one famine year in every five years is common.

2.4 TEMPERATURE

The peculiarity of the climate of the region is extremes of temperature. There is remarkable seasonal and diurnal fluctuation in the average maximum and minimum temperature. The winter is quite cold and at many places temperature even falls below freezing point . The period from December to February constitutes the cold season.

The temperature starts rising by the middle of march and the hot season prevails during the period April to June. May is generally the hottest month of the year. The mean maximum temperature in May ranges from 40° to $44^{\circ}C$ through out the region and mean minimum temperature ranges from $24^{\circ}C$ to $27^{\circ}C$.

TABLE 3

MEAN MONTHLY MAXIMUM AND MINIMUM TEMPERATURE

District	Element	Temperature (°C)											
		J	F	M	A	M	J	J	A	S	O	N	D
Ganganagar	Maximum	20.4	20.5	30.3	36.4	41.0	42.7	38.6	37.4	36.4	34.5	29.5	23.8
	Minimum	6.4	9.1	14.2	19.6	24.4	28.9	28.4	27.3	24.9	18.3	11.2	7.4
Bikaner	Maximum	21.9	26.2	31.9	37.9	42.1	41.3	38.5	36.4	36.3	36.0	30.9	24.7
	Minimum	4.9	8.4	14.6	21.3	27.6	29.3	28.0	26.9	25.1	19.1	10.7	5.6
Jaisalmer	Maximum	21.2	26.5	35.3	39.6	43.0	38.8	37.0	36.8	36.9	32.0	30.7	24.3
	Minimum	5.8	9.6	18.0	23.5	25.1	26.1	26.3	26.2	23.9	18.9	19.9	7.6

Source: Central Arid Zone Research Institute (CAZRI), Jodhpur.

TABLE 4

MEAN MONTHLY RELATIVE HUMIDITY IN THE STUDY AREA

District	J	F	M	A	M	J	J	A	S	O	N	D
Ganganagar	83%	70%	63%	39%	33%	43%	64%	70%	69%	60%	63%	79%
Bikaner	65%	59%	43%	28%	32%	52%	66%	72%	68%	47%	45%	56%
Jaisalmer	57%	53%	44%	54%	61%	70%	63%	64%	57%	58%	59%	60%

Source: Central Arid Zone Research Institute (CAZRI), Jodhpur.

TABLE 5

MEAN WIND SPEED IN THE STUDY AREA

District	Unit	J	F	M	A	M	J	J	A	S	O	N	D
Ganganagar	Km.p.h.	3.1	3.8	5.1	5.1	5.7	8.6	7.8	6.1	4.8	3.3	2.5	2.3
Bikaner	Km.p.h.	4.8	5.8	6.8	7.6	10.1	12.1	11.3	10.1	8.7	6.1	4.0	4.0
Jaisalmer	Km.p.h.	8.6	8.2	10.9	12.7	18.3	27.2	24.8	21.7	16.1	8.5	5.5	6.5

Source: Central Arid Zone Research Institute (CAZRI), Jodhpur

The diurnal fluctuation in temperature is direct result of extreme radiation conditions which normally prevailing with low humidity and little cloudiners to interfere with either incoming or outgoing radiation. On account of dryness of atmosphere, clear skies and sandy nature of soil, the heat during day increases very much and there is radiation of heat from earth soon after sunset. Thus, temperature starts falling immediately after sunset.

The table 3 shows the average monthly maximum and minimum temperature in Ganganagar, Bikaner and Jaisalmer.

2.5 HUMIDITY

Humidity is very low through out the region, except during and shortly after the period of rainy weather. The relative humidity is minimum during summer, lowest being in April. Relative humidity during Mansoon mouths is maximum, being highest in August which is the rainiest month. There is a remarkable seasonal variation in the humidity. When all other parts experience a low humidity during dry winter months Ganganagar shows slightly higher humidity. This is due to the irrigation facilities available there. (Refer Table 4)

2.6 WIND

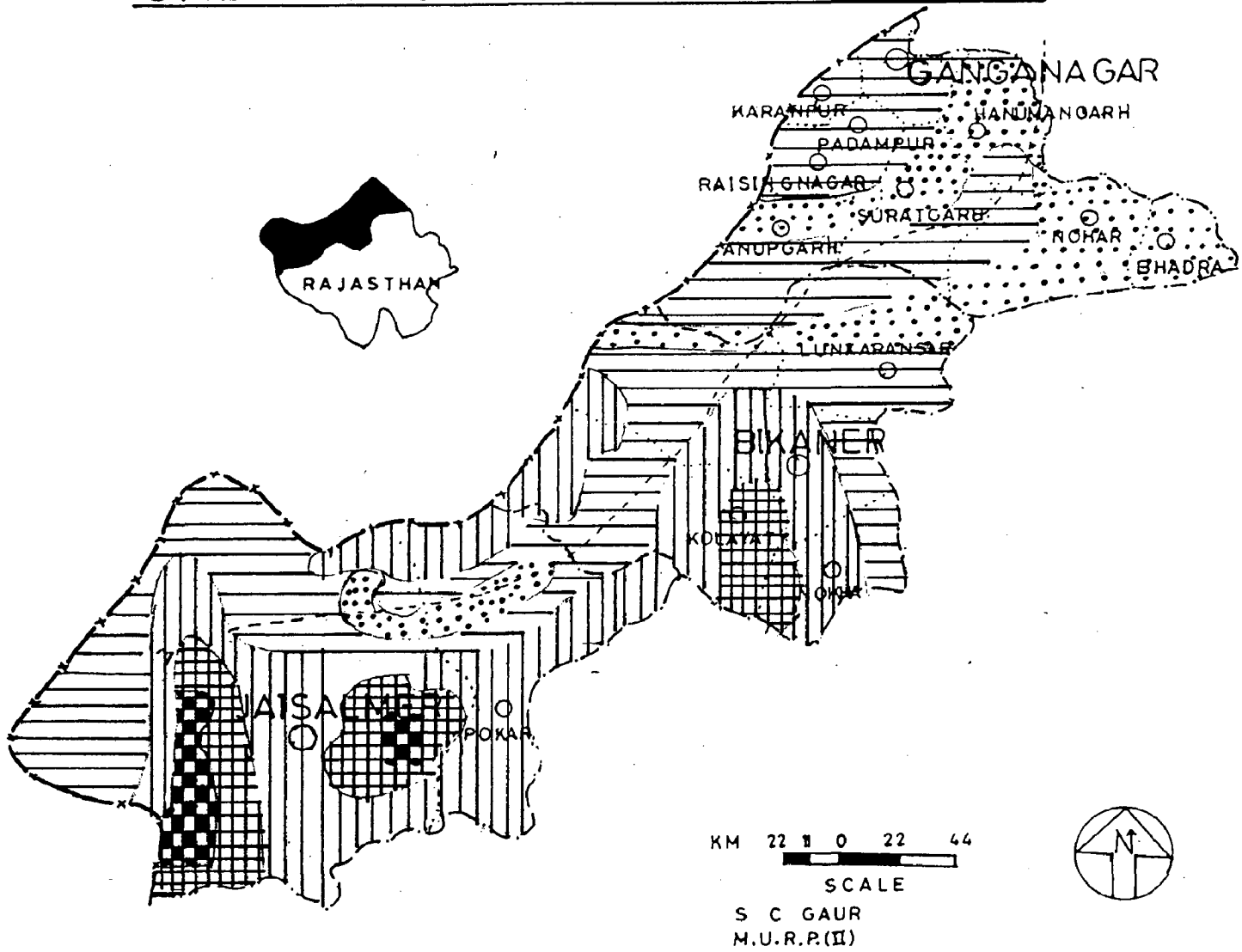
The general wind direction in the region is south west. The wind speed is highest in Jaisalmer and decreases towards north. Dust storms are very common during summer season, when hot wind prevails over the region. Maximum number of dust storms occur in June. These sand storms are more severe and common in north (Ganganagar) than in south. The dust raising winds blow from south-west and south all over the region during summer. The speed of wind is found to be 20 to 30 K.M.P.H. During winter, the winds are generally light, north-easterly and northerly winds are more frequent than those from other directions. (Refer Table 5)

Sand storms and high speed winds make the life of the inhabitants of the region miserable. The study of wind speed and direction is usefull in deciding street orientation and housing pattern to reduce the effect of storms.

2.7 GROUND WATER RESOURCE

The Indira Gandhi Canal region seriously suffers from varied problems associated with the scarce supply of water. The severity of the problem obviously increases with increasing aridity and is at its peak in the districts

UNDERGROUND WATER DEPTH



LEGEND

- 15-30 M. DEEP
- 31-60 M DEEP
- 61-90 M DEEP
- 91-120 M DEEP
- > 120 M DEEP
- INT. BOUNDARY
- STATE BOUNDAR'
- DISTT BOUNDAR

FIG. 5

POTENTIAL SWEET WATER AREA

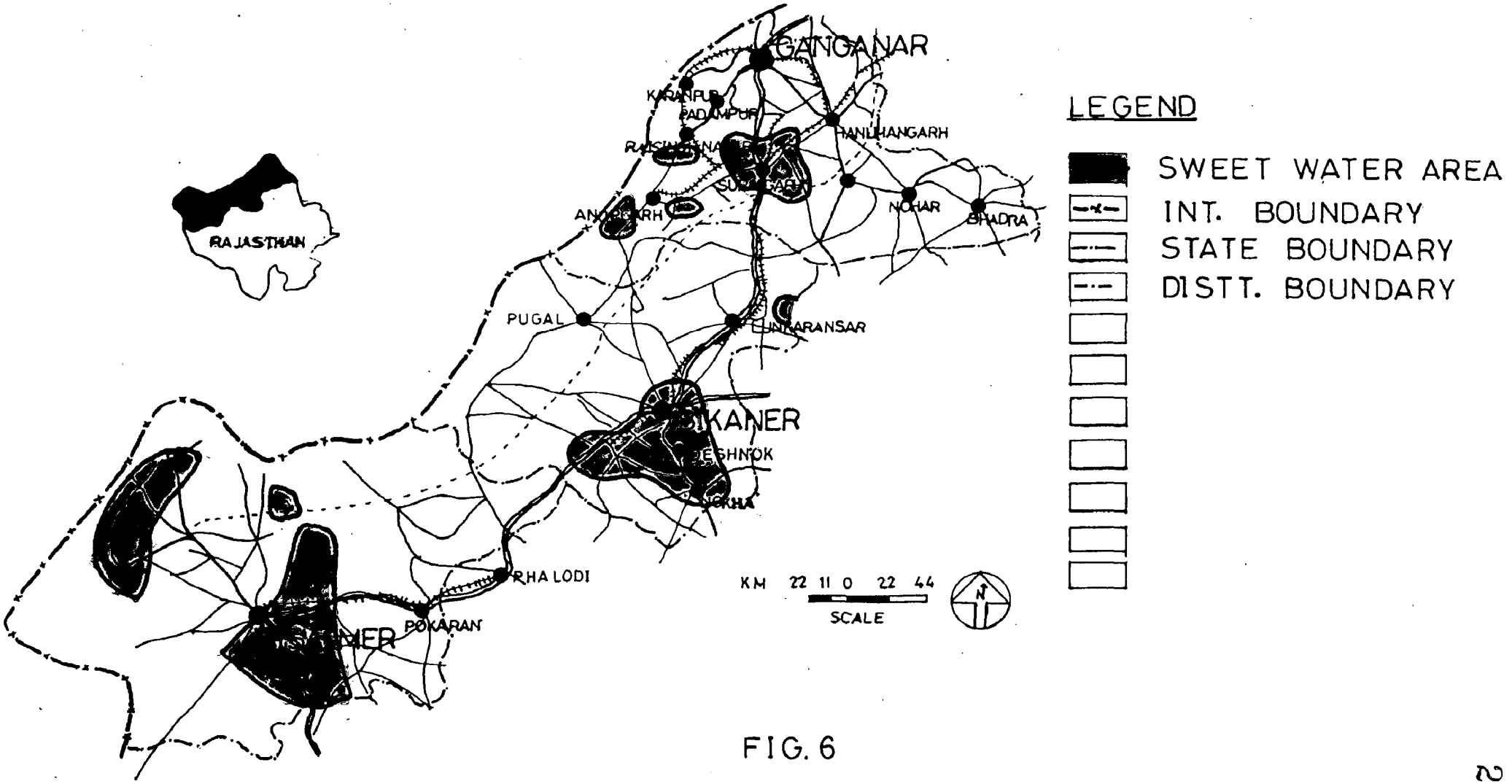


FIG. 6

of Bikaner and Jaisalmer. Under such severe conditions water is a very dear thing. During old days human settlements clustered around a well or a tank which used to provide drinking water to the inhabitants. This explains, why the name of the most of villages in the region ends with 'Sar', meaning presence of a tank or a well.

The underground water table in the region is very deep and discharge is small. The fig. 5 shows the depth of water table in the study area, the depth varies from 20M to 120M. For qualitative analysis of the under ground water, Central Arid Zone Research Institute has tested water samples of 162 wells which shows total soluble solid varies upto 180 ppm in 2.5% samples, 180-1500 ppm in 32.1% samples, 1500-3200 ppm in 30.8% samples, 3200-5000 ppm in 22.2% samples and 5000-7000 ppm in 10.5% samples. According to W.H.O. permissible total soluble solids in drinking water in 500 ppm but water containing total soluble solids more than 1500 ppm can not be used for drinking purpose. Therefore, only 34.6% of the total water is suitable for drinking purpose. The location of areas having potential sweet water has been shown in fig. 6.

CHAPTER 3. SOCIO-ECONOMIC CHARACTERISTICS OF THE REGION

The ultimate aim of planning, whether socio-economic or physical, is welfare of the community. If community welfare is to be achieved through planning activity, it becomes imperative to have as much knowledge of socio-economic structure of community as possible.

3.1 POPULATION GROWTH

There had been sharp increase in population in three districts under study in the period 1921-81. The table 6 shows that the rate of growth of population, in Ganganagar, Bikaner and Jaisalmer is much faster than that of India and Rajasthan. The year 1921 is known as 'Big Divide' because prior to this the population of districts, state and country increased slowly but after this period it has increased rapidly. The main cause of rapid growth of population for India and Rajasthan is decline in death rate and not an increase in birth rate. The higher rate of growth of population in the study area is mostly due to imigration to the canal irrigated area.

TABLE 6

DECINNIAL GROWTH OF POPULATION IN THE STUDY AREA, RAJASTHAN AND INDIA

Census Year	Percentage Decadal Variation				
	Ganganagar	Bikaner	Jaisalmer	Rajasthan	India
1911	+ 43.66	+ 8.57	+115.37	+ 6.7	+ 5.75
1921	- 17.21	- 3.93	- 20.58	- 6.3	- 0.31
1931	+102.49	+ 18.24	+ 13.61	+ 14.1	+ 11.00
1941	+ 54.58	+ 34.29	+ 23.28	+ 18.0	+ 14.22
1951	+ 18.01	+ 8.77	+ 13.10	+ 15.2	+ 13.31
1961	+ 64.64	+ 29.56	+ 28.80	+ 26.2	+ 21.51
1971	+ 34.37	+ 28.94	+ 18.82	+ 27.83	+ 24.80
1981	+ 45.62	+ 48.09	+ 44.84	+ 32.97	+ 25.00

Source : i) District Census Handbook (1981) of District Ganganagar, Bikaner and Jaisalmer
ii) Census of Rajasthan (1981), Series-18.
iii) Census of India (1981), Series-1, Part II.

TABLE 7

URBAN-RURAL DISTRIBUTION IN STUDY AREA AND RAJASTHAN (1981 CENSUS).

District/State	Population			Percentage of Urban Population
	Total	Rural	Urban	
Ganganagar	2,029,968	1,611,669	418,299	20.6 %
Bikaner	848,749	513,664	335,085	39.5 %
Jaisalmer	2,43,082	210,155	32,927	13.55%
Rajasthan	34,261,862	27,051,354	7,210,508	21 %

Source: (i) District census Hand book(1981) of District Ganganagar,Bikaner and Jaisalmer.

(ii) Census of Rajasthan,Series 18(1981)

3.2 URBAN-RURAL DISTRIBUTION

The study of rural-urban distribution is helpful from the point of view of assessing the degree of urbanization and economic development that has taken place in the region or any particular area.

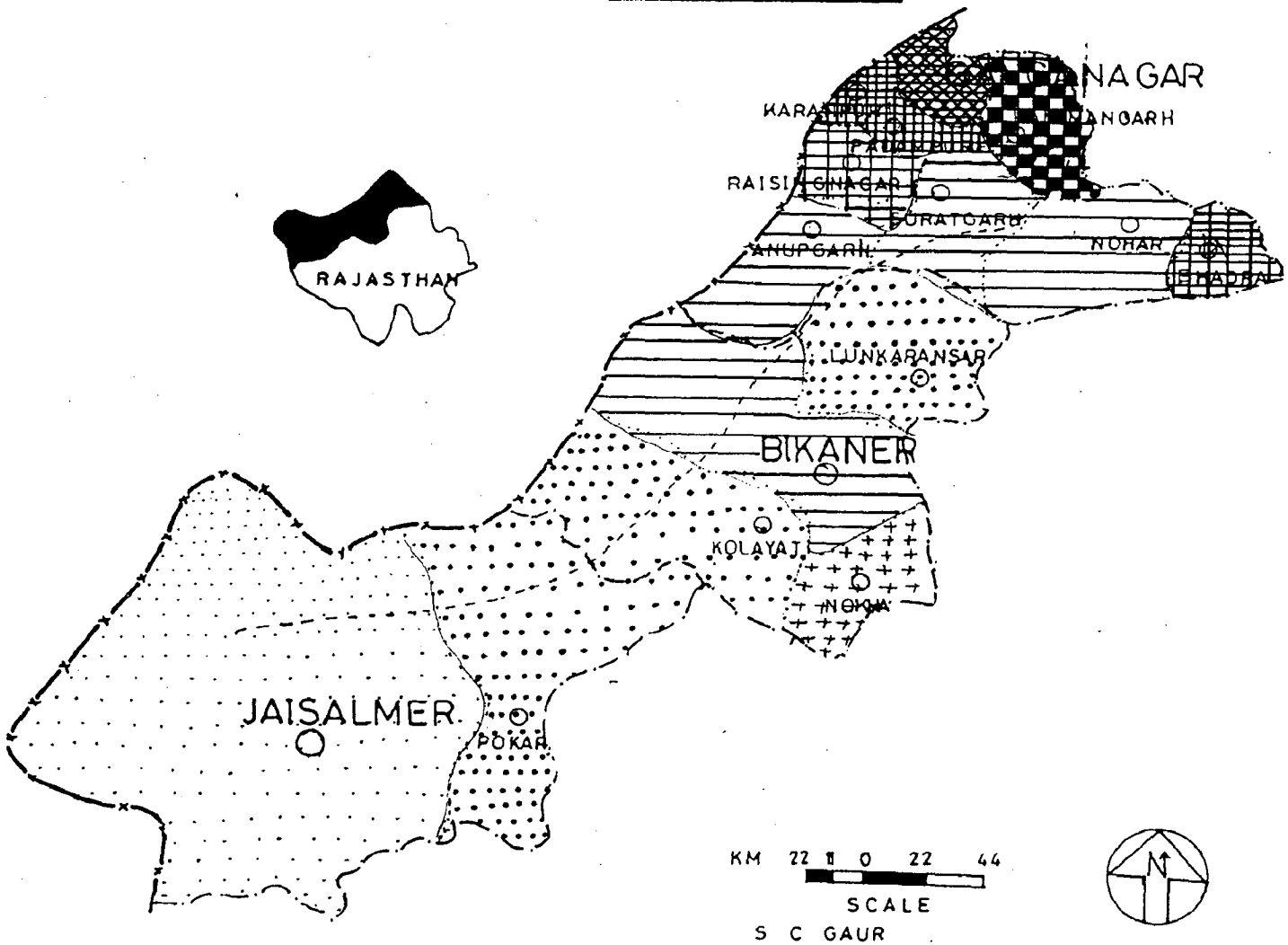
The percentage of urban population in Ganganagar, Bikaner and Jaisalmer is 20.6% , 39.5% and 13.55% respectively. The percentage of urban population in Bikaner district is higher than that of Rajasthan (21%). However, the distribution of urban population is not uniform, out of 3,35,885 persons living in urban area 2,87,712 persons (85%) are concentrated at Bikaner only. In Bikaner district, barring Bikaner, there is no other town having population more than 25000 persons.

In Ganganagar district, although there are sixteen urban centres but distribution of urban population is not uniform. Except Hanumangarh (60,071 persons) and Ganganagar (1,23,692), no other town has population more than 50,000 Jaisalmer is predominantly rural in character, there being only two urban centres, Jaisalmer and Pokaran with population 22,041 and 10,886 persons respectively. (Refer Table 7)

3.3 POPULATION DENSITY

The pressure of population on land is always the

POPULATION DENSITY



LEGEND

- ABOVE 200 P.P.S.K.
- 150-200 P.P.S.K.
- 100-150 P.P.S.K.
- 75-100 P.P.S.K.
- 50-75 P.P.S.K.
- 20-50 P.P.S.K.
- 5-20 P.P.S.K.
- BELOW 5 P.P.S.K.
- INT BOUNDARY
- STATE BOUNDAR
- DISTT BOUNDAR

P.P.S.K.: PERSONS PER SQ. KM.

FIG. 7

crux of the problem for the planners. The density data are needed not only for planning balanced population distribution but also for achieving maximum economy in space.

The Indira Gandhi Canal region being situated in extreme western desert area of the country, has the lowest population density in the country. The population density in the region varies from 4 persons per Sq.Km. in Jaisalmer Tehsil to 282 persons per Sq.Km. in Ganganagar Tehsil. The fig. 7 shows the population density in the various parts of the study area. The density which is lowest in the south-western part of the region (Jaisalmer district) shows a gradual trend of increase towards north and north-east. The density increases with increase in cultivated area. Ganganagar, due to its irrigation facilities, has maximum concentration of population.

3.4 OCCUPATIONAL STRUCTURE

Economic condition of the people of any region depends to considerable extent on the type of occupation they have, because per capita out put varies considerably from one type of occupation to other. People who are engaged in manufacturing industries earn more than persons in agriculture.

In Indira Gandhi Canal region the most predominant occupation of its people is agriculture and

TABLE 8

PERCENTAGE OF MAIN WORKERS, MARGINAL WORKERS AND NONWORKERS

District	Main Worker(%)			Marginal Worker(%)			Nonworker (%)		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Ganganagar	29.48	52.76	2.85	3.59	0.48	7.16	66.93	46.76	89.99
Bikaner	29.31	50.18	5.9	3.77	0.72	7.2	66.92	49.10	86.90
Jaisalmer	32.09	55.04	3.8	4.22	1.19	7.96	63.69	43.77	88.24

(Source: District census Handbook (1981) of District Ganganagar, Bikaner, and Jaisalmer.

TABLE 9

PERCENTAGE DISTRIBUTION OF WORKING POPULATION BY ECONOMIC ACTIVITIES

District	Cultivators (%)		Agricultural (%) Labour		Household (%) Industry		Other Workers (%)	
	Male	Female	Male	Female	Male	Female	Male	Female
Ganganagar	57.8	55.42	14.55	18.4	1.96	3.12	25.69	23.06
Bikaner	52.06	61.67	2.56	2.93	2.85	4.29	42.53	31.11
Jaisalmer	58.73	54.29	2.91	10.90	2.31	7.33	36.05	27.48

Source: District Census Hand Book (1981) of District Ganganagar, Bikaner and Jaisalmer

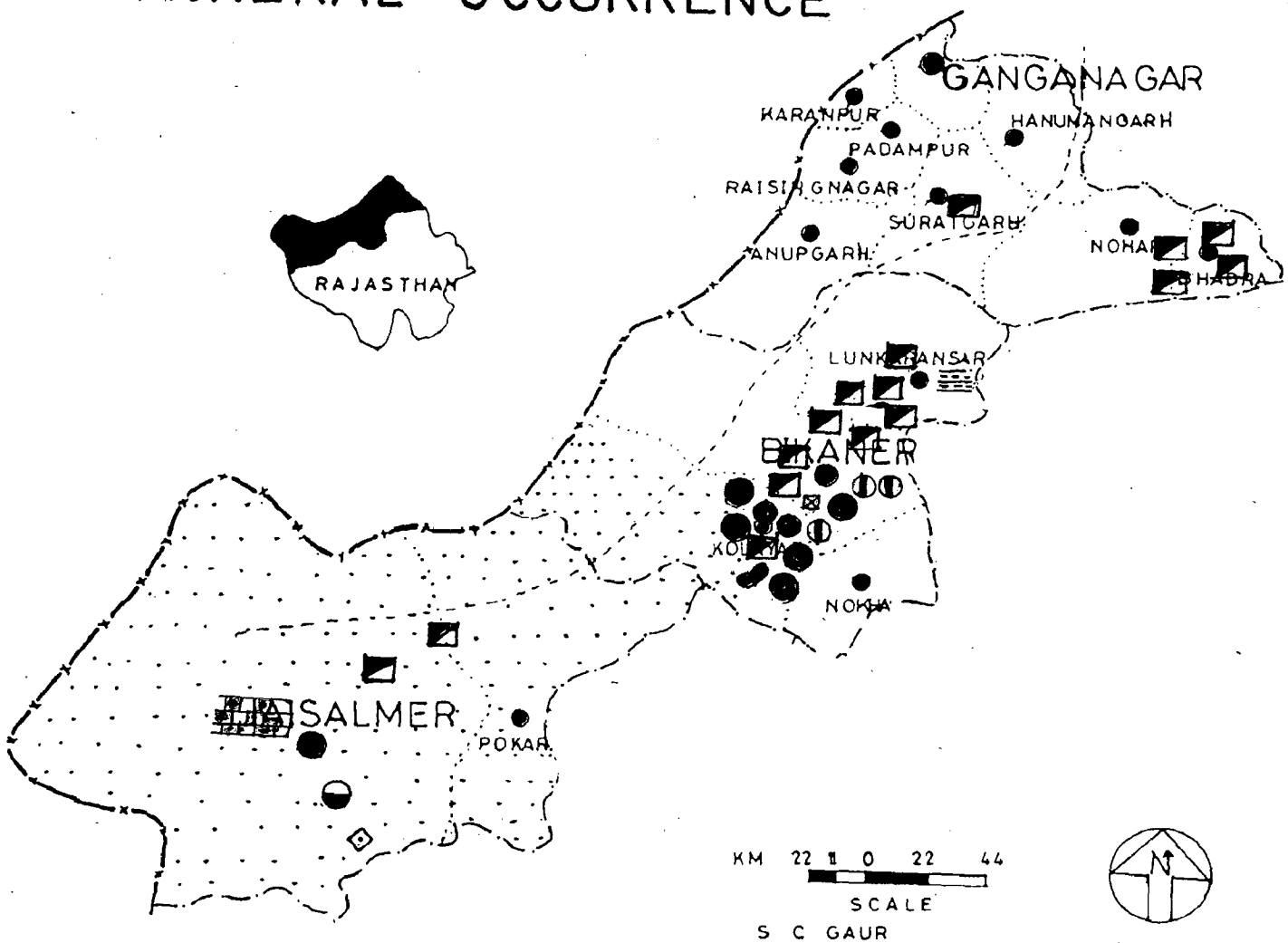
livestock rearing, inspite of the fact that the region has arid climate which makes cultivation of land a very difficult and precarious occupation. As shown in the table 8 the ratio between working and non working population is about 1:2. The marginal working population is very low, it is around 4% in all three districts. Out of the total working population, 57.8% males and 55.42% females in Ganganagar district, 52.06% modes and 61.67% females in Bikaner district, and 58.73% males and 54.29% female in Jaisalmer district are cultivators.(Refer table 9).

Livestock rearing which is an important economic activity of the people of the region, has not been categorised separately in the district census Handbook. It has been grouped with other-workers. But in practice, it is found that livestock rearing is sub-sidiary occupation to cultivation. Each farmer family, although categorised as cultivators, also earns their livelihood from livestock.

3.5 MINERAL RESOURCES

Next to Bihar, Rajasthan possesses the widest range of mineral deposits. However, inspite of widely diversified character of its mineral deposits, the

MINERAL OCCURRENCE



LEGEND

- GYPSUM
- SOAP STONE
- LIGNITE
- CLAY
- FULLER'S EARTH
- SAND STONE (RED)
- SAND STONE
- BANTONITE
- PHOSPORITE
- GLASS SAND
- PETROLEUM EXPLO TION

FIG. 8

state does not emerge as an important mineral producing area. It is due to the absence of basic minerals like coal and iron. The Indira Gandhi Canal region is also rich in mineral deposits of nonferous and non mettallic type, but most of the deposits are still unexploited. There is great possibility of occurrence of petroleum in the Jaisalmer area where gas has already been found. The fig. 8 shows the location of occurrence of various minerals.

The wide range of minerals found in the region are described in the following paragraphs:

(a) Gypsum: Out of the total estimated reserve of 468 million tonnes in the country, about 384 million tonnes are found in Indira Gandhi Canal region. The location of the occurrence of Gypsum is shown in fig. 8 . The gypsum is of good quality and contains gypsum equivalent ranging from 85.9 to 99.4 percent. Gypsum has varied industrial use , it could be used for manufacture of cement, fertiliser, and plaster of paris etc.

(b) Lignite: Occurrence of lignite have been reported at Palana, Khari, Channeri and Ganga-sarowar in Bikaner district. Of these, the deposits at Palana which is situated 20 Km South-West of Bikaner city is most important.

The reserves of lignite at this place are estimated as 28.43 million tonnes.

(c) Fuller's Earth: The deposits of fuller's earth are found in the districts of Bikaner and Jaisalmer. Total reserves are estimated as 85 million tonnes. It is mainly used for the purification of the vegetable oils.

(d) White Clay: Deposits of white clay are found at Modh, Kothi, Kolayatji and Raneri in Bikaner district. The reserves are estimated about 6 million tonnes. This clay is suitable for making high grade porcelain wares, crockery, lowtension insulation etc.

(e) Glass Sand: Deposits of glass sand are found about 5 Km from Kolayatji in Bikaner district. The total reserves are estimated of the order of 14 million tonnes. This mineral could be utilised for manufacture of glass ware and sodium sillicate.

(f) Sand Stone: Red stone of Dulmera in Bikaner district and yellow sand stones of Jaisalmer are very famous as unique building stone. The amount of reserves are not known.

(g) Bentonite: Deposits of bentonite are found near Bikaner andJaisalmer. Bentonite is used in drilling mud mixtures, purification of vegetable oils and as a filler material.

3.6 INDUSTRIAL DEVELOPMENT

Barring two Agrobased industries (Sugar and Textile industry) at Ganganagar and one woolen industry at Bikaner, no largescale industry have come up, inspite of the fact that region is rich in mineral and livestock resources. Inadequate development of transportation and communication facilities, lack of full knowledge about local resources absence of water and cheap power, and nonavailability of skilled labour are main impediment on the way to industrial development in the region.

3.6.1 Existing Industries

(a) Sugar Factory: There is one sugar factory at Ganganagar with a crushing capacity of 1000 tonnes of sugarcane per day. The unit employs 1200 workers during the busy season and 400 workers in off season. It is producing 40,000 quintals of sugar per annum. The entire quantity of mollasses available as byproduct is utilised by distillery

6

attached to it. Distillery manufactures wine, syrups and vinegar.

(b) Cotton Textile Industry: Another large scale industry of the region is cotton textile industry at Ganganagar. It is equipped with 15,296 spindles and 380 loams. The unit provides employment to 1350 workers and produces 125 lakh metres of cloth and 18.82 lakh kilograms of cotton yarn per year.

(c) Woollen Industry: Ten years back one state woollen mill was opened at Bikaner. Raw material for this industry is available in abundance. This mill engages 500 persons and presently its main production is wool yarn.

(d) Small Scale and Cottage Industries: Small scale and cottage industries provide large scale employment and require less capital, they offer an effective method to ensure more equitable distribution of national income and mobilize resources which would otherwise remain unutilised. In Indira Gandhi Canal region the small scale industries of modern type are poorly developed. The industrial structure is dominated by traditional cottage industries the modern industries operated by power are almost insignificant. Most of the small scale industries are based on the locally available resources.

CHAPTER 4. IMPACT OF THE CANAL ON THE REGION

The paucity of water was a major impediment on the way to development of the region. Now with the advent of Indira Gandhi Canal a number of primary and secondary activities could be possible. A prosperous economy is likely to emerge in the region. In other words, the canal will truly transform the desert from its present sandy dry land in to fertile stretch humming with life and activities.

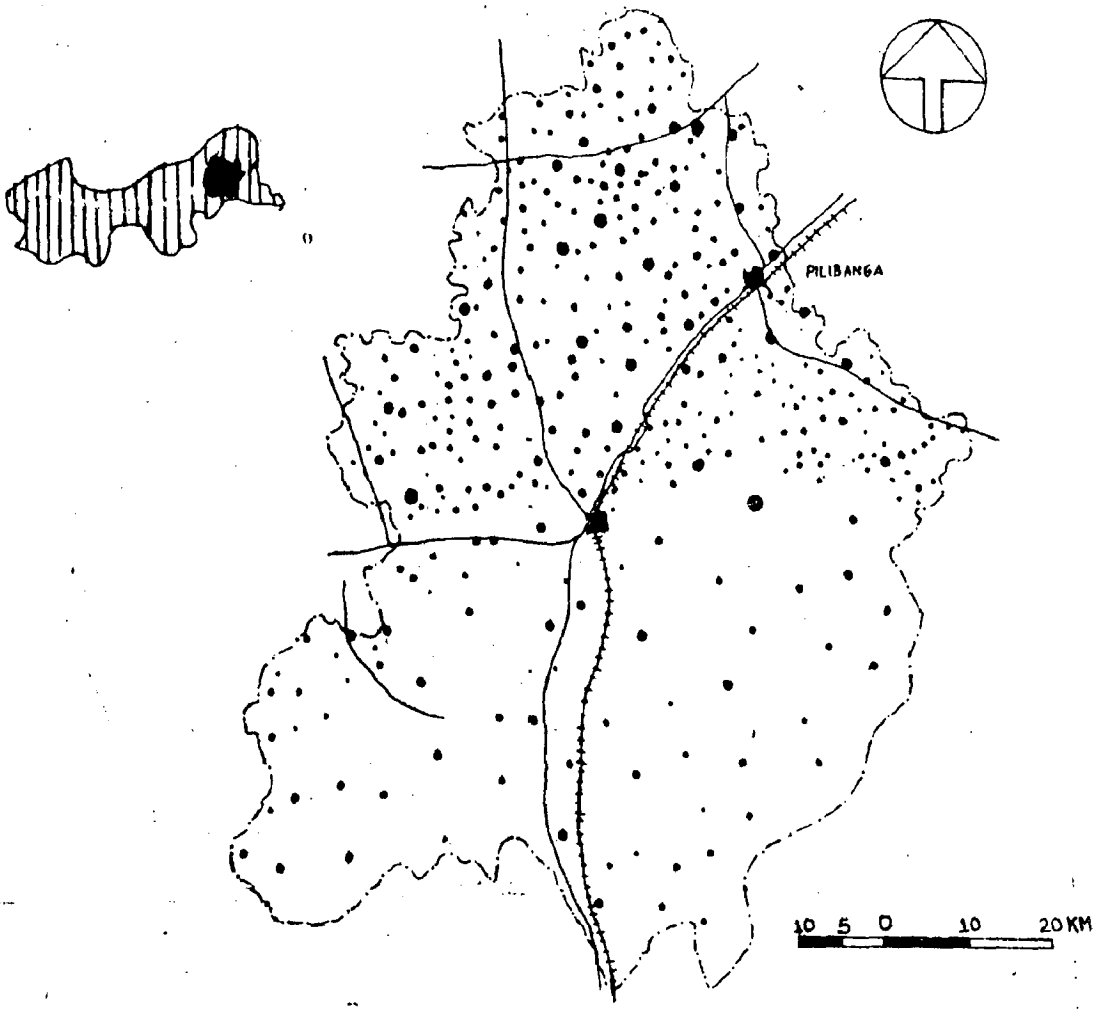
4.1 DENSITY OF POPULATION

Ever since the begining of human civilization, most of the settlements have come up,and flourished along the water bodies. Because at such places food, water and transportation were at hand. Same impact could be seen in Indira Gandhi Canal region. The density of the settlements as well as density of the population is higher in the irrigated area of the region as compared to unirrigated area. This impact is shown on Suratgarh tehsil of Ganganagar district. (Refer fig.9)

4.2 INTENSIVE CULTIVATION

The table 10 shows the year wise production and area under cultivation from 1974 to 1985. The area

IMPACT OF THE CANAL ON SETTLEMENTS IN SURATGARH TEHSIL



IRRIGATED AREA

CANAL REGION

RURAL SETTLEMENTS

UPTO 199

200 - 499

500 - 999

1000 - 1999

2000 - 4999

5000 & above

FIG. 9

TABLE.10

YEAR WISE PRODUCTION AND AREA UNDER CULTIVATION IN THE CANAL COMMAND AREA

Area in hectare
Production in M.Tonnes

Sl. No.	Year	Wheat		Gram		Mustard		Cotton		Paddy		Ground nut	
		Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
1.	1974-75	49973	63515	66733	49115	32947	20489	23090	-	6655	-	-	-
2.	1975-76	68082	97493	69608	64526	19129	7069	33304	-	7716	21219	-	-
3.	1976-77	70911	113014	68906	66976	14639	9969	32627	29039	7887	23558	-	-
4.	1977-78	75442	124882	62687	65069	32232	22111	50645	50138	7633	21891	-	-
5.	1978-79	82567	151923	72555	76908	27517	22288	58068	65849	8025	26899	933	-
6.	1979-80	81862	149398	84834	69394	27354	18518	71600	82340	8513	33124	738	1307
7.	1980-81	64417	117561	93021	76277	28617	17743	68579	71390	6879	13840	1111	1777
8.	1981-82	88880	215356	99402	70575	29584	27938	79597	80791	6131	20502	1060	1553
9.	1982-83	108564	258382	79452	67931	39533	38386	87790	99202	5476	20606	2168	3284
10.	1983-84	120044	225322	63599	41339	46693	49027	94960	86793	7149	30811	4883	8838
11.	1984-85	98642	131391	43626	26460	65486	68434	96292	102747	10301	41564	14059	25503

Source : Rajasthan Agriculture Department, Bikaner

where nothing grew till few decades ago has produced 131391 tonnes of wheat, 26460 tonnes of gram, 68434 tonnes of mustard and 102747 tonnes of cotton in the year 1984-85. The main crops in the region are wheat, gram, mustard in Rabi season, and paddy, cotton, jawar in kharif season. Cropping pattern has also been tremendously changed, it can be seen from the table that in Rabi season the area under wheat is decreasing, whear as that under mustard is increasing. Similarly area under cotton is increasing continuously. Besides this, some new crops like groundnut, which was non-existent before 1978, now the production is 25,503 tonnes and it is expected that it will increase in the comming years. This intensive cultivation is bringing prosperity in the region.

4.3 FLORA AND FAUNA

The flora of the region has tremendously changed after the introduction of the canal. There is a thick line of trees along main water channels and a large area is under double cropping pattern. At a regional landscape scale, the earth surface appears to be fully covered with green and colourful flora in the form of crops during the Rabi and Kharif season, particularly in the stage I area. It does not appear

AFFORESTATION

DUNE STABILIZATION

FIG. 10(a)

AGRICULTURAL FARM

FIG 10(b)

to be a desert area at all as it was in the past.

The fauna system of the region has also changed tremendously with the incoming of water in abundance. These days the fauna of the area includes wild life in the form of Chittal, Blue Bill, Jackal, Fox, Rabbit and birds of various types.

The changed flora at large in the region has helped in reduction in soil erosion by winds, reduction of the severness of the dust storm, improvement in the climate and enhancement of the aesthetics. The changed fauna has affected the region both in positive and negative sense. While they help in pollination and control of pests etc. on the other hand damage to crops is caused directely and through introduction of new diseases.

4.4 FISHERY AND FISH FARMING

The availability of water, both static and flowing provides opportunity for fishery. Water can be diverted from the canal and fish farming can be integrated with irrigated agriculture. This may give a new direction to the economy of the irrigated area. In 1985-86 the total fish production was 2.92 lac Kg and total money received from fishing tenders worth Rs. 28.67 lakh.

4.5 DESERT CONTROL (AFFORESTATION)

It is feared that the 'Thar Desert' is marching in to fertile land of Uttar Pradesh, Delhi, South Punjab and Haryana. Recent topographic surveys show that the great Indian desert of Rajasthan has been spreading outwards in a great convex arc through Ferozpur, Patiala and Agra towards Aligarh and Kashganj at the rate of 1/2 mile per year. The green belt that the Indira Gandhi Canal will raise in its command area will be an effective check to this process.

Shifting sand dunes are biggest menace for the inhabitants. Stabilisation of sand dunes could be possible to some extent with the canal water. This has helped in protecting fertile fields, human habitation and lines of communication from drifting sand.

4.6 NATIONAL SECURITY

The 1965 war with Pakistan has proved that the 'Thar desert' which had been taken as a natural barrier can be easily crossed over with the help of modern technology and machines. The vast stretch of unoccupied land all along the border thus becomes a danger of foreign invasion. The Indira Gandhi canal project which will inhabitate the 45 Km wide stretch of the land all along

the border will help in defending our western frontrier.

4.7 WATER LOGGING

At many places, particularly in stage I area where claycontent of the soil is a bit higher, the land gets water logged. For agricultural purpose, land is called water logged when its productivity and fertility is affected by high water table. The major cause of water logging is seepage from canal system and over irrigation of fields. In water logged area cultivation operations are almost impossible. The rise of water table also causes accumulation of alkali salt on the surface soil. Moreover, the climate of water logged area becomes damp and formation of stagnant pools may become breeding places for mosquitoes. The climate thus becomes extremely detrimental to the health of community.

To prevent the areas from getting waterlogged the lining of the canal must be effective. The cultivators should be educated for economic use of water and induced to divide his field in to 'Kiaries' to avoid wastage. The losses by percolation from field channels are of the order of 20% and above, their lining will further check the inflow of canal water to subsoil through field channels. Otherwise sprinkler method for irrigation could be used.

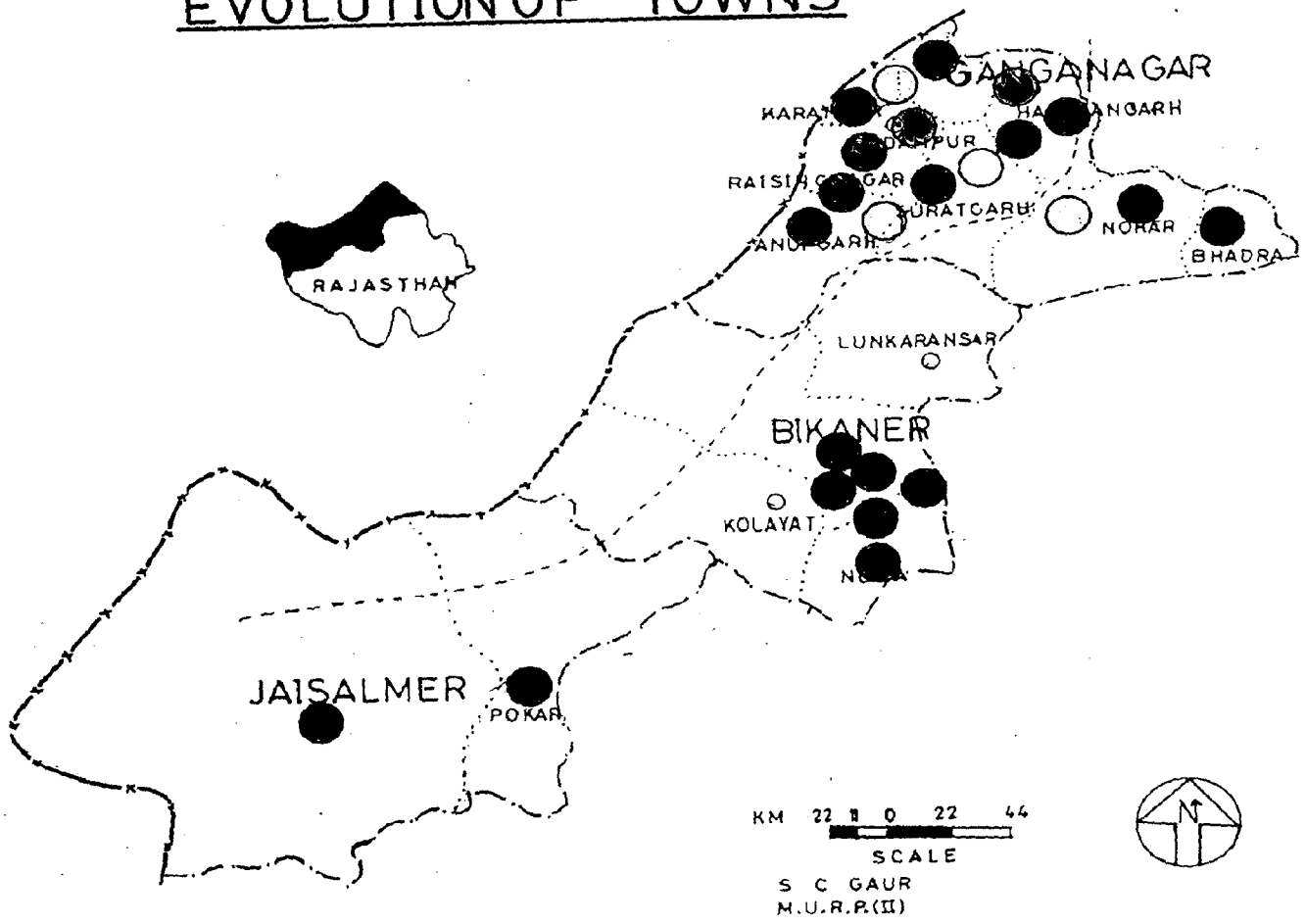
CHAPTER 5. ANALYSIS OF PRESENT AND PROJECTED SITUATION

5.1 EVOLUTION OF SETTLEMENTS

Historically, the area was having well developed civilization during Mohanjodaro Harappa period. The exacavation work of the department of Archaeology, Government of India, during sixties has revealed that Kalibanga was developed exactly on the same pattern of the town of Mohanjodaro and Harappa. The region was, once, quite flourishing and full of habitation. But slowly the region started converting in to arid landscape devoid of human habitation.

Agriculture and animal husbandary have been the main occupation in the region throughout the history of human habitation. When ever there was few inches of rainfall, people tried to till the land but again a continuous drought spoiled all prospects of good harvest. Eventually people had to depend on their cattles, which lead to nomadic culture. As it is expected in nomadic culture, the scattered settlements with small population were distributed throughout the region. As shown in fig. 11 , there were only six towns in the region before 1901, and

EVOLUTION OF TOWNS



LEGEND

- EXISTING IN 1901
- ADDED IN 1921
- ADDED IN 1931
- ADDED IN 1941
- ADDED IN 1951
- ADDED IN 1971
- ADDED IN 1981
- INT. BOUNDARY
- STATE BOUNDARY
- DISTT. BOUNDARY

FIG. 11

from 1901 to 1941 only five towns more came up making total number of towns as 11. There was a sharp increase in the number of towns during 1941-51 period, seven new towns came up during this period. The major reason far this increase was migration from Pakistan. After 1951 six more towns were added, two in 1971 census and four in 1981 census. All these six newtowns have come up in Ganganagar district only.

5.2 EXISTING SETTLEMENT PATTERN

The Indira Gandhi canal region is predominently rural in character. About 80% of total population of district Ganganagar and Jaisalmer lives in villages. Although the percentage of rural population is comparatively lesser (60.47%) in Bikaner district, but 86% of the total urban population lives in Bikaner only. Out of total inhabited villages 55.25% in Ganganagar, 25.04% in Bikaner and 42.21% in Jaisalmer district are having population less than 200 persons and only 3.65%, in Ganganagar, 9.81% in Bikaner and 1.73% in Jaisalmer have population more than 2000 persons (Refer table 11). This can be concluded from this table that scattered settlements with small population are distributed in all three districts. In Bikaner and Jaisalmer district the average inter village distance is about 22 Km,

TABLE 11

DISTRIBUTION OF VILLAGES BY POPULATION RANGES

District	Total inhabited villages	No. of villages in each range					
		Less then 200	200-499	500-1,999	2,000-4,999	5,000-9,999	10000 and above
Ganganagar	3,886 (100.00)	2,147 (55.25)	888 (22.85)	694 (17.86)	142 (3.65)	15 (0.39)	-
Bikaner	571 (100.00)	127 (22.24)	143 (25.04)	239 (41.86)	56 (9.81)	5 (0.88)	1 (0.17)
Jaisalmer	462 (100.00)	195 (42.21)	145 (31.38)	112 (24.24)	8 (1.73)	1 (0.22)	1 (0.22)

(Figure in parenthesis indicates percentage of village in each range)

Source: District Census Hand Book (1981) of District Ganganagar, Bikaner and Jaisalmer

TABLE 12

DISTRIBUTION OF URBAN CENTRES IN THE STUDY AREA

Population Size	Number of Urban Centres			Total
	Ganganagar	Bikaner	Jaisalmer	
Below 5000	-	-	-	-
5000 - 10,000	2	-	-	2
10,000 - 20,000	8	3	1	12
20,000 - 50,000	4	2	1	7
50,000 - 1,00,000	1	-	-	1
1,00,000 and above	1	1	-	2

Source: District Census Hand Book (1981) of District Ganganagar, Bikaner and Jaisalmer

where as it is about 12 Km in Ganganagar district.

5.2.1 Urban Centres

In all, there are 24 urban centres in three districts under study. There is a great variation in population size of urban settlements. As shown in table 12 , only two towns, Ganganagar and Bikaner have population more than one lakh. Out of 24 urban centres,12 lie in the population range of 10000-20000 persons. It is evident from the table 12 that modern urbanization trends have not been much effective in this region and urban centres are mostly concentrated in Ganganagar district (16 out of 24).

5.3 LAND MANAGEMENT IN IRRIGATED AREA

5.3.1 Land Distribution

With local exceptions, land in the Indira Gandhi canal command area is Government owned. The canal command area is along our international border with Pakistan. Therefore special attention is to be given while allotting the land, so that unscrupulous elements could not create any problem.

The whole area is divided into squares. The reallotment of the land to the existing land holders is

also done in the shape of murabbas (squares). Practically, whole land is divided into blocks, each Block is further devided into 64 Murabbas, one murabba consists of 25 Kilas and one Kila is equal to 25 Biswa.

One Biswa	=	33' x 33'	
One Kila	=	25 Biswa	= 165' x 165'
One Murabba	=	25 Kila	= 825' x 825'
	=	15.625 acres	
	=	6.25 ha.	
One Block	=	64 Murabba	= 6600' x 6600'
	=	1000 acres	= 404.55 ha.

The standard allotment is one Murabba (6.25 ha.). The allotment is made by lottery among qualified farmers. The policy of Rajasthan Government has been to give priority in land allocation to the persons as given below -

(a) Existing land owners.

(b) Agricultural graduates

(c) Land less person of the same village

(d) Land less person of same tehsil

(e) Land less person of other tehsil of same district and persons of continguous tehsil of same district, major part of which is in the Indira Gandhi canal command area.

(f) Land less persons of such contiguous district of Rajasthan which does not have major or minor irrigation project.

(g) Land less persons of any other district of Rajasthan having no major or minor irrigation project.

The work of allotment is done by allotting authorities, one at each tehsil. The basis of allotment is that the farmers could occupy the land before the water of the canal reaches to that area.

5.3.2 Revenue Collection

The price charged for the land in irrigated area depends upon the productivity of the soil. The price charged for different categories of land is as follows:

Soil Class	Price Per hectare in Rs.
Nali Soil	5,600
Light loam	4,725
Sandy loam	3,500

The land not with in irrigation command is charged Rs.1050 per hectare.

The payment is spread over 15 years, begining with the year in which irrigation water first becomes available. The rate of payment is graduated from 2 percent of cost in the first year to 8% in sixth year and thereafter.

EXPECTED MIGRATION TREND

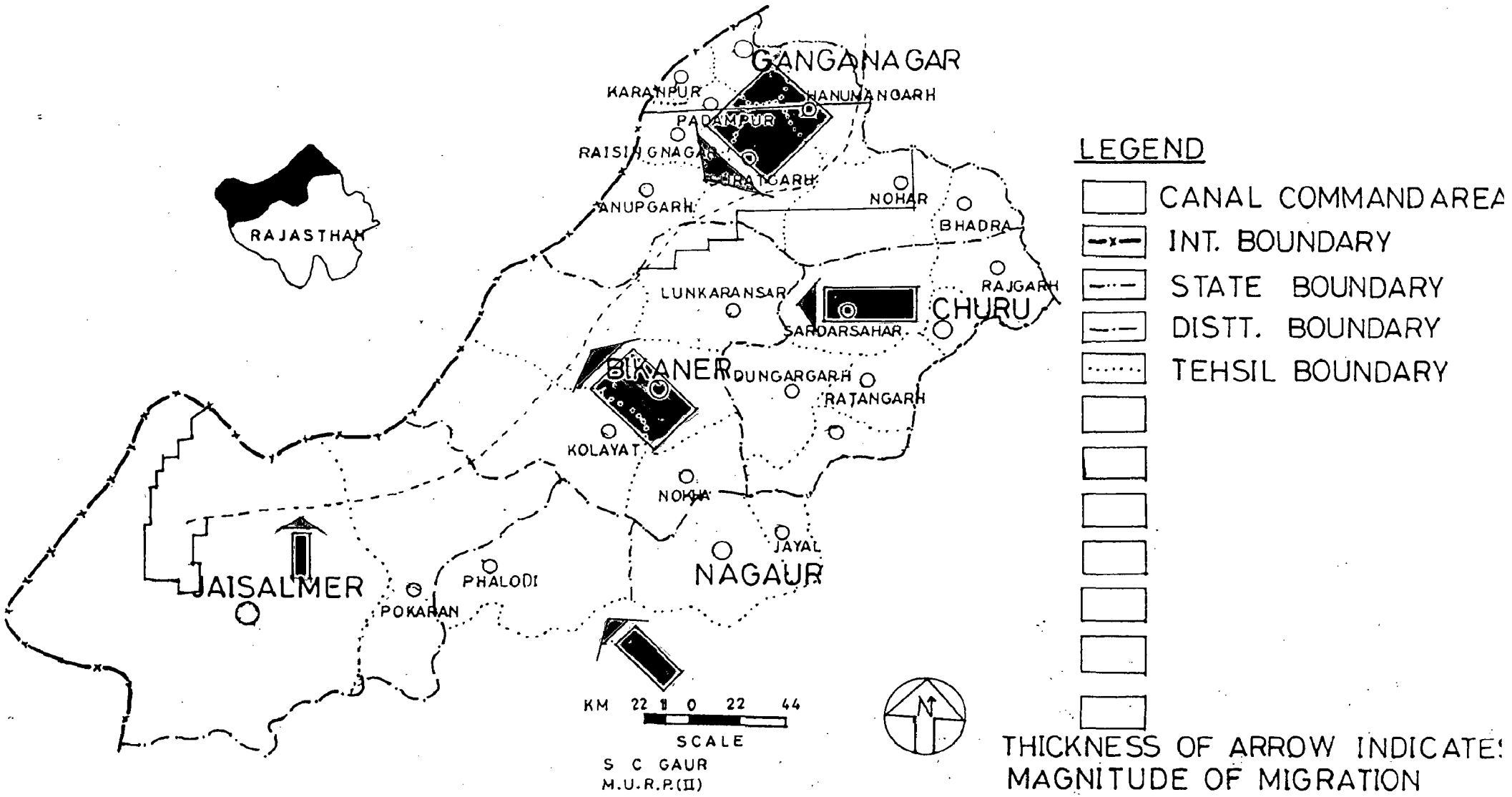


FIG. 12

5.4 MIGRATION

It is expected that the people will migrate in big numbers to the canal irrigated tract. It has already been discussed about the policy of state Government for allotment of land (see 5.3.1) to local land less labours and persons of Rajasthan only. This will check people coming from outside the state, specially from Punjab and Haryana. Therefore migration would be mostly internal in nature. It is very difficult to assess the magnitude of migration from various directions, nevertheless, it is expected that major amount of migration will take place from district of Ganganagar. Other areas where from people will migrate are unirrigated area of Bikaner and Jaisalmer districts, and churu and Nagaur district. A small percentage of migrants (say about 10%) are also expected to come from out side Indira Gandhi canal region to this canal tract. The fig.12 shows the trend of migration from various directions to canal tract.

Since migration will be mostly internal in nature, the growth of population of three districts will not be affected much by this factor. However, it is anticipated that Bikaner area will flourish industrially when mineral deposits in the area will be fully explored. The influx of population from Jodhpur and Nagaur areas is expected to occur due to industrial development in Bikaner.

5.5 POPULATION PROJECTION

Estimation of population is a pre-requisite and vital part of planning analysis. Long range planning can not pherhaps be under taken in a rational and realistic manner unless it is based upon the fundamental facts of population growth. There are various methods of population projection and it is essentially a matter of judgement to select most suitable method for the region.

Commonly used methods for population projection are as follows:

(a) Arithmetic progression method

(b) Geometrical progression method

(c) Logistic Curve Method

(d) Graphical Projection Method

(e) Graphical Comparison Method

5.5.1 Arithmetic Progression Method

The method is based upon the assumption that the population is increasing at constant rate. The future population P_n after n decades is given by

$$P_n = P + nI$$

P_n = Future population at the end of n decades

P = Present population

I = Average increment for a decade.

5.5.2 Geometric Progression Method

In this method, it is assumed that the percentage increase in population from decade to decade remains constant. Thus, average value of the percentage increase is calculated and population P_n after n decades is given by

$$P_n = P\left(1 + \frac{I_g}{100}\right)^n$$

where I_g = Average percentage increase per decade.

5.5.3 Logistic Curve Method

In this method it is assumed that the rate of increase of population never remains constant, but it grows according to logistic or S curve. Therefore in starting, rate of growth will be slow, followed by high rate and to a progressively lower rate of the saturation population.

5.5.4 Graphical Extension Method

In this method, a graph is plotted between time and population with the help of census data of previous few decades, so that the shape of the population curve is obtained upto the present. The curve is then carefully extended upto the desired year.

5.5.5 Graphical Comparison Method

In this method, the areas having conditions similar to the area whose future population is to be estimated are first of all selected. It is then assumed that the city under consideration will develop as the selected area have developed in the past.

5.5.6 Selection of Particular Method

To select any particular method to project the population of the three districts under study area, it is a must to understand the suitability of that method. The Arithmetic progression method is only suitable for areas where future growth is practically controlled and constant increment occurs periodically. The Geometrical progression method is very well applicable to the areas with unlimited scope for expansion and development and large scale industrialisation is likely to occur in the future. The Logistic curve method is suitable in case where the rate of increase or decrease of population with time or population growth is likely to reach the saturation limit. The Graphical extension method is very approximate method, where as for Graphical comparison method it is very difficult to find out the similar arid area in the country.

When all said and done, the Geometrical progression method is best suited for the region. Because hitherto, the region is totally undeveloped and large scale industrialisation and agricultural development will take place in coming years.

5.5.7 Projected Population

(a) Ganganagar District:

I_g = Average percentage increase per decade (From 1941 to 1981)

$$= \frac{54.58 + 18.01 + 64.64 + 34.37 + 45.62}{5}$$

$$= 43.44\%$$

P_{1981} = Population according to 1981 census

= 20,29,968 Persons

P_{2001} = Projected population for 2001.

n = No. of decades = 2

$$P_{2001} = P_{1981}\left(1 + \frac{I_g}{100}\right)^n$$

$$= 20,29,968 \left[1 + \frac{43.44}{100} \right]^2$$

$$\boxed{P_{2001} = 41,76,666 \text{ persons}}$$

(b) Bikaner District :

$$I_g = \frac{34.29 + 8.77 + 29.56 + 28.94 + 48.09}{5}$$

$$= 34.62\ \%$$

$$P_{1981} = 8,48,749 \text{ persons}$$

$$n = 2$$

$$P_{2001} = 8,48,749 \left[1 + \frac{34.62}{100} \right]^2$$

$$\boxed{P_{2001} = 15,38,150 \text{ persons}}$$

(c) Jaisalmer District :

$$I_g = \frac{44.84 + 18.82 + 28.80 + 13.10 + 23.28}{5}$$

$$= 25.76 \%$$

$$P_{1981} = 2,43,082 \text{ persons}$$

$$n = 2$$

$$P_{2001} = 2,43,082 \left[1 + \frac{25.76}{100} \right]^2$$

$$\boxed{P_{2001} = 3,84,450 \text{ persons}}$$

5.6 TRANSPORTATION NET-WORK

In the modern economy the transportion is a major infrastructure for development of any region. Increasing economic activities require and ultimately depend on increasing mobility. Therefore it is a must to envisage a system of transport network which will facilitate the distribution of fertilizers, better seeds and improved agricultural implements to the remotest of farm land as well as collection of surplus farm products to be transported to Mandi towns.

TABLE 13

TRANSPORTATION NETWORK IN THE STUDY AREA

District	Area in Sq.Km.	Rail length in Km.	Rail length per 100 Sq.Km.	Road length in Km.	Road length per 100 Sq.Km.
Ganganagar	20,634	824	4	2034	9.86
Bikaner	27,244	491	1.8	1366	5
Jaisalmer	38,401	105	0.27	1976	5.15

Source : District Census Hand Book (1981) of District Ganganagar, Bikaner and Jaisalmer

TRANSPORTATION NETWORK

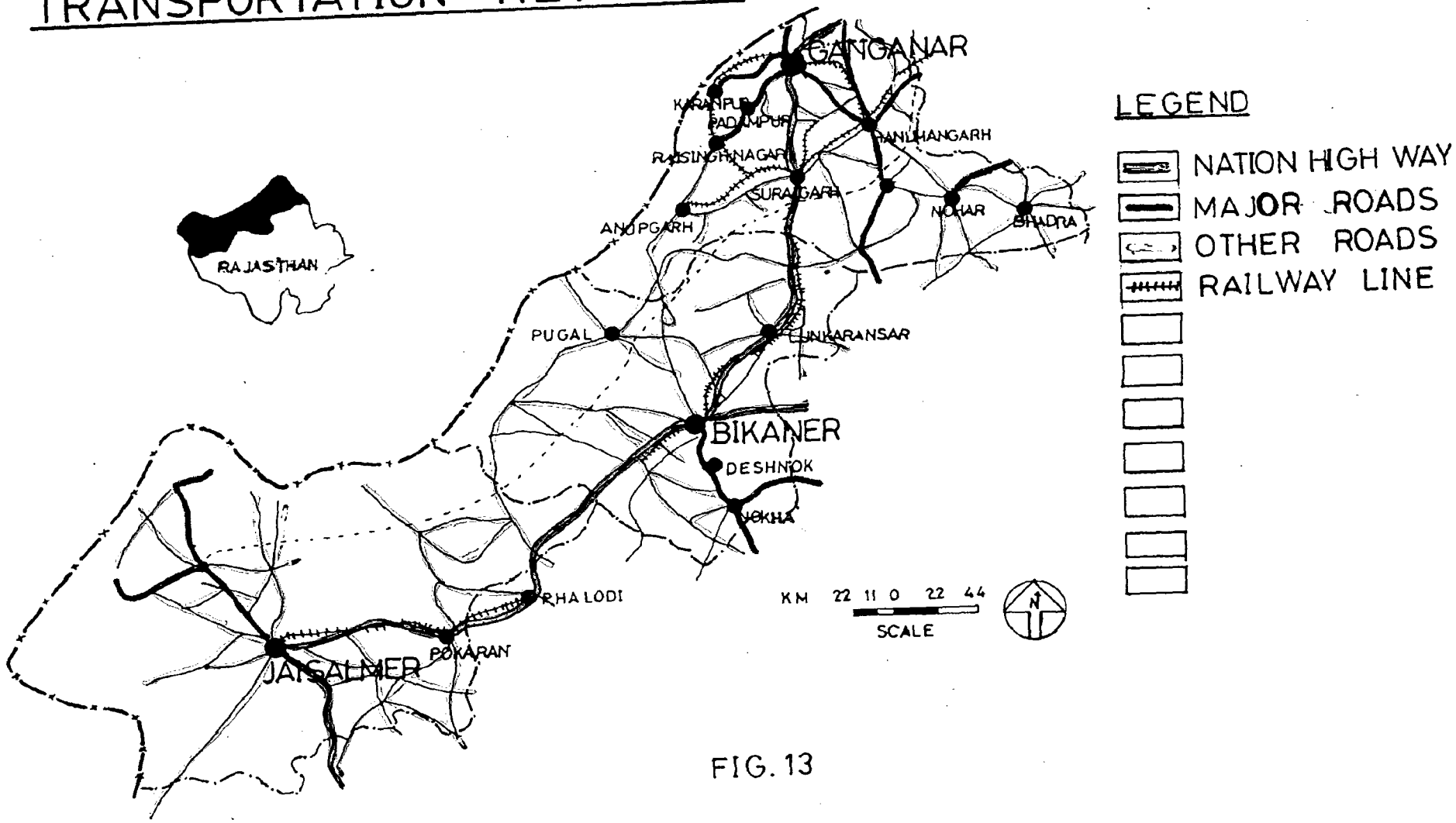
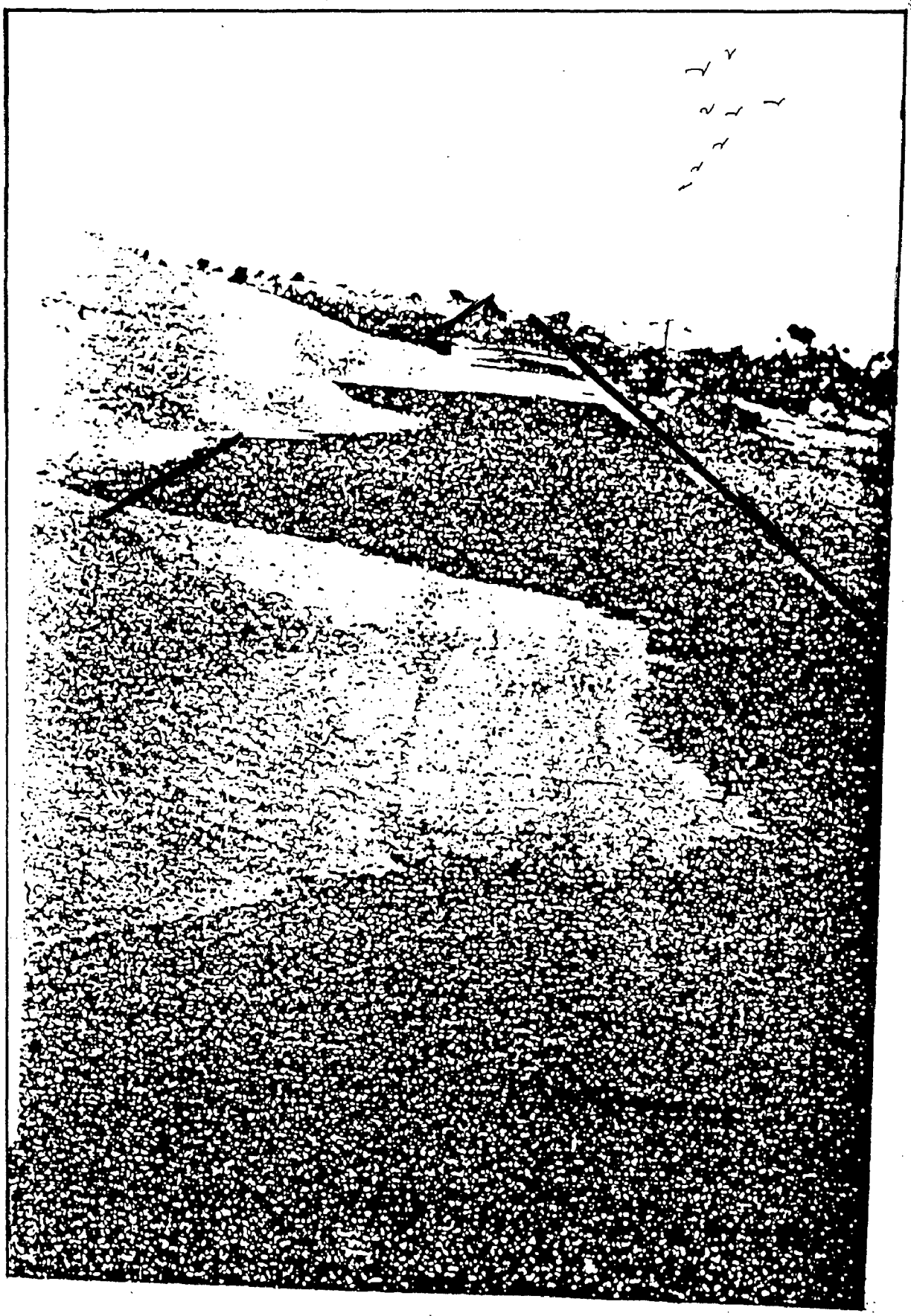


FIG. 13



ROAD ENCROACHED BY SAND DUNE

FIG. 14

Total rail length in Ganganagar, Bikaner and Jaisalmer district is 824 Km.,491 Km.,and 105 Km. respectively. This rail length gives 1.8 Km. length per 100 Sq.Km. in Bikaner, 4 in Ganganagar and 0.27 in Jaisalmer. Therefore, the rail net work coverage with respect to the geographical area is very low (Refer Table 13).

The fig.13 shows the transportation network in the study area. All the three districts have a network of painted metalled roads, gravelled roads and weather roads. Two National Highways (NH 11 and NH 15) pass through the region. Total road length in Ganganagar is 2034 Km. whereas in Bikaner 1366 Km.,and it is 1976 Km. in Jaisalmer district. As shown in the fig.14, a large part of these roads get burried under sand and becomes unserviceable during summers. But in absence of any other alternative means of transport, roads continue to play a vital role in the economy of the region.

CHAPTER 6 PLANNING STRATEGY

With the advent of Indira Gandhi canal, large scale development and multifarious activities have been envisaged in the region. The region provides challenge for planners to utilise the resources of the region and to visualize their conception and plan on this vast land which is almost devoid of any structure.

6.1 CONCEPT OF THE STRATEGY

The basic concept of the planning strategy is to establish relationship between resources of the region and population that can be supported by these resources. The major objective of the Indira Gandhi canal has been to irrigate a part of the desert, nonetheless, some part of the canal water could be utilised for other purposes to bring about integrated development. To avoid the imbalance in economic structure of the region, both agricultural and industrial development has been envisaged. This resource based planning strategy would help in solving problem of the region and materialistic civilization can be established there.

6.2 OPTIMUM LAND HOLDING

To determine the optimum size of the farm, detailed farm management studies and input-output analysis has been done.

6.2.1 Input-Output Analysis

Size group of holding (Acres)	Farm investment per acre (in Rs.)	Input-Output ratio
0 - 5	235	1 : 0.81
5 - 10	168	1 : 1.11
10 - 15	115	1 : 1.31
15 - 25	120	1 : 1.35
25 - 50	130	1 : 1.41

(Source: Central Arid Zone Research Institute (CAZRI), Jodhpur)

It is clear from the table that per acre farm investment is maximum (Rs. 235) in the size group 0-5 acres and it diminishes to Rs. 115 in size group 10-15 acres. Thereafter tendency is reversed.

The total input comprises of value of human labour, value of seed, manures and fertilizers, irrigation charges, land revenue and other taxes,and depreciation on bullocks and implements. Whereas, the output is total income comprising the value of all produce raised on the

farm whether to be sold or consumed at home. The results indicate that output is less than input in size group 0-5 acres, it shows slightly marginal surplus in 5-10 acres holding, but the surplus becomes significant from the 10-15 acres holding onwards.

6.2.2 Farm Management Study

Size group of holding (Acres)	Employment of human labour (No. of labour days)	Land utilization % of intensity of Cropping
0-5	86.13	109
5-10	171.88	106
10-15	254.34	103
15-25	271.43	93
25-50	653.62	93

(Source: Central Arid Zone Research Institute (CAZRI) Jodhpur)

To keep farmer fully employed, the form must be able to provide work for atleast 240 labour days. It is only holding in the size group 10-15 acres that is able to provide this full employment. Below this, farmer will be underemployed and above this size group, he will have to hire labour.

As size of holding increases the intensity of cropping decreases. The tendency seems quite logical, because, if farm is small, farmer has to exploit the land as fully as possible for subsistence. But this often impairs the productivity of the land in the long run.

High economic results have been observed in case of farm of 10-15 acres. On this basis 15 acre land holding could be accepted as the optimum land holding. But, the analysis carried out is based on the experiments of Central Arid Zone Research Institute (CAZRI), which were done at farm near Jodhpur and does not incorporate the actual problems existing in the desert area. Besides this higher land holding will attract more farmers to the area. On this consideration 20 acre land holding has been considered as optimum land holding.

6.3 HIERARCHY OF SETTLEMENTS

The advent of canal irrigation and great agricultural and allied development have changed entire ecology and economy of the irrigated area. Not only existing population is to be settled, but settlers coming from out side would require living space. This requires systematic and well planned programme of organised development of settlements. The

correct hierarchy of settlements should ultimately result in to the most efficient functioning of economy, social life and defence strategy (As the region forms western frontier of our country with Pakistan). On the basis of these criteria, a three tier system of human settlement has been worked out. These are classified as follows -

1. Basic Village
2. Amenity Village
3. Mandi Town

6.3.1 Basic Village

This is the smallest unit of human settlement. Persons who would settle here will be farmers around the village settlement. The size of village should be such that it can sustain its educational, heath and other facilities. According to Planning Commission, Govt. of India, a village needs to have a minimum population of 200 families to induce stability in the economy and social structure. A village size smaller than this can not maintain the social overheads. Therefore, if on average there are 5 persons per family, then total population commes out 1000 persons. Moreover, basic village must support a primary school with

enrolment of 150 children. It is assumed that 15% of the total population of village is of primary school age, and all children attend the school, then the population of village would thus be $\frac{150 \times 100}{15} = 1000$ persons.

Each basic village should cover an area of 60 Acres for habitation with a gross density of 16.6 persons per Acre. There should be about 250 metre thick Green Buffer in each basic village in the south-west direction. The function of this Green Buffer would be :

(a) to reduce the wind velocity, check dust storms and drifting of sand.

(b) to meet the local demand for fire wood and timber.

(c) to improve the microclimatic condition of the area.

(d) to improve the aesthetic beauty and land-scape of the area.

The optimum land holding found out here is 20 Acres. Therefore the total command land required for 200 families would be=200 x 20 = 4000 acres. This gives the influence radius around 3 to 3.5 Km.,

which is reasonable distance to travel for farmers to reach their farms. The general criteria for locating a village site are as follows :-

(a) Each Basic Village should be located for an area of 3 to 3.5 Km. radius, therefore the distance between two basic villages should be approx. 6 to 7 Km.

(b) It should be located on uncommand land so that valuable command land is not wasted.

(c) It should be located on higher ground to avoid the danger of flooding in case of breaching of canal. It should preferably have flat topography or a very gradual slope so that roads etc. can be easily laid.

(d) It should be close to some irrigation channel so that water for drinking purpose could be made easily available.

(e) It should be near a culvert provided on the canal distributary, if any, to enable farmers to cross over the canal distributary.

(f) All existing villages should be retained as Basic villages.

(g) There should be enough scope for expansion of

village, which would avoid acquisition of command land in future.

6.3.2 Amenity Village

The Amenity village is second order settlement in the hierarchy. There are so many facilities and services required by rural population that can not be made available in each and every basic village as it is being too small. Thus, there should be a central and bigger village which would satisfy such needs.

Only existing villages should be developed as Amenity villages and population of Amenity villages should range from 3000 - 4000 persons. Their services should be planned to cater its own population and population of 6 to 7 surrounding Basic villages. Therefour total population of 10,000 persons would be served by one Amenity village. The facilities to be provided should include one high school, allopathic dispensary (6 beds), filtered water supply, electricity, co-operative bank, veterinary dispensary, work-shop and bus stop. The Amenity village should be well connected with the villages in its hinterland. The influence radius of Amenity village should be around 7 to 8 Kms, therefore the distance between two Amenity villages should be about 14 to 16 Kms.

The location of Amenity village should also be decided on the same principles as given for location of Basic village (As given in 6.3.1).

6.3.3 Mandi Town

Next in the hierarchy of settlements is Mandi Town. It is a centre of trade and commerce. Its population varies from 10,000 to 50,000 depending upon its location and hinterland it serves. The Mandi Town will provide wide range of town level facilities required to serve its own population as well as population of its rural hinterland. Services like wholesale market, retail market, offices of Government departments and public agencies connected with development of command area, bank services, warehouse and godowns, small and large scale industries, higher order educational, medical and cultural facilities should be provided in Mandi Town.

Various considerations taken into account in deciding the location of Mandi Town are as follows:-

(a) In market there should be an approximate arrival of 5 to 6 lakh quintals of crops annually.

(b) From distance point of view, the farthest village from Mandi town should be 18 to 20 Kms.

Therefore any two towns should be about 36 to 40 Kms. apart.

(c) The Mandi town meets the requirements of facilities of higher order. Therefore, these should be properly distributed in the entire area so that people may not have to travel a long distance to avail these facilities.

(d) Only the existing village or town should be made Mandi Town, so that some nucleus is available for growth.

(e) In locating Mandi-Town, the physical location with respect to existing condition, on ground and their interlinkages with other Mandi Towns should also be taken into account.

(f) The Mandi town should not be located near Pakistan border.

6.3.4 Application of Contemplated Hierarchy of Settlements in Pugal Distributory Area

The hierarchy of settlement comtemplated here is applied on Pugal Distributory Area. The Pugal distributary takes off from 'Sidhewala Head', at about 180 Km from starting point of main canal. Gross area covered by distributory is 3.725 lac acres and total command area under irrigation is 2.877 lac acres, which

LOCATION OF PUGAL DISTRIBUTORY AREA

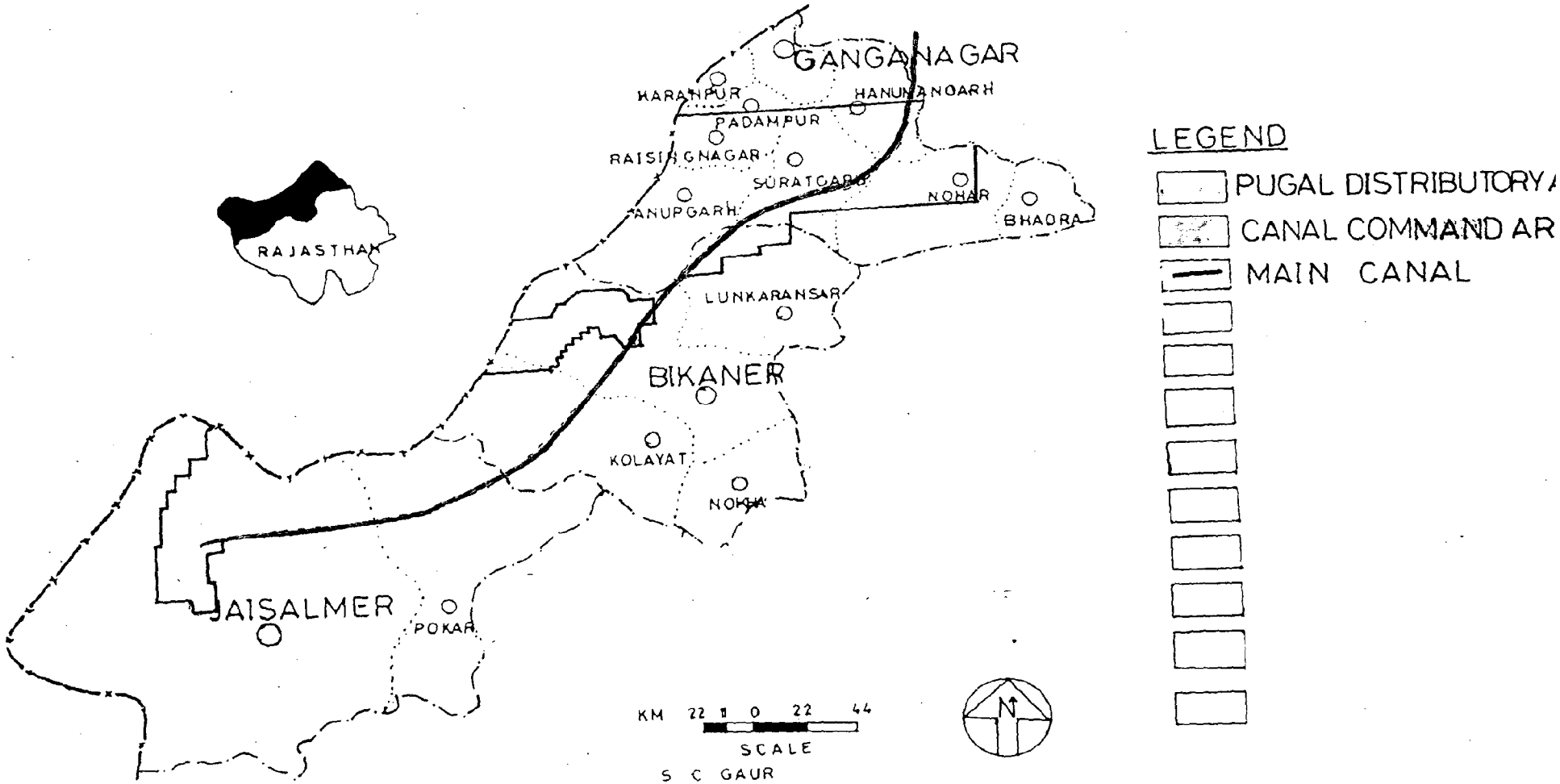
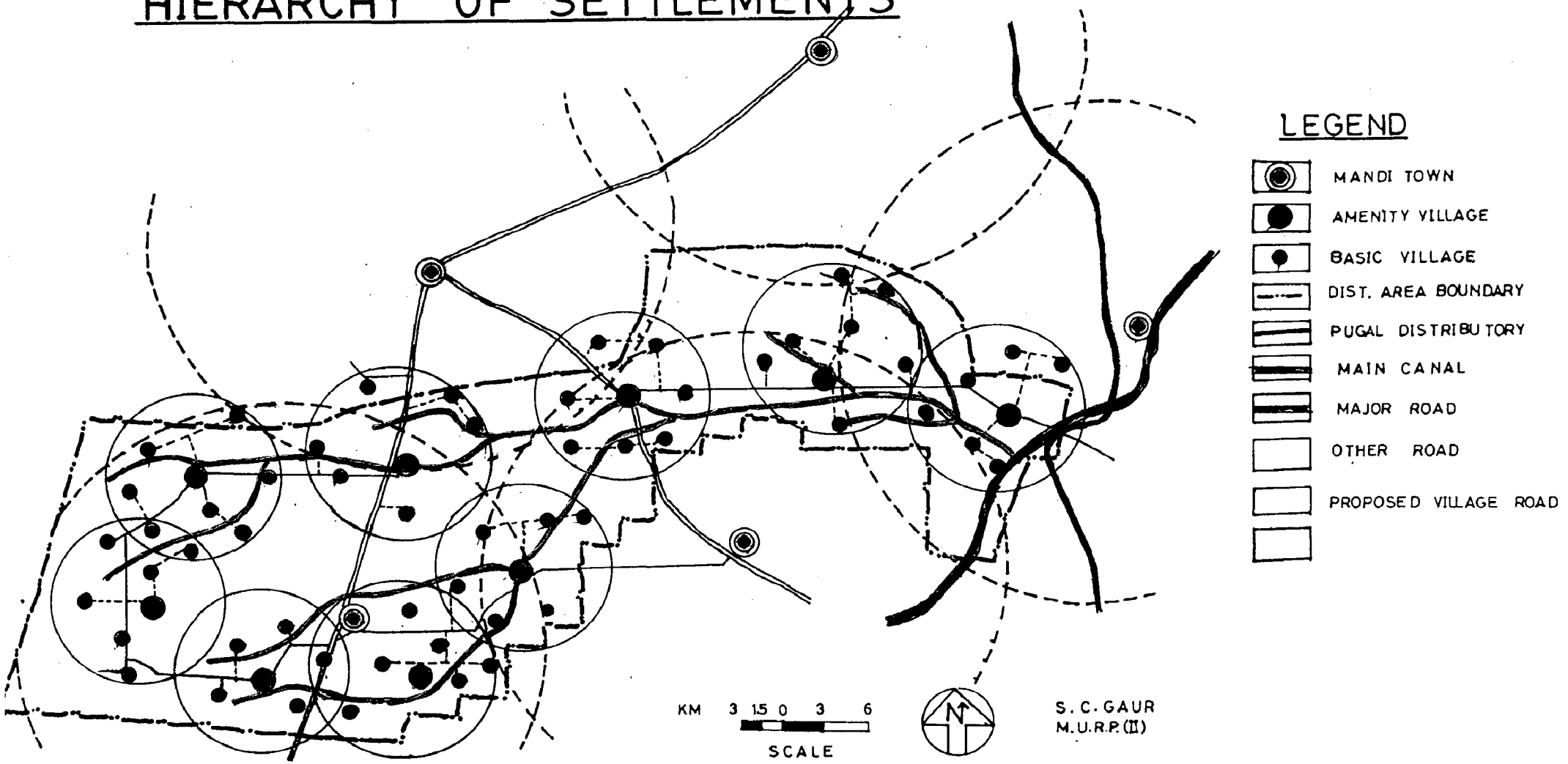


FIG. 15

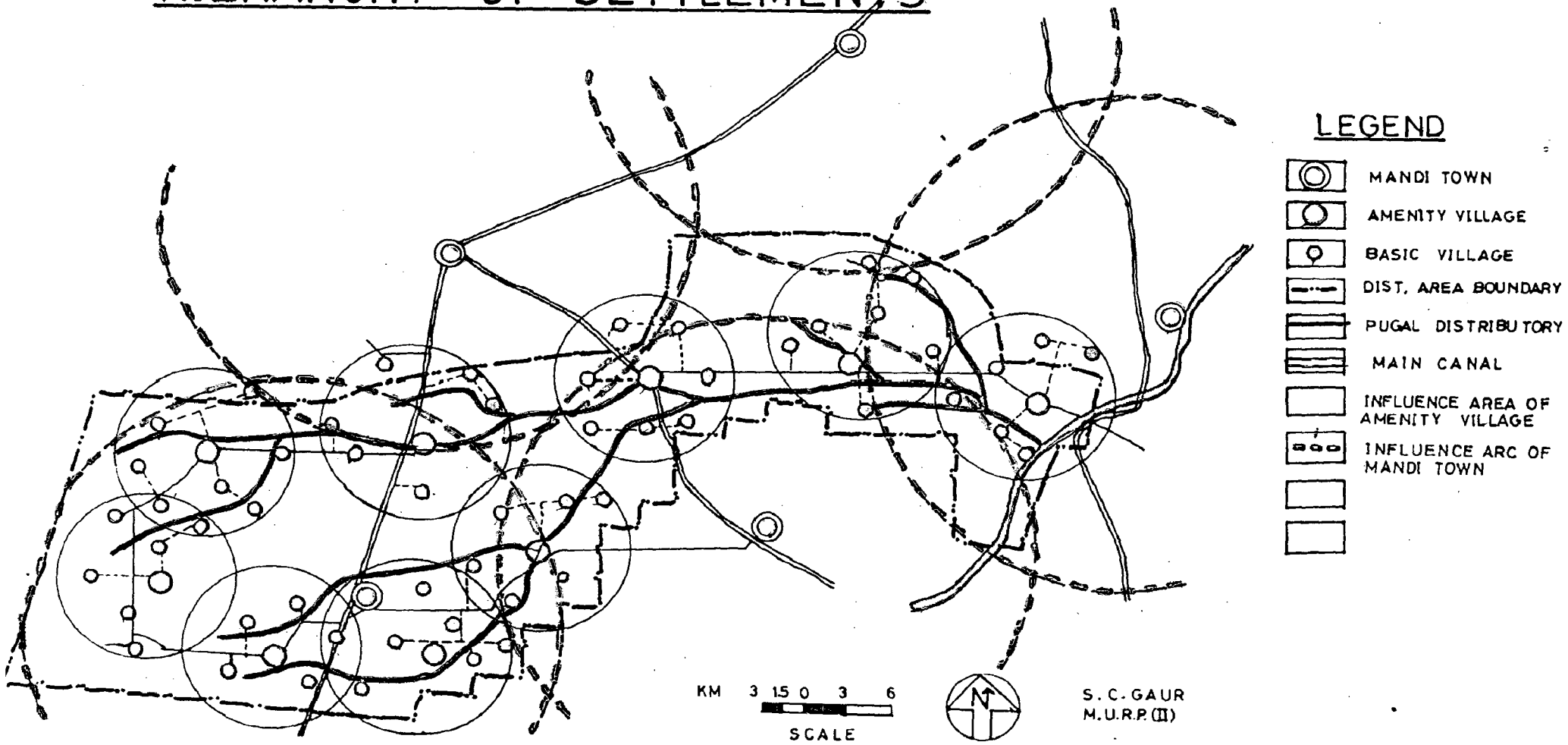
HIERARCHY OF SETTLEMENTS



SPATIAL DISRIBUTION OF SETTLEMENTS IN PUGAL DISTRIBUTORY AREA

FIG. 16

HIERARCHY OF SETTLEMENTS



INFLUENCE AREA OE AMENITY VILLAGE AND MANDI TOWN

FIG.17

is about 76% of the total area.

The spatial distribution of the settlements is shown in fig. 16. Total number of settlements in different categories are as follows :-

(a) Basic Villages - 58
(b) Amenity Villages - 9
(c) Mandi Towns - 5

Out of the proposed five Mandi Towns, four are situated out side the Pugal distributory area, nonetheless, they will have influence on the settlements in the distributory area.

6.4 DRINKING WATER

There is no regular source of surface water in the region and potable ground water is very rare. People generally depend on rain water stored in tanks. Unless drinking water is made available in the settlements, nobody would tempt to settle there. It is thus clear

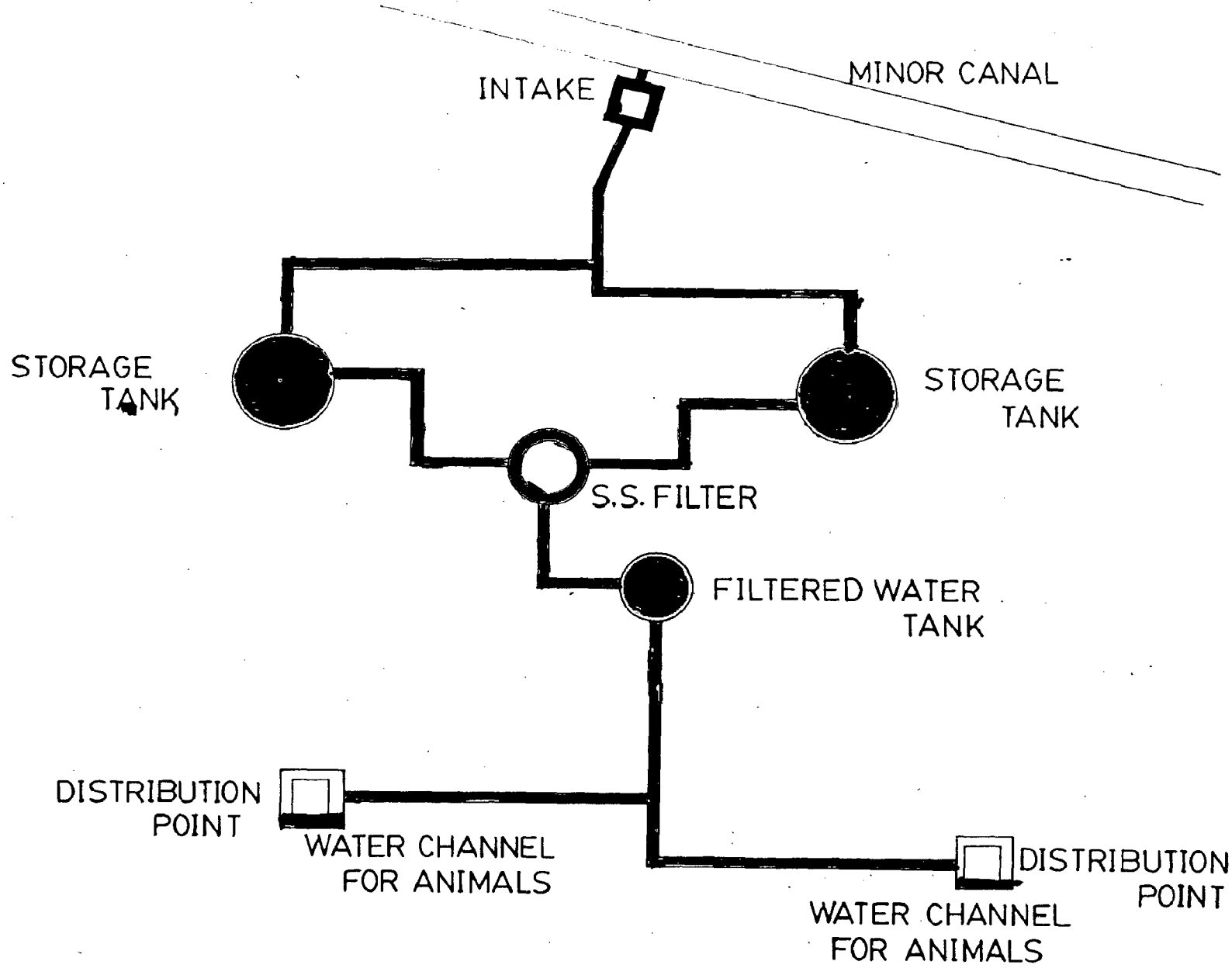
that Indira Gandhi Canal water would be only substantial source of water for drinking water requirement. Necessary treatment of water has to be done in order to make available safe drinking water for every town and village.

6.4.1 Water Supply For Mandi Town

The water carried out from canal should be stored in storage-cum-sedimentation tank in each Mandi town. A sufficient storage in necessary to meet requirements during break down of canal and other unforeseen factors. The storage will also help in sedimentation of insoluble particles, thereby decreasing turbidity of water. The decrease in turbidity would reduce load on filteration plant, resulting in economy in maintenance. This water should be filtered and disinfected further to ensure that drinking water is potable as per standards.

6.4.2 Rural Water Supply

With the view to provide potable water as a part of essential infrastructure for rural settlements (Both Basic villages and Amenity villages), it has been proposed to provide two under ground tanks to cater to the normal drinking water demand. The capacity



PROPOSED RURAL WATER SUPPLY NET WORK

of these tanks should be sufficient to provide storage for closure period of water course. The water from these tanks should be passed through slow sand filters. Finally, filtered water should be pumped to the distribution points in the village. The proposed network for rural water supply has been shown in fig. 18.

6.5 PROPOSAL FOR INDUSTRIAL DEVELOPMENT

It has already been discussed in Chapter 3 that the region is rich in mineral and live stock resources. Even then industrial development in the region is almost nil. The resources of region have largely been unexploited. A number of families of top ranking businessman and industrialists hailing from this part of Rajasthan have settled in other states and never paid attention to the setting up of industries in their home state, may be, because the infrastructure for such development is lacking.

With its rich and huge deposits of minerals, abundance of wool and cattle products, and good prospects for agricultural development with the advent of canal, the region has very high potential for industrial development. National highway '15' passing through Ganganagar, Bikaner and Jaisalmer can form industrial

PROPOSED INDUSTIAL DEVELOPMENT

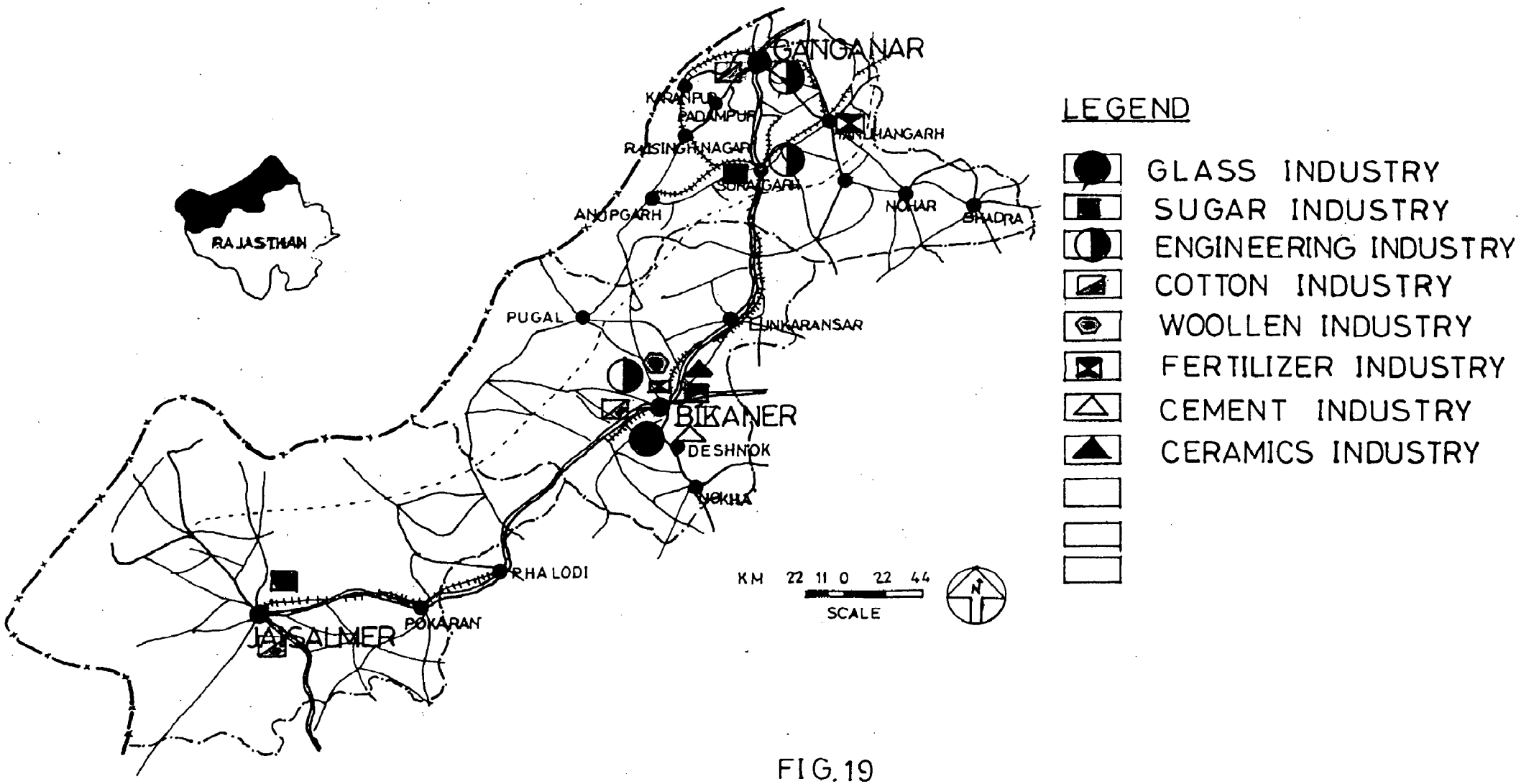


FIG. 19

belt in the region. This road forms central axis of the region and important towns are located on this road. It has advantage of minerals located around Bikaner, agro and livestock based raw materials could be made available from the canal tract. It has additional advantage of railway link except between Phalodi and Kolayat. The location of already established Urban centres in this belt like Ganganagar, Hanumangarh, Bikaner, Pokaran, Jaisalmer etc. is an additional advantage in terms of availability of skilled labour, water and market. Such facilities are available only in important urban centres of the region. The industrial belt and the location of proposed industries is shown in fig. 19.

6.5.1 Agro-Based Industries

The production of sugarcane is likely to increase substantially in the Canal irrigated area. Three more sugar factories, in addition to the one at Ganganagar can very well come-up at Suratgarh, Bikaner and Jaisalmer in future.

One more cotton textil mill at Ganganagar and one additional mill at Bikaner can very well flourish.

The woolen mills at Bikaner can very well be expanded and mill can be expected to produce even finer

variety of woollen cloth in addition to blanket, carpet making and wool processing etc.

6.5.2 Mineral Based Industries

Hanumangarh and Bikaner are good locations for setting up fertilizer factory, as the raw materials like gypsum and lignite are available locally.

One cement factory can come up at Bikaner as lime stone is available near Nagaur and gypsum is available in abundance locally. Coal has to be imported from Bihar or West-Bangal.

As silica sand, lime stone and feldspar are available in the region, a glass factory which will produce sheet glass, bottles, containers and other glass products can very well come up at Bikaner At present there is only one glass factory in the state at Dholpur and the glass and glasswares have a large market. Thus the products of this factory shall have good market out side.

As clays, bentonite, glass sand, lime stone, gypsum etc. are available near Bikaner, one industry producing stonewares, tile, H.T. and L.T. insulators can be set up at Bikaner.

6.5.3 Metal Based Industries

Bikaner, Suratgarh, Ganganagar are convinient locations for development of Engineering industries. Industrial fastners like bolts, nuts, rivets etc. can be produced at these places.

An industry to produce tools and implements in view of development in agriculture and mining may be set up at Suratgarh.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

7.1.1 Only a part of the desert is put under irrigation by Indira Gandhi Canal, leaving a huge area of the desert untouched. Therefore, problems of the desert will continue if adequate care is not taken to control the desert.

7.1.2 The topography of the most of the area is undulating and requires mechanical reclamation.

7.1.3 Climatic conditions are very extreme and trying for man. Summers are excessively hot and winters are very cold.

7.1.4 The average annual rainfall throughout the region is meagre. Possibility of agriculture with this rainfall is very gloomy.

7.1.5 Dust storm and soil erosion are two of major problems seen in the region.

7.1.6 Shifting sand dunes is the biggest menace for the agriculture as well as human habitation. Therefore, afforestation and dune stabilization is must for betterment

of the region.

7.1.7 Population density is very low, particularly in Western and Southern part (district Jaisalmer and Bikaner) of the region. This creates problem in providing basic infrastructure in the region.

7.1.8 Urban centres are concentrated in northern part only, moreover, they have weak ties with rural side. Their spheres of influence are limited and greater part of the region has no urban influence.

7.1.9 There is acute shortage of water, both for drinking and irrigation purposes. Condition of underground water is not very encouraging, it is mostly brackish and found at greater depths with low discharge.

7.1.10 Inspite of abundance of natural and livestock resources the region is still industrially backward. The industrial backwardness has aggravated the poverty.

7.1.11 Transportation network existing in the region is inadequate and connection between rural and urban areas is very poor.

7.1.12 A large portion of road network comes under cover of sand dunes in summers. Therefore alignment of the road is required to be done carefully to avoid such a situation.

7.1.13 The percentage of forest coverage is very low in the region throughout. Now, with the availability of canal water forests can be developed.

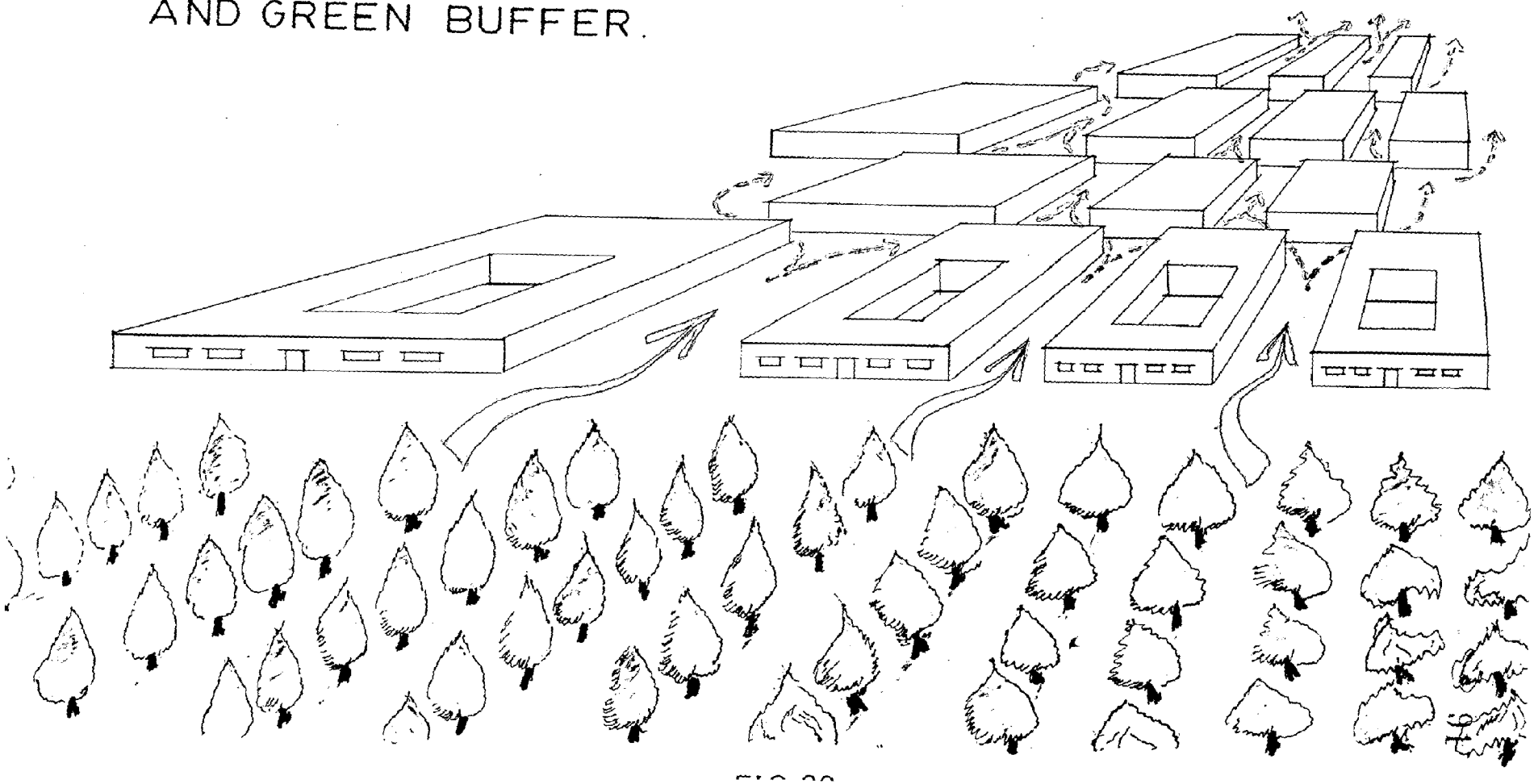
7.1.14 Indira Gandhi canal has changed entire ecology and economy of the region. Large scale agricultural and industrial development is expected in the region, with the advent of this canal.

7.2 RECOMMENDATIONS

Based on the above conclusions drawn by the author, the general recommendations for development of the region are as follows.

7.2.1 For stabilization of sand dunes, trees, shrubs and perennial grasses should be grown on the dunes.

REDUCTION OF EFFECT OF STORMS
DUE TO BLOCKED STREET PATTERN
AND GREEN BUFFER.



7.2.2 There should be green belt in the south-west direction of (General wind direction) each settlement to reduce wind velocity and check dust storms. (Refer fig. 20).

7.2.3 The alignment of the roads in Jaisalmer district, where shifting sand dune are most common, should be along the direction of wind (South-West) and not across. Because longitudinal sand dunes only shift along their axis, which is always, the direction of wind.

7.2.4 Provision of drinking water in each settlement should be given top priority and where ever possible canal water should be made available for drinking purpose.

7.2.5 Industries should be developed to utilise indegenious raw material, proposals for which have already been given in Chapter 6 (see 6.5).

7.2.6 Street orientation and housing pattern in the settlement should be considered carefully. Parallel streets may open the area to wind ventilation, on the contrary, if streets are blocked ones, they will reduce the effect of storms. This effect has been shown in fig. 20.

7.2.7 While distributing land in the canal irrigated area, following points should also be taken into account.

(a) Land should be given to younger peope. Their age should not be more than 30 years, as development in virgin area requires a vision and pioneering spirit.

(b) Special care should be taken while allotting border land so that unscrupulus elements may not take undue advantage.

7.2.8 Where ever land is getting waterlogged, farmers schould be advised to use lined field channels or sprinkler system for irrigation.

7.2.9 Existing road network is quite inadequate, roads should be constructed to connect each Basic village with its Amenity village and Amenity villages must be well connected by road with Mandi town. So that farmers don't have any problem in bringing their products to mandis.

7.2.10 Two important urban centres of the region, Bikaner and Jaisalmer are not connected by railways. Therefore railway line should be laid from Kolayat to

Phalodi to connect these two towns by railways.

7.2.11 Road side plantation should be done to improve aesthetics and ecology of the region.

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APPENDIX-I

RAJASTHAN

A Dream Canal

LAST month, when Rajasthan Chief Minister Harideo Joshi pleaded with Dr Manmohan Singh, deputy chairman of the Planning Commission, for major Central assistance to the Indira Gandhi Canal Project, he wasn't the first chief minister to have done so. If the massive canal is an incredible dream in this backward desert state, it is also one that has caused immense financial frustration.

Sometime in 1986, work on the 445 km-long main canal will be finished but in the absence of the subsidiary network of canals, that milestone will be little more than a propaganda victory. Officially, talk continues of completing the entire project by 1995. However, the unpalatable truth—as senior officials admit privately—is that at existing levels of funding, the project, begun in 1958, cannot be finished before 2005.

To the Rajasthani, the deadline for completing the work finally can only seem to be receding. At the outset, it was to be wrapped up by 1965 at a cost of just Rs 60 crore. But planners and political leaders have continuously increased its size and scope. For instance, the original scheme to have an earth-lined canal was dropped in favour of brick lining—this reduces water losses through seepage to a seventh but also multiplies costs manifold. In another move last year, justifiable alterations were ordered hiking the cost of the project's stage II from Rs 944 crore to Rs 1,331 crore.

Workers along the canal: snail's pace

The state's requests for heavy Central funding are more than two decades old. Indeed, at one point, in 1967-68 Delhi did offer to not only fund but also execute the project when the state exhibited its empty pockets. But the Centre in turn wanted the right to allot lands in the command area as it chose—and this the state Government was unwilling to concede. Since then, the entire money has come from state resources, except for Rs 40 crore from the Centre.

While it is true that when completed the project will alter the economic fortunes of vast areas of the desert (already, the irrigated area of stage I yields crops worth well over Rs 250 crore annually), there have been others who have felt that "the state has mortgaged its future to a single project".

Perhaps nothing illustrates better the awesome task that this economically backward state faces in finding money than a recent official calculation. According to it, at 1985 prices, were the entire system to be built today, it would require between Rs 3,000 crore and Rs 3,500 crore. It is an impossible sum for Rajasthan, the seventh plan size of which is just Rs 3,000 crore. More than a thousand crore still has to be spent on stage II and at an average allocation of Rs 50 crore annually, it is bound to take another 20 years.

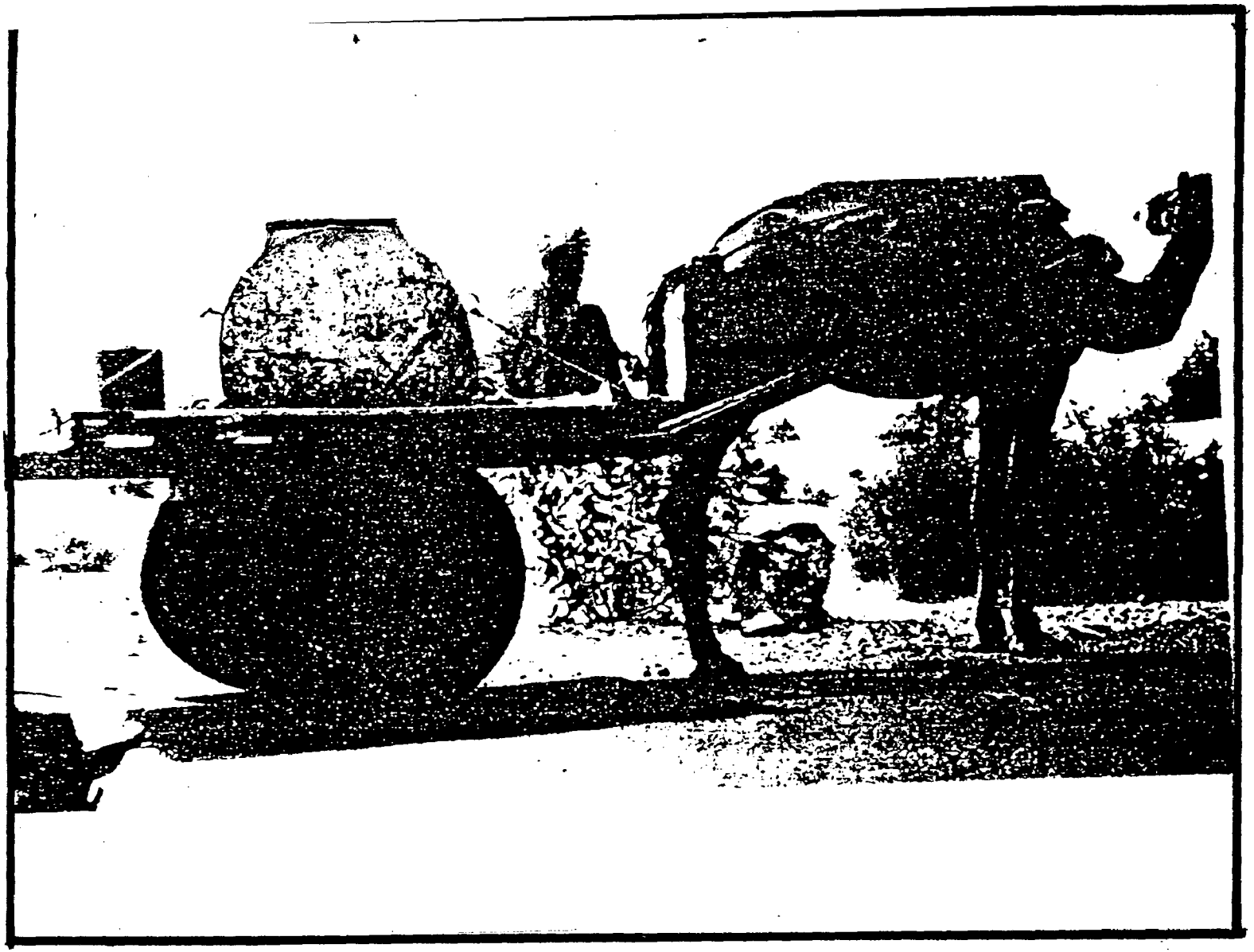
In the late '70s and until the early '80s the pace had been slow in large part due to the erratic supply of raw materials. The task of lining suffered because the enormous quantities of cement (average annual consumption: 50,000 tonnes) and coal (40,000 tonnes) were not always available. While that problem has now been sorted out, the problem of cash remains.

Says a top-level state official: "The canal has become a back-breaking burden for Rajasthan, considering our poor resources position. Although it is the second largest state in the country area-wise, our plan size is nominally larger than tiny Haryana and smaller than Punjab. Uttar Pradesh and Maharashtra's allocations are three and a half times bigger and even Gujarat's plan size at Rs 6,000 crore is twice ours." Over the last seven years, roughly 10 per cent of the state's annual outlay has been devoted to this single project. In the outlay for 1986-87, recently announced, the canal has been allotted Rs 45 crore out of a total of Rs 525 crore or 8.57 per cent. In the current year it is Rs 50 crore of Rs 430 crore or 11.63 per cent. And in 1982-83, the percentage was 12.50—which meant that every eighth rupee spent went into the canal.

This contribution could be made only at the cost of other important programmes. In 1985-86, the amount spent on the Indira Gandhi Canal was 60 per cent of the amount spent in Rajasthan on social services: health services, providing drinking water, education, social welfare and the nutrition programme. And in 1986-87 as much will be spent on the canal as on transport, mining and industry put together.

But if the Rajasthan Government is unwilling to reduce its commitment to the canal, it is because the benefits of the first stage are all too visible. In an area where nearly nothing grew until a few decades ago, 26,000 tonnes of gram, 23,000 tonnes of groundnut, 40,000 tonnes of paddy, 68,000 tonnes of mustard, and 100,000 tonnes of cotton are now produced annually, among other things. The pot at the end of the rainbow is all too alluring; it is only the end of the rainbow that is not in sight.

—SREEKANT KHANDEKAR



WATER BEING CARRIED ON CAMEL CART BY A VILLAGER.

A VILLAGE IN INDIRA GANDHI

CANAL AREA

FIG. A-2