CHAPTER - I

INTRODUCTION

SCOPE AND PURPOSE

The alluvial plains of north Gujarat and southwest Rajasthan constitute an important segment of the Quaternary terrain of Western India. The vast accumulation of partly consolidated to unconsolidated Pleistocene and Holocene sediments are not exclusively fluvial in origin, but also include products of aeolian as well as fluvio-marine processes. They can better be designated as representing continental Quaternary deposits. These Quaternary deposits extending from Narmada river in the south to as far as Luni river in the north exhibit an interesting depositional sequence which inturn reveal evidences of significant control

exercised by the factors of Quaternary tectonism, glacio-eustatic sea-level changes and paleoclimatic fluctuations. The deposits provide an insight into the late Quaternary geological history of western India and throw considerable light on the various processes and factors responsible for the deposition of these dominantly fluvial deposits.

The north Gujarat plains are important because they comprise a terrain which marks the area of transition from the humid to semi-arid zone of Mahi-Narmada of central Gujarat to semi-arid to arid zone of south Rajasthan. The Quaternary sequences are exposed in the cliff sections of the major rivers draining the Gujarat plains viz, Narmada, Mahi and Sabarmati. Interestingly the sequences exposed in the three river sections show striking similarity, but the river Sabarmati provides more or less ideal locations in its cliffy banks. To the south and north of the Sabarmati river the Quaternary terrain is somewhat different. Whereas the Mahi and Narmada environs show some inhibited development of the uppermost Quaternary sequence, the portion bound by the rivers Sabarmati and Luni forming a major part of north Gujarat plains is ideal in the sense that it provides a more or less complete late Pleistocene-Holocene stratigraphy, typically illustrating the signatures of the climatic changes and neotectonic movements. Considering this fact the author selected the northern part of the alluvial plains for his present study.

The area extending from Sabarmati to Luni with its characteristic landscape and drainage pattern has been found to provide an ideal terrain for understanding the nature of the relationship existing between depositional processes; aeolian and fluvial, tectonic movements and the influence of climatic fluctuations between semi-arid to arid. The study area has also preserved

numerous features pointing to various changes in the drainage systems prevailing during the Upper Quaternary times, -Middle Pleistocene to Recent. The author carried out investigations in the study area with a view to collect maximum available information through detailed on the spot studies of the various river sections; gave maximum emphasis on the Sabarmati river as it was found to provide an almost unbroken exposed sequence of the Quaternary sediments starting with Middle Pleistocene. The data obtained from this river as well as some of the shallower rivers further north viz, Rupen, Pushpavati, Khari, Saraswati, Banas and Luni, bore-hole information from the unexposed intervening areas, were synthesized, with the present day landforms dominantly pointing to a dunal topography, enabled the author to arrive at a more or less coherent sequence of Quaternary events.

His study has enabled him to throw some light on (i) Pre-Quaternary configuration of the depositional basin, essentially a feature related to Cambay Basin tectonics, (ii) a protracted and complex fluvial history and deposition of sediments varying in thickness from 100 to 300 m, (iii) influence of climatic changes and tectonic movements, both in the provenance as well as with depositional sites on the fluvial processes and (iv) the disruption of the pre-existing fluvial regimes.

As of today the entire landscape consisting of present day drainage system, exposed river sections and topographic features have preserved within them an interesting Quaternary history. In this thesis, the author has made an attempt to unravel and understand the evidences as preserved in the sediments and their configuration. No doubt many gaps have still remained but it has been possible to throw new light on this important Quaternary terrain.

APPROACH AND METHODOLOGY

The entire strategy of investigation by the author was based on the presumption that the various controlling factors like climate, tectonism and different depositional processes played significant role all throughout and the depositional sequences exposed and unexposed have adequately preserved a number of evidences of these controlling factors. His approach has been essentially field based emphasizing on collection of maximum information obtained through extensive field work and examination of deposits as seen in the field. Ofcourse his main emphasis has been on the studies along the Sabarmati river and its environs. He has however critically examined the various smaller rivers viz, Rupen and Banas; though these rivers are smaller and shallower today they do reveal a more effective fluvial role in the past. The importance of Luni river has also been critically examined. This river though exposing only the upper most part of the continental sequence has furnished valuable information enabling thereby to understand the closing period of the main fluvial depositional event.

In order to properly organize and plan his field work the author (i) perused through almost all important research publications on Gujarat and south Rajasthan written by geologists, geomorphologists and archaeologists, (ii) analysed the drainage characteristics and physiographic characteristics of the study area and parts of south Rajasthan on Survey of India Toposheets (Scales 1:250,000 and 1:50,000) and (iii) studied the satellite imagery (Landsat and IRS FCC) to obtain a regional picture as well as those smaller details which are not available on the toposheets.

Representative samples from different locations from different horizons were collected. This enabled the author to obtain a clear insight into the behaviour of sediments laterally as well as vertically. The actual mode of occurrence of the various lithological types identifiable in the field and their temporal and spatial relationships. Paleosol horizons and those of calcretes were critically examined with a view to understand the influence of climatic factors. The samples collected were subjected to various laboratory analysis to know their gross-lithology, granulometry, mineralogy and genetic aspects.

Though it has not been possible to fix a precise geochronology of the various depositional episodes, paleoclimatic changes and tectonic events, an attempt has been made to provide a broad chronology with the help of (i) global sea-level and climatic curves and (ii) available absolute dates from the Sabarmati, from the neighbouring areas of Saurashtra, Ranns of Kachchh and Rajasthan.

The synthesis of the observations and results has provided a clearer picture of the phenomenon of Quaternary deposition in the north Gujarat plains, the details of which have been presented in the various chapters of this thesis.

GEOGRAPHIC LIMITS

The study area lies between the two major rivers of N. Gujarat, the Sabarmati in the south and the Luni in the north, covering parts of the districts of Ahmedabad and Banaskantha (Gujarat) and Barmer district (South West Rajasthan). Bounded by N. latitudes 22° 15' to 25° 45' and E. longitudes 71° 15' to 71° 15' (Fig. 1.1). The area forms parts of Survey of India Topographical sheet Nos. 46 A, 46 B, 45 C, D, 41 M and 40 0 & P (1 : 250,000 scale).

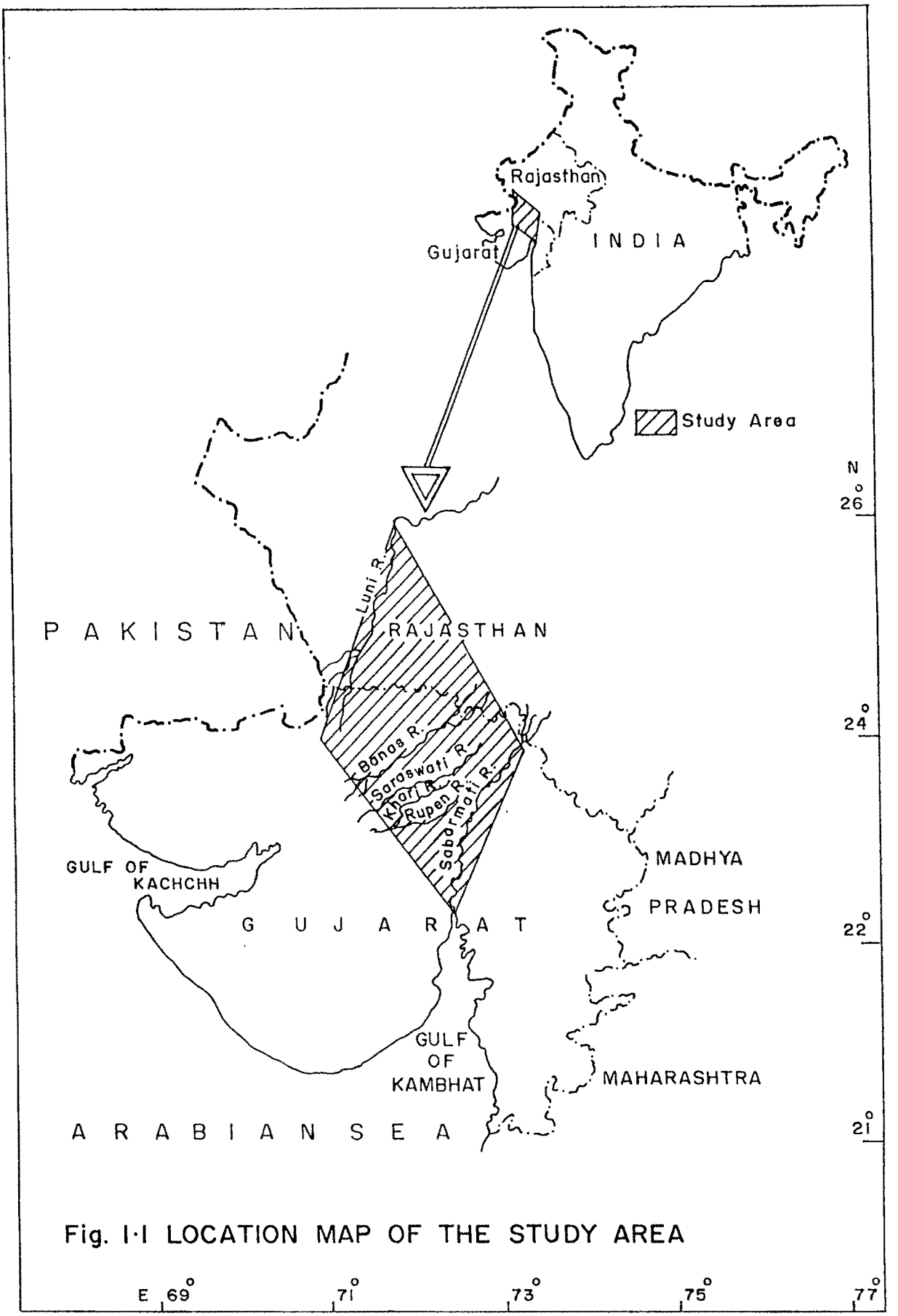


Fig. 1·1 LOCATION MAP OF THE STUDY AREA

PHYSIOGRAPHY AND DRAINAGE

Physiographically, the area flanked by the Aravalli hills in the north and northeast, comprises the alluvial plains of the various rivers viz., the Sabarmati, Rupen, Saraswati, Khari, Pushpavati, Banas and the Luni. To the southwest the boundaries of the area are delimited by the Great and Little Ranns of Kachchh. The average elevation of the area is around 100 m amsl with the heights gradually rising almost from the sea level northwards upto 200 m. The general slope of the area is towards southwest.

A number of rivers and streams traverse the area. Whereas the Sabarmati, Banas and the Luni form the major rivers. Saraswati, Khari, Pushpavati , Rupen and Sukri are the other higher order drainages of the region (Fig 1.2).

The Sabarmati which is the principal river of the study area arises from the Aravalli hills near Wekaria in Rajasthan and flows for a total length of 416 km before emptying into the Gulf of Cambay, the catchment area of the river being 1,433 sq km. The main tributaries meeting the Sabarmati river from northeast and east are Shelwa, Ghela, Andhli, Khari, Vatrak, Meshwo, Hathmati, Wakol and the Shedhi. The Vatrak river, a major tributary originating in Rajasthan flows SSW before meeting the Sabarmati river at Wautha. The Meshwo river originates in the Dungarpur hills and meets the Sabarmati near the village Bhuval. The Khari forming one of the significant tributaries of the Sabarmati originates near Himatnagar, and joins the Sabarmati river near Kheda.

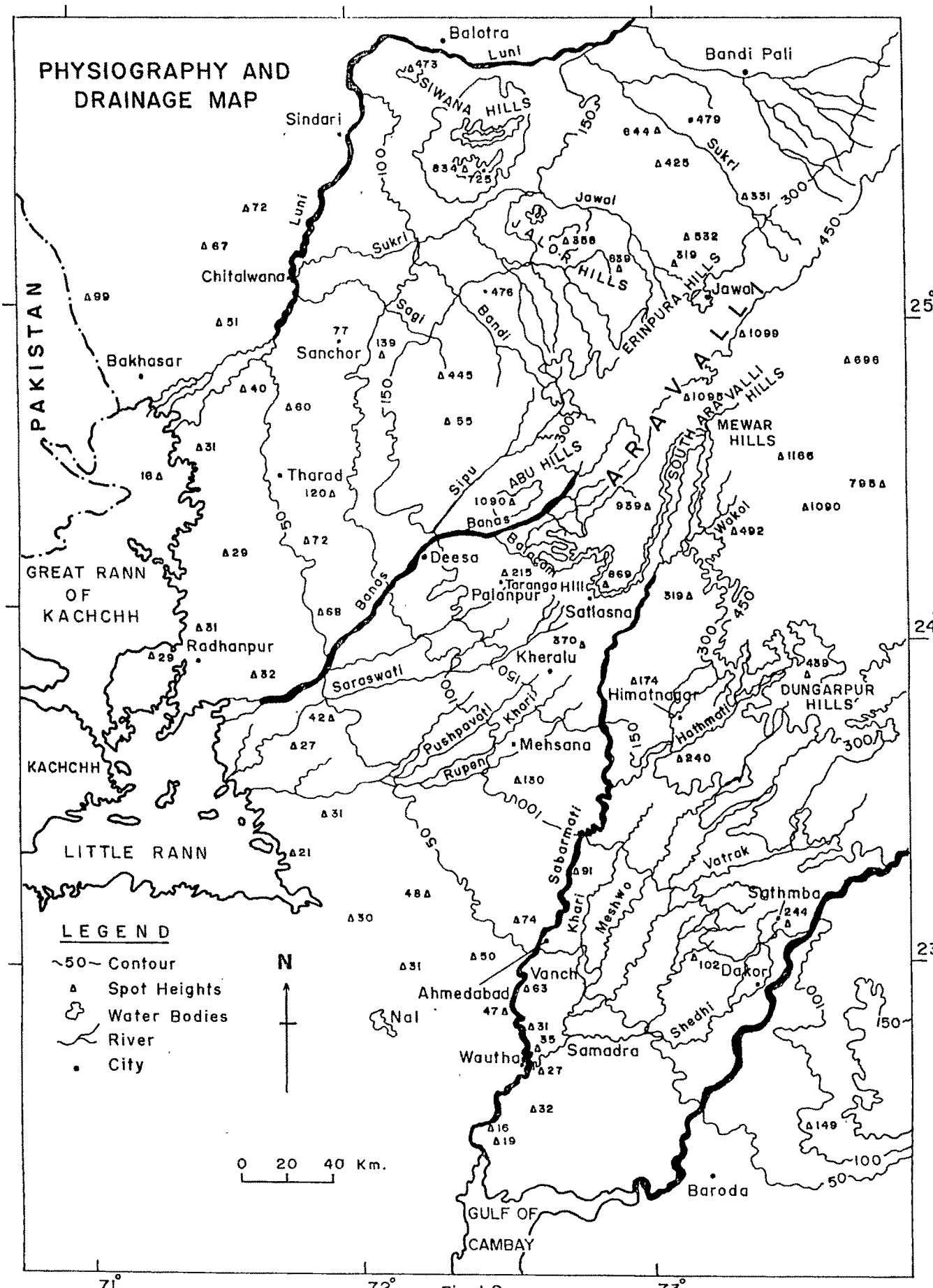

PHYSIOGRAPHY AND DRAINAGE MAP
Balotra
Luni
Bandi Pali
Sindari
SIWANA HILLS
Sukri
Jawal
JALOR HILLS
Chitalwana
Jawal
ERINPURA HILLS
ARAVALLI
PAKISTAN
Bakhasar
Sanchor
Sagi
Bandi
Tharad
Sipu
ABU HILLS
SOUTHARAVALLI HILLS
MEWAR HILLS
Banas
Deesa
Wakal
GREAT RANN OF KACHCHH
Palanpur
Taranga Hills
Satlasna
Radhanpur
Kheralu
Saraswati
Himatnagar
DUNGARPUR HILLS
Pushpavati
Khari
Hathmati
Mehsana
KACHCHH
Rupen
LITTLE RANN
Sabarmati
Vatrak
Sathmba
Meshwo
Vanch
Ahmedabad
Dakor
Nal
Shedhi
Samadra
Wautha
Baroda
GULF OF CAMBAY
LEGEND
50 Contour
Spot Heights
Water Bodies
River
City
N
0 20 40 Km.
71°
72°
73°
25°
24°
23°

Fig 1·2

Most rivers of N. Gujarat originate in the Aravalli and Abu hills. They are entirely dependent on monsoon and dry up during summer. The Banas and the Saraswati arising from the spurs of the Aravalli hills, flow into the Little Rann of Kachchh and remain dry for greater part of the year. These rivers have developed broad and shallow channels in their own sandy and gravelly deposits and are at places 1-2 km wide. The Banas has a total length of 258 km and flows westward into the Little Rann of Kachchh after originating in the Udaipur hills of Rajasthan. Its chief tributaries are the Sipu and the Balaram. The Sipu and the Balaram arising from Nimaj hills and Balaram hills and meet the Banas at Bhadath and Karja near Palanpur, respectively.

The rivers Khari, Rupen and Pushpavati are the minor streams of the study area originating from the foothills of the Aravalli, flow in a WSW direction before disappearing into the Little Rann of Kachchh.

The Luni originates near Ajmer in the Pushkar hills, flows westwards through the desert and then takes an abrupt southward turn at Balotra to meet the Great Rann of Kachchh near Bakhasar. The Sukri river a major tributary of Luni, originating in the Sirohi hills flows westwards and joins the main river near Chitalwana. The Bandi, Jawai and Sagi constitute the other drainage network of the Luni.

FLORA

The plant life of the area has evolved over a long period of time. Changes in climate and the areal extent of land and water bodies through changes in

drainage networks, movement of sea and the anthropogenic changes have led to a marked diversity in the distribution and character of plants.

The wide variations in climate and topography of the region have resulted in various types of forest growth. The alluvial plains are mostly devoid of forest cover. Natural growth in reserved and protected forests of Ahmedabad district consists of Baval, Awal, Khijda, Cassia, Piluri and Xerophilous plants, a flora characteristic of semi-arid to arid climate.

The other species seen in this region are the `Puccawood" trees prevalent in Palanpur area of North Gujarat, and include varieties of (i) *Acacia Catechu willd*, (ii) *Acacia arabica willd*, iii) *Diosypeos Melanoxylon Roxb* and (iv) *Salmalia malabalica.*

FAUNA

The essential uniformity of the terrain in the south and the usage of land mostly for intensive agriculture has led to the air fauna being rich and varied as compared to the sparse mammalian fauna. However in the northernmost parts, the mammalian fauna are quite abundant.

The mammals are typified by the various domesticated animals like the cattle (cows and buffaloes), camels, sheep, goats which belong to the Order Artiodactyla and family Bovidae. To the same family belongs the once abundant but now restricted to the fringes of the Rann, the Indian Blackbuck (*Antelope Cervicapra*) and the elegant Indian Chinkara Gazelle (*Gazella gazella*). The cat family (Felidae) being represented by the Leopard (*Panthera pardus*) and the

jungle cat (*Felis chaws*), jackals, hyaena, the mongoose and the smooth Indian otter are some of the other wild life of the region.

From the order Insectivora is the Grey Musk Shrew and its family and from the order Chiropetra, family Vespertilionidae are the bats. The area bordering Rajasthan still has a few sloth bears (*Melerssus Ursinsus*), which after the extermination of the Tiger(*Panthera tigris*)from the forests has become the largest carnivora in the area.

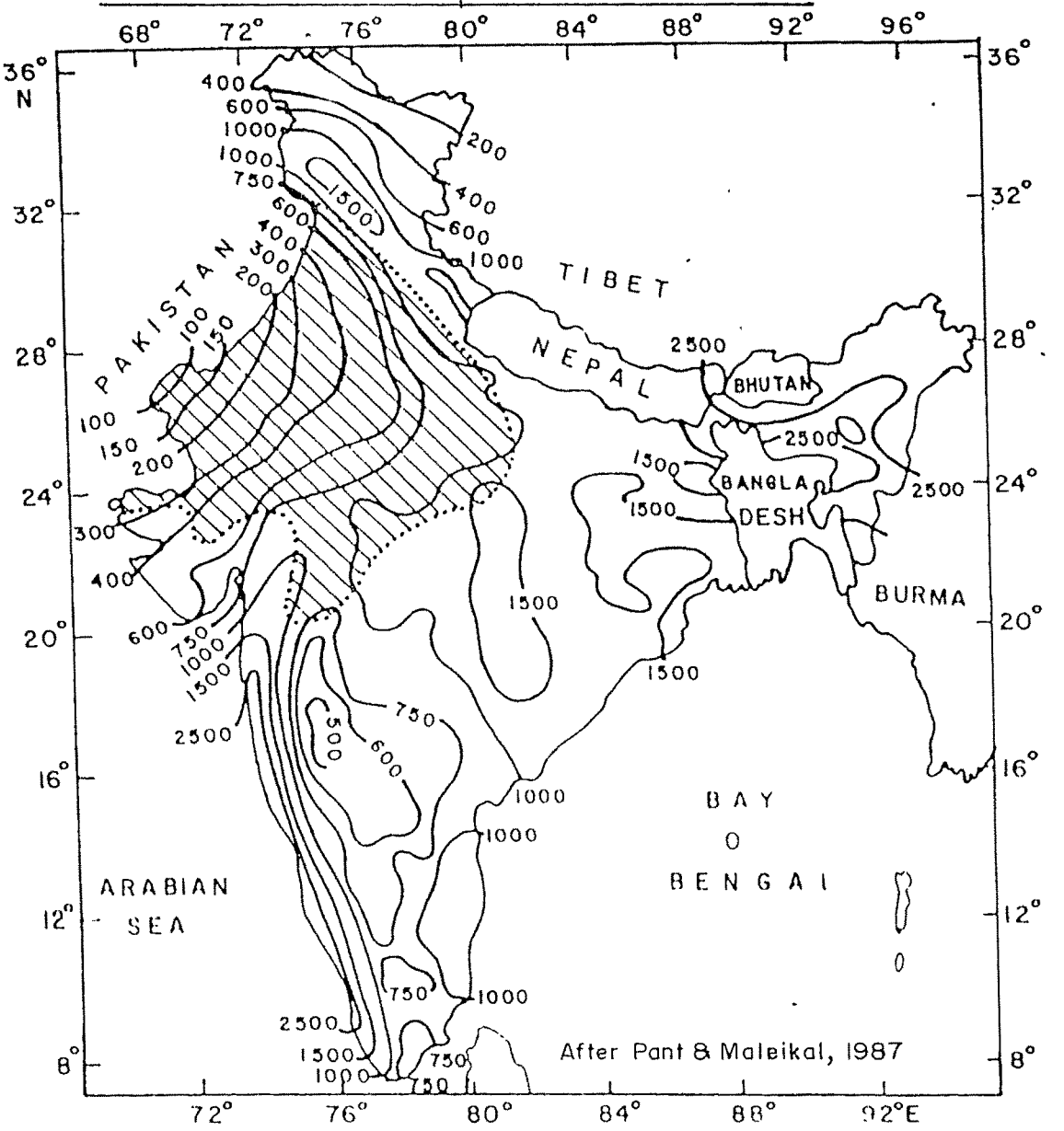
The Banaskantha region has about 400 species of birds divided into 60 families grouped into 18 orders ranging from small to medium sized birds aquatic in nature to the birds of prey (Eagles, Vultures. Hawks etc).

CLIMATE AND RAINFALL

The area falls within the arid and semi-arid zones and is well demarcated by the variability of annual rainfall and high annual temperature extremes (Fig. 1.3). The climate in general is dry except for the monsoon season. The winter season starts from December upto February. Summer approaches from March and peaks in May and June. The monsoonal rain starts from the middle of June and continues upto September.

During the summer months, the mean daily maximum temperature is around 40^{o}C and mean daily minimum temperature around 25^{o}C, although temperatures touching peaks of 44-45^{o}C are not uncommon. Clear skies, low humidity and light northeasterly, northerly and northwesterly winds characterise the winter season. During the coldest month of January the normal minimum

Fig. 1·3 ANNUAL ISOHYET MAP OF INDIA



temperature varies from 7°C to 18°C (mean around 14°C); occasionally the mercury dips below to 3-4°C.

In winter, the surface and low-level circulation of the entire Indian sub-continent is dominated by the outflow of dense air from the very cold Siberian land mass. During this season, clear skies, characteristic of anticyclonic conditions over northwestern India, give way to sporadic spells of cloudy skies and precipitation when eastward moving systems in association with middle latitude westerly winds, known as Western disturbances, give rise to cyclonic circulation at low altitudes over Pakistan and northwest India (Pant and Maliekal, 1987). These Western disturbances affect northwest India, but since the air is hot and dry with surface sediments of fine grained sand and alluvium. severe dust storms are produced in the region (Middleton, 1986).

Monsoon weather sets in the southern portion of Gujarat State by the second week of June, advances into north Gujarat and Southeast Rajasthan by early July. The entire Rajasthan State is covered by middle of July. Depressions may also form in the northeast or east central Arabian Sea early in June bringing the monsoon lows into Gujarat and then Rajasthan, providing relief from the scorching sun. The withdrawal of the monsoon commences first from W. Rajasthan by the beginning of September and takes roughly a fortnight to complete its withdrawal from N. Gujarat.

The mean annual rainfall of the region varies from 800 mm in the north Gujarat alluvial plains to around 450 mm in southwest Rajasthan (Singh *et al.*, 1991). The rainfall pattern (continuity, intensity and frequency) is of great importance for this region, particularly as it is situated on the margins of the desert

in which natural and agricultural ecosystems are highly sensitive to small variations in rainfall.

COMMUNICATION AND TRANSPORT

Ahmedabad, Gandhinagar, Himatnagar, Mehsana, Palanpur, Deesa, Radhanpur, Tharad in N. Gujarat and Sanchor and Balotra in S. Rajasthan are the major cities of the study area. The cities are well connected by all weather tar roads with most of the surrounding villages (Fig. 1.4). National Highway No. 8 connecting Ahmedabad with Delhi and No. 15 connecting Tharad with Sanchor and passing through Rajasthan are the major National highways of the Study area. State Highway Nos. 61, 68, 69, 90, 93, 104, 120, 130 and 163 link all the other cities. The more interior villages can be approached by metalled roads, jeepable in fair weather and by cart and foot tracks. State Transport bases and private jeeps are the chief means of communication in the area and ply to most of the villages. The area also has a good railway system with all the major cities linked by metre gauge railway.

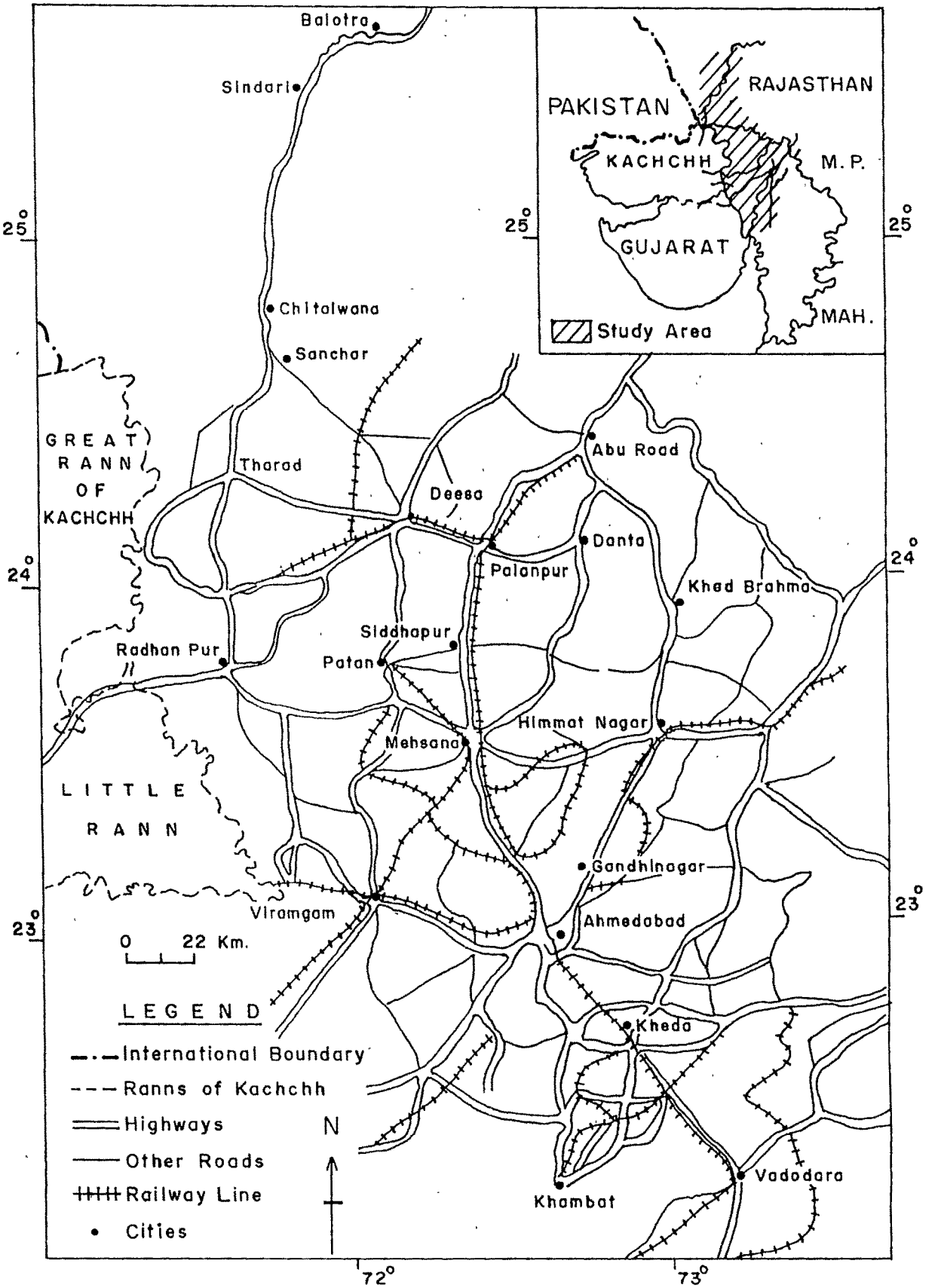


Fig. 1·4 COMMUNICATION MAP