OVERLAY AND DEFINITION OF PROBLEM

OVERLAY AND DEFINITION OF THE PROBLEM

BARODA - A NOSTALGIC RIDE ALONG THE HISTORY LANE

The state of Gujarat is situated along the west coast of India between latitudes 20.1° & 24.7° north and between longitudes 68.4° & 74.4° east. With an area of 187, 090 Sq Km. (72,235 Sq. miles), the state constitutes approximately 6% of the total area of the Indian Republic. Gujarat became a separate state in 1960 as a result of bifurcation of the former Bombay state (Fig- 1). The city of Baroda which was the capital of the erstwhile princely state, is situated along the Bombay-Ahmedabad rail route at a distance of about 400km north of Bombay and 100 Km south of Ahmedabad. The cultural history of Baroda dates back to the mid-pleistocene period (about 2, 00,000 years ago), when early man lived on the banks of the river Mahi (Fig- 2), which must have formed the flood-plane at that time. There are evidences for existence of early man of paleolithic or old stone age in the Mahi river valley, at a number of sites within 10-20 km to the north and north-east of the present day Baroda (Barodawala,

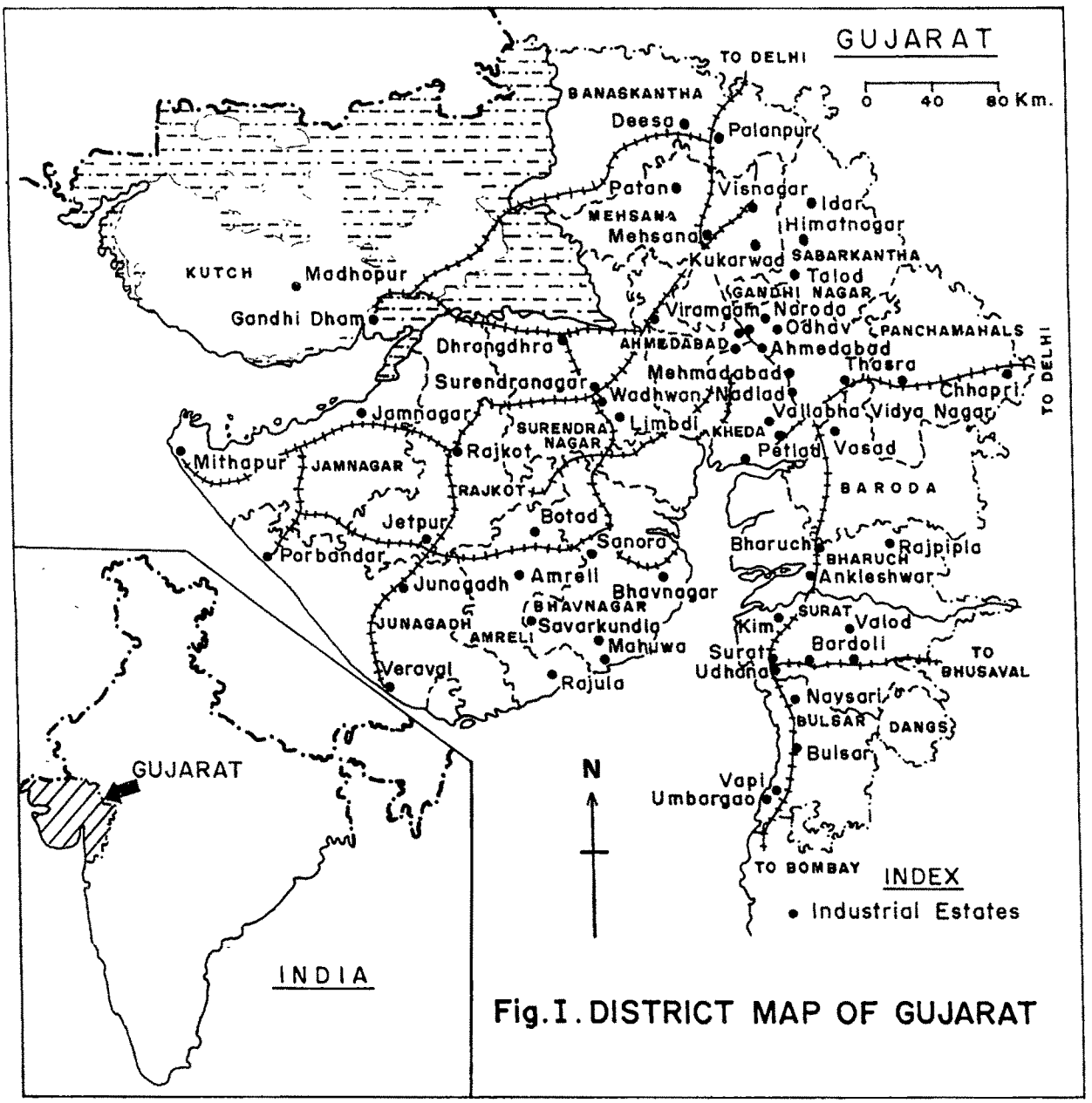


Fig. I. DISTRICT MAP OF GUJARAT

Figure 2 : Ravines of River Mahi, the supposed site of early human settlement


2

1990). The next phase in the pre-historic development of Baroda witnessed the first human settlement. This human settlement which flourished, dates back to 1000 B.C. (Barodawala, 1990). Around the beginning of the christian era (about 300 A.D.), a small township developed at the same spot where the above mentioned settlement flourished on the right bank of the river Vishwamitri (Fig- 3), which came to be known as Ankotakka (Fig- 4) i.e., the present day Akota. The mound on which the settlement was estabilished came to be known as "Dhantekri". Due to its location on the ancient trade route between Gujarat and Malwa, this township flourished into a commercial centre and is said to have had a commercial link with Rome.

The township of Ankotakka developed during the rule of Guptas and Vallabhis. The township was subjected to periodical heavy floods and one such severe flood forced the inhabitants to abandon this township and move away from the bank of the river Vishwamitri. This event occurred during 600 A.D. and, the inhabitants moved to the east of Ankotakka, to another elevated portion which coincides with the present Kothi area and formed the nucleus of a new township named Vadapadraka (Figs- 3,5), so named due to abundance of banyan trees. This township occupied an area of about 2.5 Sq km and, between 600 & 1000 A.D., there was constant shifting

Fig.3. MAP SHOWING THE HISTORIC DEVELOPMENT AND DIRECTION OF GROWTH OF BARODA, BETWEEN 1000 B.C. TO 1500 A.D

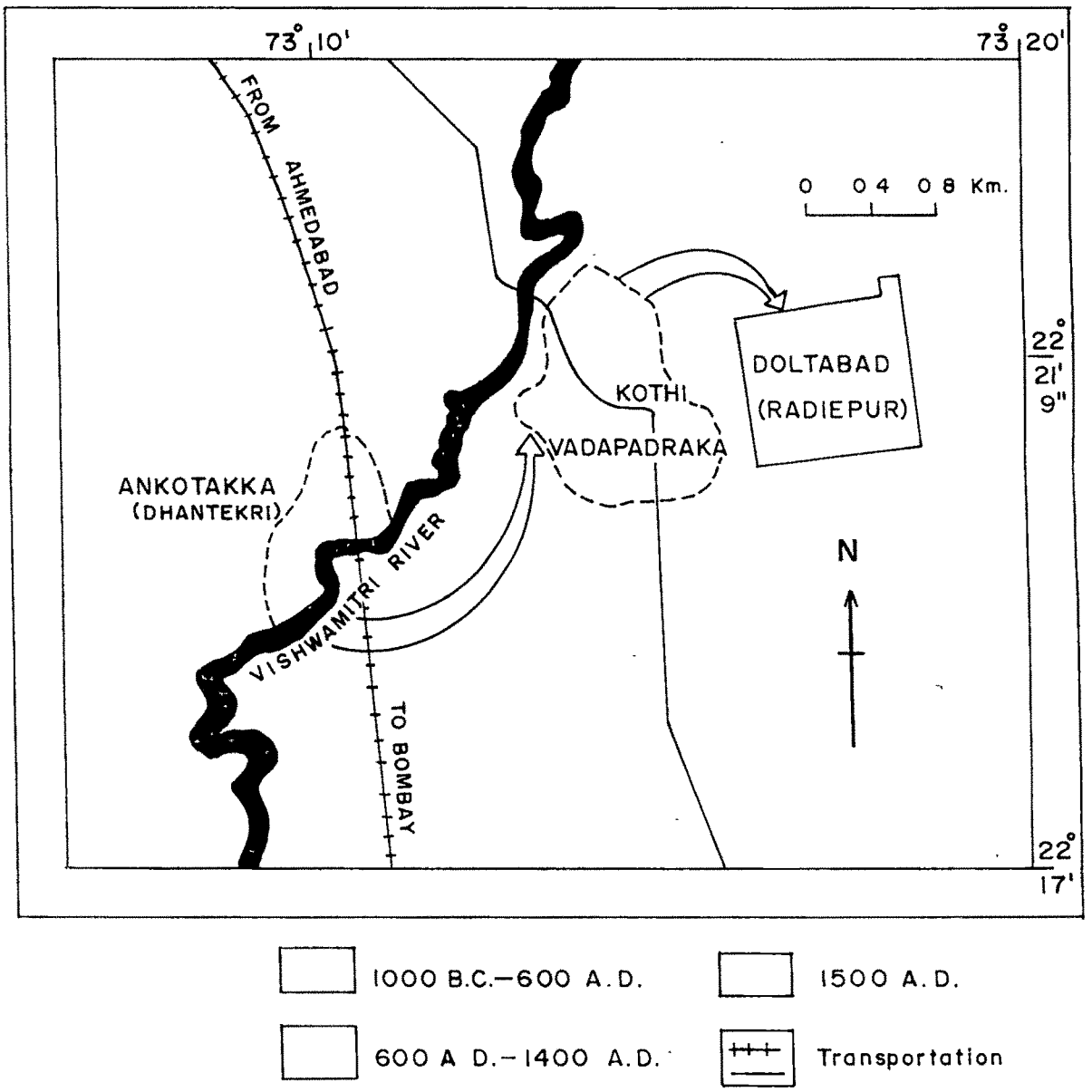


Figure 4 : Present day Akota, the site of human settlement on the bank of river Vishwamitri, the then Ankotakka.

Figure 5 : Present day Kothi, the then Vadapadraka to which the human settlement shifted form Ankotakkka.

4

5

of habitation between Ankotakka and Vadapadraka. The development of Baroda continued with the Kothi area as the nucleus of this habitation and between 1100 and 1400 A.D., the growth spilled towards north. In 1500 A.D., Vadapadraka (present Baroda) was given as Jagir by Mohammad Begra to his son Prince Khalil Khan. After he become sultan Muzaffar Shah II in 1511 A.D., it is said that he founded a new town named "Doltabad" (Fig- 3). He built the modern fort of Baroda occupying an area of 0.6sq. km, one and a half miles east of Vadapadraka (Fig- 6). This new township was called "Radiepur" according to Wollebrandt Geleynseen de Jongh, an officer in the Dutch East India company. After the construction of the fort, several lakes were constructed towards the north and east of the fort for supply of water to it. The area of the fort expanded towards east and south and the city was limited to an area within four gates. Vadapadaraka was later inhabited by the Marathas. The Maratha invasion (as represented by the present Gaekwad family) of Baroda in 1734 was celebrated by the construction of the Mandvi gate in 1736 (Fig- 7) by Malhara Rao Gaekwad. Baroda was ruled by the then Fathesingh till his death in 1836. In the 18th century, one of the landmarks of the present day Baroda, the Sursagar lake, was made in order to augment water supply to the western part (Fig- 8). In this phase of turbulent Indian history, Arabs, who had the control of the 4 gates, due to

Figure 6: The wall of old fort built by sultan Muzaffar Shah II at Doltabad to the east of Vadapadraka.

Figure 7 : Mandvi gate built by Malhar Rao Gaekwad in 1736.

6

7

Figure 8 : The sursagar lake built in the 18th centuray for supply of water to the western part of Baroda. Now totally beref it of the old charm and usage.


સુરસાગર નૌકા વિહાર

some infighting among Marathas, ultimately agreed to leave Baroda peacefully under British mediation and, a British resident was posted.

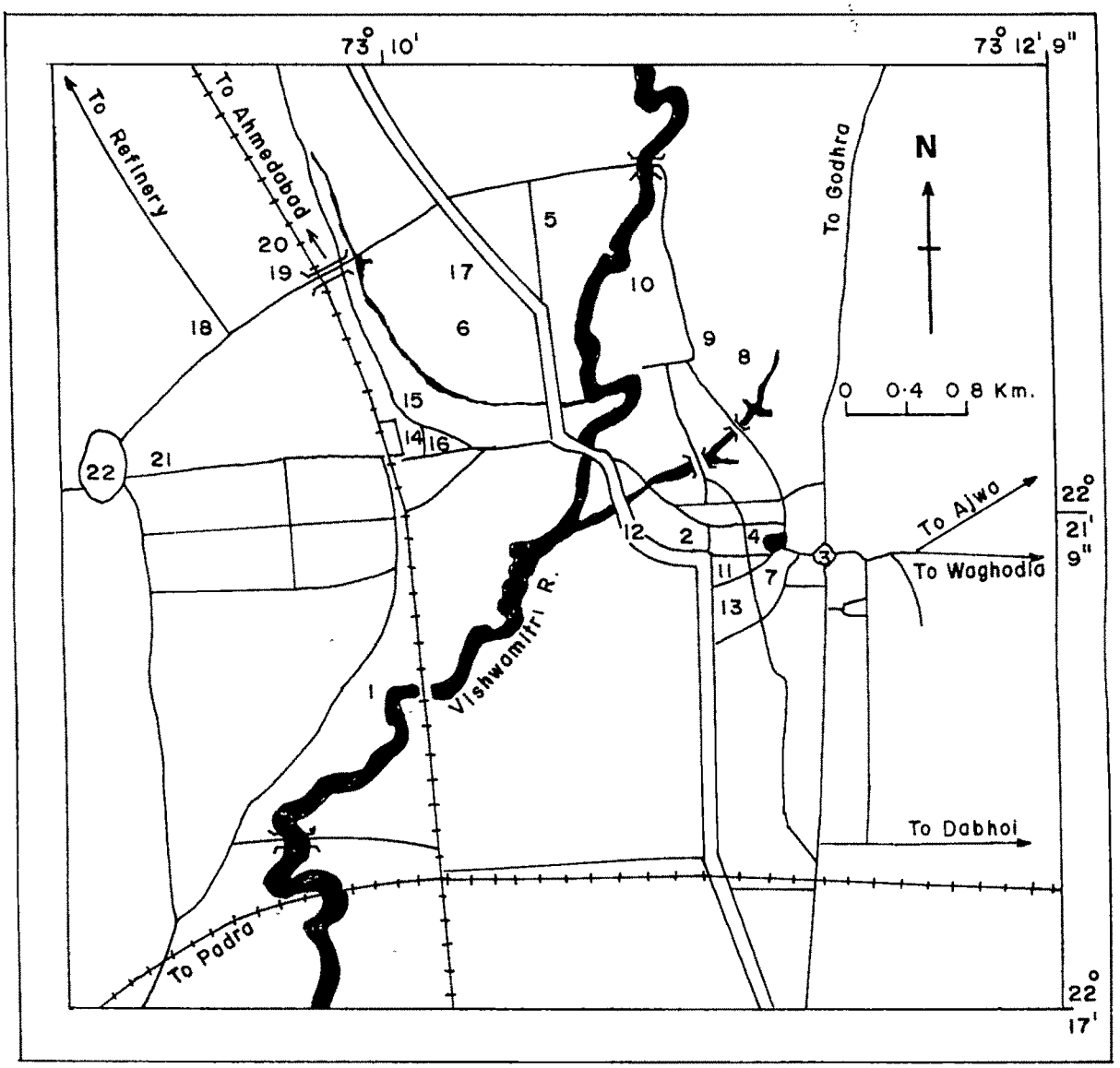
With the coronation of Sayajirao in 1875, an era of peace and order descended in the history of Baroda. Most of the developmental activities took place to the west of the Sursagar lake and the western margin was marked by the Viswamitri river (Fig- 9) The population of Baroda in 1872 was 1,16,274 and the total area occupied by Baroda in 1876-78 was 12,70 square km. (Table 1, Fig- 10)

The Baroda college was built in 1882 by acquiring the agricultural land lying between the present day Railway station and Viswamitri river owned by a certain Sureshwar Desai. The land around the Baroda college was used as a playing field and, this area was used to build more educational departments, houses and hostels later. The construction of Ajwa lake was started in 1885 and was completed in 1890 which was used mainly for the supply of drinking water to the Baroda city (Fig- 11). The catchment of Ajwa lake lay in the Pavagadh hills, constituted by a series of lava flows which had undergone magmatic differentiation.

INDUSTRIALISATION

Traditionally, Gujarat is one of the main states of

Fig. 9. MAP OF BARODA SHOWING IMPORTANT LANDMARKS DURING ITS GROWTH BETWEEN 1511 A.D. TO 1947 A. D.



LOCATION INDEX

1 Akota	8 Kareli Baug	15 Sayajigunj
2 Kothi	9 Mental Hospital	16 Hirak Baug
3 Mandvi	10 Sayajibaug	17 Pratapgunj
4 Sursagar	11 Dandia Bazar	18 Sarabhai Chemicals
5 Fatehgunj	12 Indira Avenue	19 Jyoti Ltd
6 M.S. University / (Baroda College)	13 Khanderao Market	20 Alembic Glass
7 Nyay Mandir	14 Railway Station	21 Alkapuri
		22 Racecourse

TABLE 1: STATEMENT SHOWING VARIATION IN POPULATION OF BARODA FROM 1872-2001

YEAR	MALE	FEMALE	DECADE VARIATION + / -	DECADE VARIATION (in %)	AREA OF BARODA CITY (BMC LIMIT) (in Sq.km)
1872	63524	52750	-	-	12.76
1881	56750	49762	-9762	-8.39	12.76
1891	62871	53549	+9908	+9.30	12.8
1901	56009	47781	-12630	-1084	12.8
1911	53616	45729	-4445	-4.28	12.8
1921	51555	43157	-4633	-4.66	13.02
1931	62744	50116	+18148	+19.16	13.21
1941	84666	68635	+40441	+35.83	13.21
1951	113518	97889	+58106	+37.90	16.91
1961	166852	142864	+98305	+46.50	47.7
1971	252080	214616	+156980	+50.68	57.5
1981	388723	345750	+267777	+57.37	108.2
1991	611733	544106	+421367	+57.37	187.2
2001*	966256	859834	+670250	+57.37	347.3

* Data based on Projections

Source : Statistical atlas of Baroda State (1946)
Census of India, Baroda district (1951, 1961, 1971, 1981 part XII A and B)

Fig.10. DIFFERENT PHASES OF BARODA URBAN SPRAWL

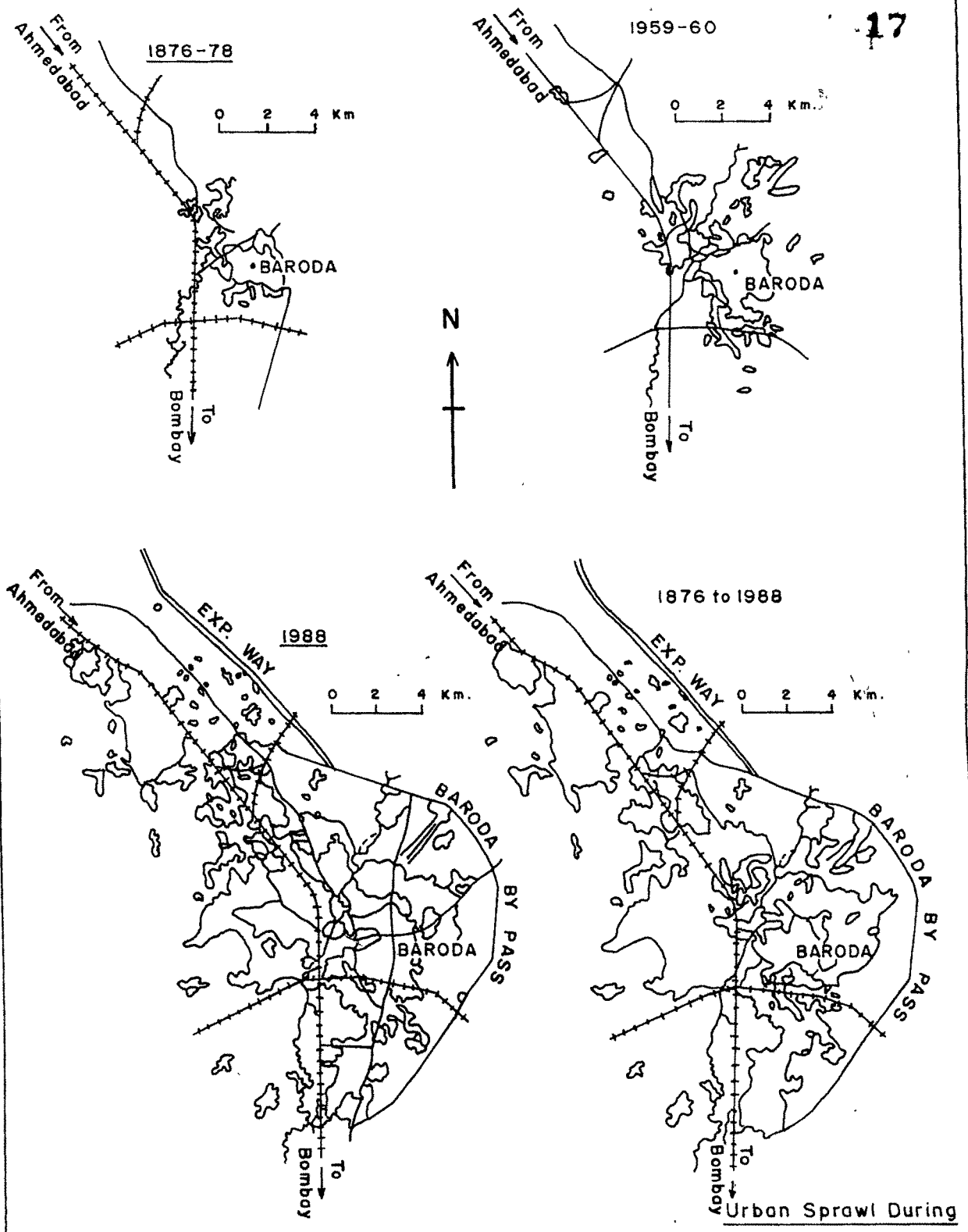


Figure 11: Ajwa lake constructed in 1890 for supplying drinking water to Baroda city.

Figure 12a: Nyaya mandir built in 1891 now housing the civil court.

Figure 12b: Nyaya mandir gate, the western gate of old Baroda city.

11

12 a

12 b

of Baroda was merged with the Bombay state. There was no major industrialization during this period but the residential area called Alkapuri came into existence during this time (Figs- 9, 21). The population of Baroda city increased significantly between 1931 and 1951 (Table 1), mainly due to migration from other states for employment in the above industries and also due to flourishing educational opportunities available at the then Baroda college.

Gujarat became a separate state in 1960 and Baroda city became the district headquaters. The population of Baroda city in 1961 was almost double than that in 1951 (Table 1) and the area of the then Baroda urban complex was 23.66 sq km (Table 2 and Fig- 10).

The discovery and commercial exploitation of oil and gas in the state of Gujarat led to rapid industrial growth. Nearly thousands of oil wells have been drilled and the largest output of Oil (2.5 to 3 million tons per annum) is from the Ankleshwar wells situated about 40 km south of Baroda. The gross daily output of oil from the state has been estimated to be over 0.02 million tons per day. Near about 10,000 industries have been established in the entire state and the bulk of these industries are located in the large industrial complexes around the cities of Ahmedabad, Baroda, Surat, Valsad, Rajkot, Vapi and Jamnagar. On the

TABLE 2 : URBAN SPRAWL OF BARODA CITY

(INCLUDING RESIDENTIAL AND INDUSTRIAL AREAS, AND EXCLUDING OPEN VACANT LAND)

SR.NO	CATEGORY (AREA IN sq.km)	BEFORE URBANISATION AND INDUSTRIALISATION		AFTER URBANISATION AND INDUSTRIALISATION
		1876-78+	1959-60+	1988*
	[A] Residential Area			
1.	Densely populated	5.63	13.06	14.50
2.	Moderately populated	4.07	7.32	13.20
3.	Sparsely populated	3.00	0.50	11.02
	[B] Mixed built-up Area	-	1.18	20.50
	[C] Recreational Area	-	1.60	1.55
	[D] Industrial Area	-	-	21.56
	TOTAL	12.70	23.66	82.33

\+ Based on Survey of India Toposheet Nos. 46 F/3, 4, 7 years 1876-78 and 1959-60.

* Based on SPOT_I HRV_2 MLA band $B_1G_2R_3$ dated 15th January 1988.

India, which was rich in cotton textile industries and engineering units. In 1885, several small scale textile industries were started on the western bank of Viswamitri river in Baroda, a year during which the underground drainage system of the then existing Baroda city was commissioned. In 1891, Nyaya mandir building was built (Figs- 12a,b) and in 1898, the mental hospital near the present Karelibaug was built (Figs- 9,13). In 1906, the walls of the old Baroda fort were broken and connecting roads were made in all directions. The area to the north of the present palace and residence of the erstwhile royal family, was covered by thick vegetation (Figs- 14a,b). The present road connecting Sayaji Baugh (Kamati Baug; Figs- 15a, b) and Dandia Bazar (Figs- 9, 16) now known as Indira avenue used to be a tree lined bouleward. The first commercial building, the Khande Rao market (Figs- 17a,b) was built in 1907.

Though chemical and pharmaceutical industries have been a more recent addition in Gujarat, as early as in 1943, three large industrial concerns i.e., Sarabhai Chemicals, Alembic Glass and Jyoti Ltd. preceded by Alembic Chemicals in 1909, were started in Baroda (Figs- 18-20). All these were located on the banks of a small tributary of the river Viswamitri for easy disposal of their effluents. In 1947, with India attaining independence, the princely state

Figure 13: Mental hospital at Karelibaug built in 1898.

Figure 14a: Baroda palace, the royal residence of Gaekwads seen from the western side.

Figure 14b: Main entrance of Baroda palace, on the eastern side along the road coming from Kothi down south.

13

14a

14b

Figure 15a: Present day Kalagoda circle. On the far side can be seen the entrance ot Kamatibaug.

Figure 15b: A view of the Kamatibaug from the inside.

Figure 16: Present day Dandia Bazar - The road that was built to connect Baroda city with Indira Avenue (far end)

15a

15b

16

Figure 17a: Khande Rao market, the first commerical building built in 1907

Figure 17b: The main gate of Khande Rao market facing north.

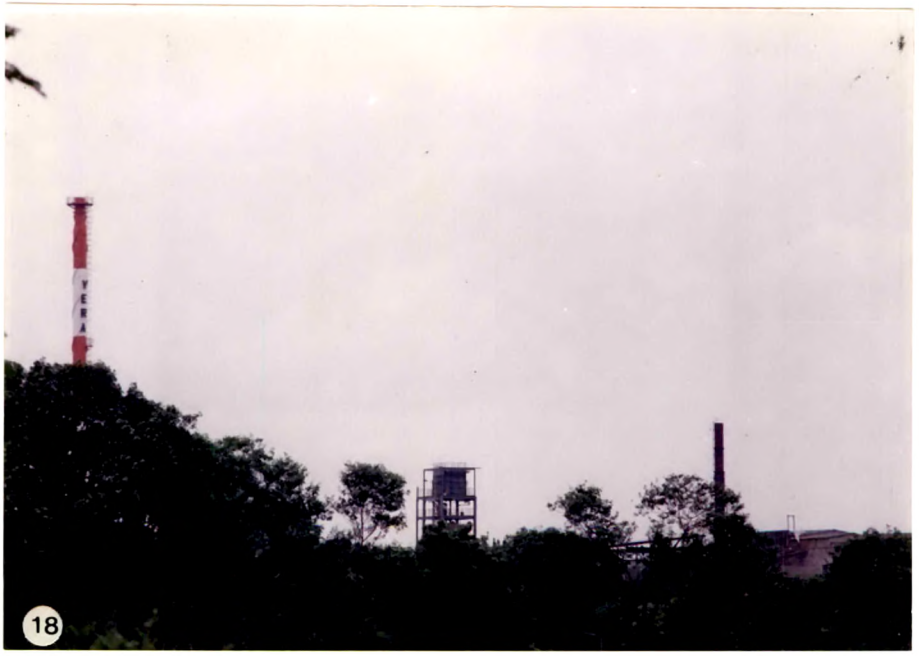
17a

17b

Figure 18: Alembic glass factory started in 1943 (behind the trees)

Figure 19: Sarabhai chemicals started in 1943 (The structure behind the white board on the far side)

Figure 20: Jyoti Industries Ltd. started in 1943 (behind the compound wall on the farside).



18

19

20

Figure 21: Alkapuri road leading from station towards main Alkapuri area

21

industrial map of India, Gujarat occupies third position behind West Bengal and Maharashtra. About 30% of cotton textiles, 95% of soda ash and over 55% of salt are produced in Gujarat.

The first major chemical industry to be set up in Baroda was the Universal Dyestuff Industry at Sankarda in 1960, about 10 km north of Baroda on the banks of the river Mini. The easy accessibility of this river as a disposal bin seems to have influenced the setting up of other giant industrial complexes like the Gujarat State Fertilizer Corporation (GSFC 1962), the Gujarat Refinery (1965) and the Indian Petrochemical Corporation Ltd. (IPCL,1969) (Figs- 22-24). All these mega industries have been responsible for severe atmospheric pollution as well as indiscriminate disposal of their effluents into the Mini and Mahi rivers. The mega Nandesari chemical industrial complex was setup in 1967 in the vicinity of the above mentioned mega complexes with many of the small industries located in this zone dependent on the mega industries for their raw materials. The effluents from these industries were also indiscriminately dumped into the nearby gullies and ravines connecting these rivers. Another industrial complex was established at Makarpura in 1960's housing mostly engineering and some chemical units. The atomic energy commission erected the

Figure 22: GSFC started in 1962 (entire complex in the background)

Figure 23: Gujarat Refinery started in 1965. The complex visible in the back drop with burning waste gas chimneys (arrows)

Figure 24: Indian Petrochemicals Corporation Limited (IPCL) started in 1969; a complex in the back drop.


22


23


24

Heavy Water Plant in 1974 adjacent to the G.S.F.C. The industrialization of Baroda city is so vast that the city is dotted with industries all over (Fig 25) The largest industrial complex in the state is a fast developing one at Baroda in an area of about 30 Sq km between the villages of Bajwa and Koyali on the north west and between Chhani and Nandesari further up along the National Highway, number 8 (Fig- 25 boxed area). The industries are of diverse type consisting of petroleum based, chemicals, fertilizers, petrochemicals, synthetic polyester, nylon, rubber, dye stuffs, pigments, pharmaceuticals and heavy water besides fringe engineering and ancillary units. The rapid industrialization of Baroda is well reflected in the steep population increase from 3,09,796 in 1961 to 7,34,473 in 1981 (Table 1). With continuing mushrooming of medium and large scale chemical units around the nucleus of the Nandesari complex, both, population as well as, aerial and water pollution loads increased tremendously.

ENVIRONMENTAL POLLUTION - EFFLUENT PROBLEMS

Most convenient disposal dump of effluents from the above industrial belt has been the river Mahi and its tributary Mini. The Mahi river originates from the Vindhya hills near the village Sardarpur in Dhar district of Madhya

Fig 25 INDEX MAP OF BARODA SHOWING THE LOCATION OF INDUSTRIES

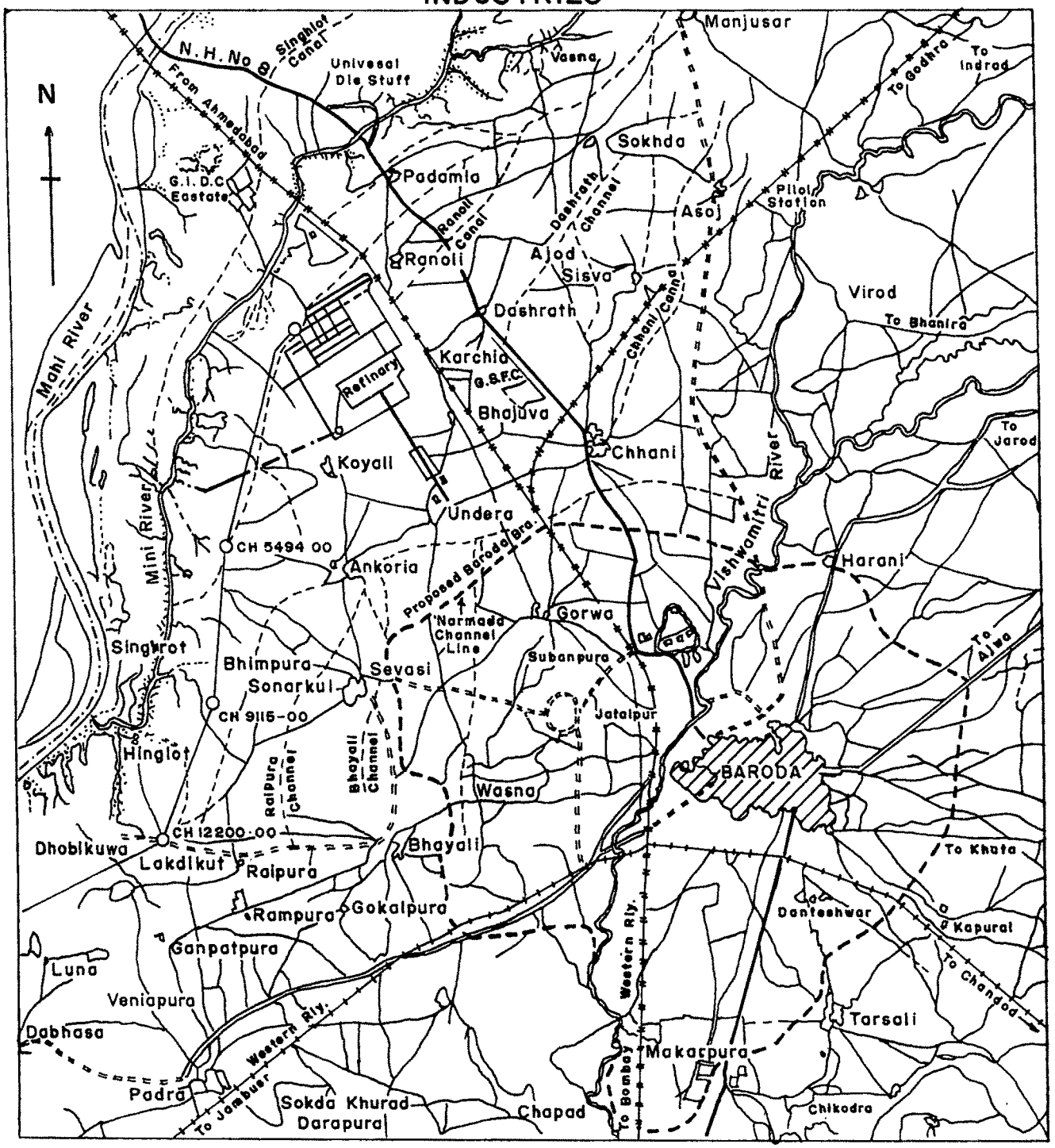
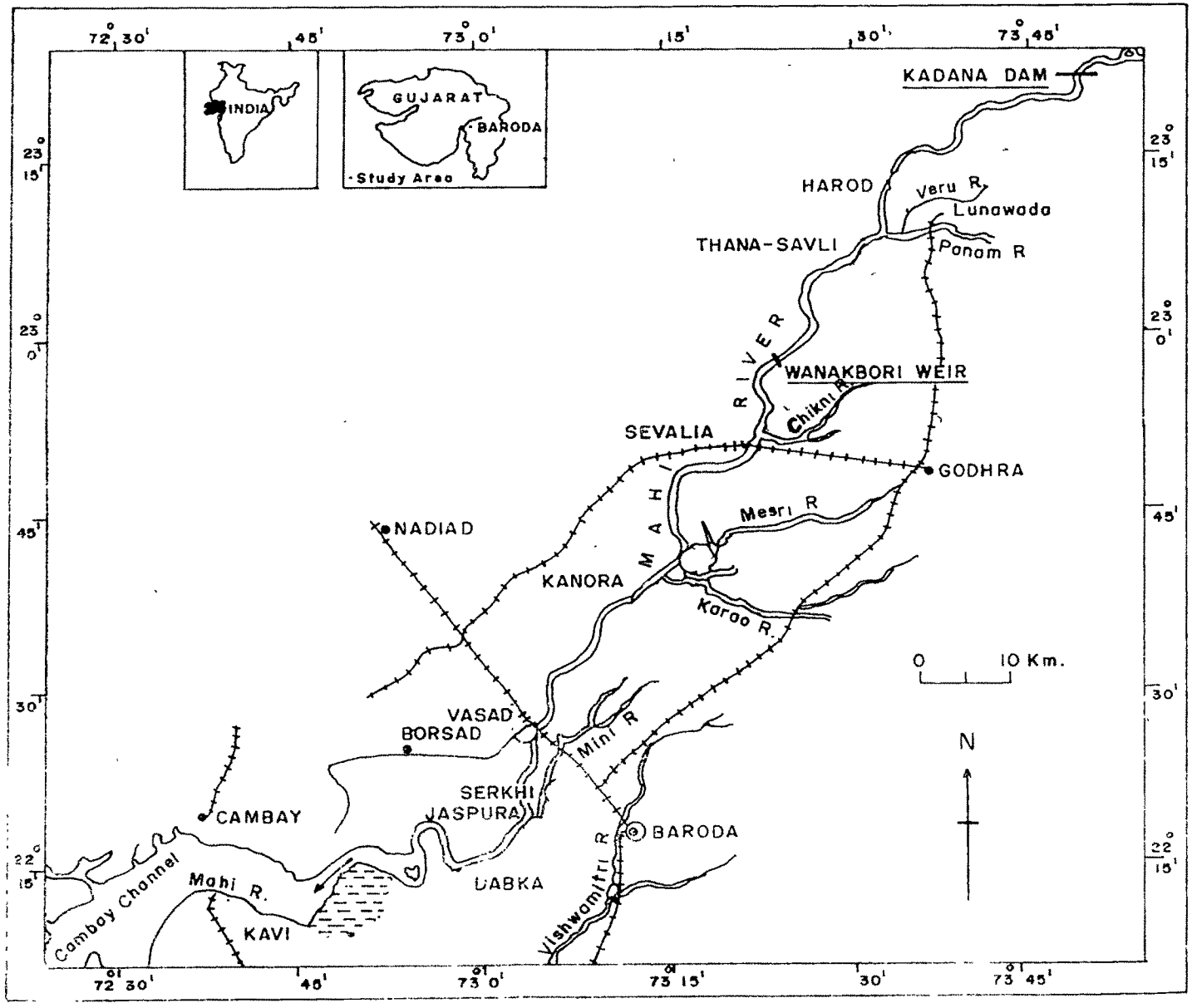


Fig 26 MAP OF MAHI RIVER AND MINI RIVER AND THE OPENING OF THE MAHI INTO THE GULF OF CAMBAY.



Pradesh. It flows through the state of Madhya Pradesh and Gujarat over a distance of 600 km (360 miles) before it joins the Arabian sea at the Gulf of Cambay (Fig- 26) The Mini river, a tributary of Mahi originates at a point about 30km north east of Baroda. It courses parallel to Mahi & flows towards west before rejoining Mahi between the villages of Jaspur & Sindhrot about 15 km downstream of Vasad (Fig- 26). It crosses the national highway & the railway line to Ahmedabad at a distance of 16 km from Baroda (Fig- 27).

The disposal of industrial wastes into the river Mahi through Mini dates back to 1962 when the Universal dye stuffs limited, a small factory located on the right bank of the Mini river commenced production. Later, in 1964-65 Surhid Geigy Ltd, a factory that manufactures dyes, pigments, textiles, auxillary chemicals, and pharmaceuticals was started at Ranoli. These two factories used to discharge about 0.6 mgd (2725 m^3/day) of waste water into the Mini river. The Gujarat Refinery used to discharge about 2 mgd of waste while, the GSFC used to discharge about 3 mgd (NEERI, 1975.)

The Mini river, a seasonal one, has served as a major receptacle of effluents from various industries in the last three decades. Most of the water flowing through this river in the non - monsoon months is the effluents discharged by

Figure 27: Mini river crossing the national highway before Nandesari.


27

Figure 27a: The Mini after Nandesari complex with its effluent load flowing towards its confluence with Mahi.


27 a

the industries. The first reports on pollution of the Mahi river and fish kill came in october 1968. The inhabitants of the villages of Bajwa & Undera are reported to have represented to the Government regarding contamination of water in their village tanks and wells causing the death of some animals. Such complaints became quite recurrent. Large scale fish mortality was also frequently reported from the villages along the river upto Dabka and beyond (NEERI, 1975).

The gargantuan industrial network located in this north-western part of Baroda, in the vicinity of river Mahi, has made this area a hotbed of industrial pollution totally offsetting the lucrative employment opportunities and economic returns that accrue from them. By emitting many obnoxious gases and metals (aerially) and contributing to the phenomenon of acid rains, vast area of fertile land has been turned into totally barren waste land besides, the effluent waste of diverse nature being dumped into the rivers of Mahi and Mini, making them virtually inhospitable for aquatic life and unsuitable for human consumption or use. Ironically, nearby areas of Nandesari, like Koyali and Angadh and also Jaspur and Sindhrot villages lying in the vicinity of river Mini, have ground water contamination problem. Sporadic incidence of death of fishes and cattles after drinking water, has occurred at the confluence point of Mini and Mahi.

The state public health authorities, concerned with the increasing river water, pollution, represented to the Government of India for a thorough investigation and, the ministry of Petroleum and Chemicals of Government of India appointed a technical committee of experts to enquire into the alleged pollution of the Mahi river (Government of India No 7/14/68 OR dt 30-11-1968). Meanwhile, the problem of disposal of waste water by the industries was also under investigation by the scientists of National Environmental Engineering Research Institute (NEERI). Simultaneously, the Public Health Engineering department of Gujarat State had formulated detailed plans based on preliminary- physical and topographical surveys, for constructing a channel to convey the waste water for discharge at a suitable point downstream of Mahi river.

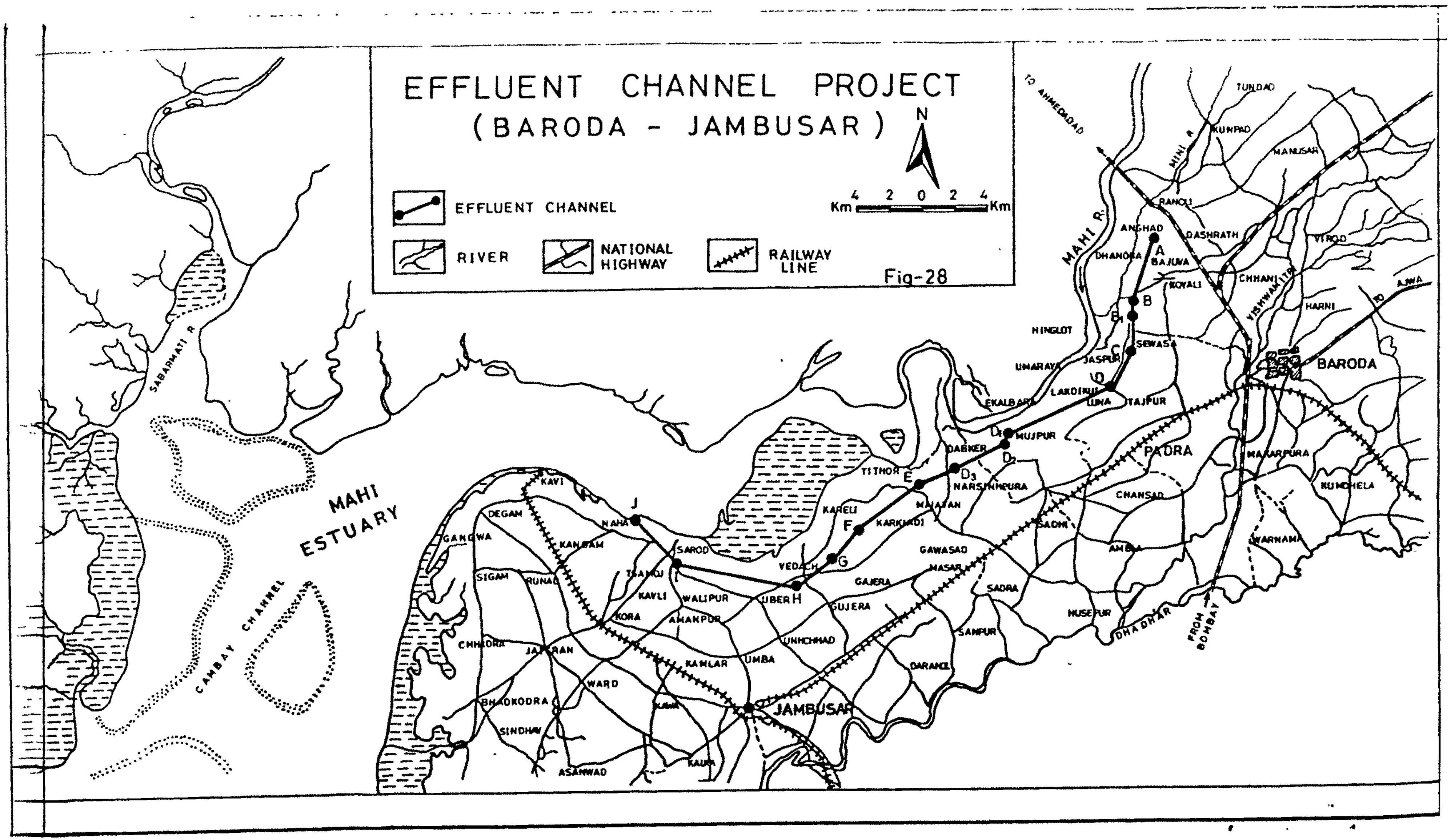
GENESIS OF THE EFFLUENT CHANNEL

As a consequence of this ruckus and rumpu regarding the increased pollution load of the Mahi and Mini rivers, the Government of Gujarat appointed a technical committee in 1969, to fathom the magnitude of the problem and suggest palliative measures. The Committee recommended conveying the industrial waste waters from Baroda to Jambusar for discharge

into the estuary at the Gulf of Cambay. Subsequent to the planning by Gujarat State Public Health Engineering department, and, study on ecological effects, by NEERI and hydrographic survey by National Institute of Oceanography (NIO) between 1972-1979, a decision was made to receive effluents into a common channel and discharge it into the sea at the Gulf of Cambay. Ultimately, a 56 km long, India's only longest effluent channel, passing through the agricultural land of 24 villages of Baroda and Bharuch districts before its termination into the estuary of Mahi river near village Sarod, was built and commissioned in 1983 (Fig-28). Points "A" to "J" marked in the figure represent the alignment points at different villages and point "J" is the terminal point. In the present study "J" Point has been considered as that part of the estuary where the channel effluent gets mixed. Starting with an initial membership of 13 industries, it has currently as many as 150 industries as member participants. The participating industries are required to treat the effluents in their own treatment plants before disposing them into the collection wells at Dhanora from which they are conveyed into the channel.

IMPACT OF THE CHANNEL - OBJECTIVES OF THE STUDY

The channel, a closed conduit of U-shaped bricks


EFFLUENT CHANNEL PROJECT
(BARODA - JAMBUSAR)
N
Km 4 2 0 2 4 Km
EFFLUENT CHANNEL
RIVER
NATIONAL HIGHWAY
RAILWAY LINE
TO AHMEDABAD
TUNDAD
KUNPAD
MINI R.
MANUSAR
RANOLI
MAHI R.
ANGHAD
DASHRATH
VIROD
DHANORA
BAJUWA
KOYALI
CHHANI
VISHWAMITRI
TO AJWA
HARNI
HINGLOT
SEWASA
JASPUR
BARODA
UMARAYA
LAKODIRUI
LUNA
TAJPUR
EKALBARA
MUJPUR
DABKER
PADRA
MAKARPURA
TITHOR
NARSINHPURA
KUNDHELA
CHANSAD
KAVI
MAHI ESTUARY
DEGAM
NAHA
KARELI
KARKHADI
SADHI
WARNAMA
GANGWA
KANGAM
SAROD
VEDACH
GAWASAD
AMBLA
MASAR
SIGAM
RUNAD
TANKOJ
GAJERA
SADRA
KAVLI
WALIPUR
UBER
GUJERA
HUSEPUR
DHADHAR
FROM BOMBAY
CAMBAY CHANNEL
KORA
AHANPUR
SANPUR
SABARMATI R
CHHIDRA
JANTRAN
UNHCHHAD
KAMLAR
UMBA
DARAPUR
WARD
BHADKODRA
KAHA
JAMBUSAR
SINDHAV
ASANWAD
KAURA
A
B
B1
C
D
D1
D2
D3
E
F
G
H
I
J
Fig-28

masonary covered with R.C.C. slabs, provides easy access for human pilferation. During the dry summer months, agricultural activity in the area is severly restricted as the river water is highly saline due to tidal effects and, the ground water in some of these areas are also unsuitable on account of high salinity. In this scenario, the easily accessible effluent channel has become a blessing in disguise for the farmers along the channel as they are able to conveniently indulge in pilferation of the effluent water from the channel by temporary installation of water pumps. Hundreds of such pumps in operation all along the channel during the summer months has become a common sight (Figs- 29a-d). Many different varieties of vegetables and grains are grown on the adjoining lands, irrigating them commonly with the channel effluent (Figs- 30a-l). As these vegetables and grains find their way into the markets of Baroda, there is a risk of entry of potentially toxic chemicals, into the human system. Besides, due to the continuous use of the channel effluent for irrigation for the last one and a half decade, the problem of bio-magnification of toxic chemicals through soil and vegetation poses a great threat for the future. Another matter of great concern is a possibility of contamination of the ground water of that area and, consequently the wells in the area, as these agricultural lands are flanked on one

Figure 29a: A water pump installed along the channel with the RCC slab lifted for access.

Figure 29b: The pipe from the pump leading towards cultivated land.

29a

29b

Figure 29c: A pipe from a pump leading towards built in irrigation cum distribution channels. Note the cultivation along the channel.

Figure 29d: The pump from the channel pumping water into an irrigation channel for taking water to cultivation fields.

29c

29d

Figure 30a: A view of the bajara field along the channel.

Figure 30b:A brinjal field along the channel. note the channel and dried tobacco leaves atop.

30 a

30 b

Figure 30c: A bananna (*Musa paradisiaca*) field along the channel seen in the far ground.

Figure 30d: A field of cotton (*Gossypium hirsutum*) plant grown with effluent water.


30 C


30d

Figure 30e: A parwar (*Trichosanthes dioica*) climber with the fruit (eaten as vegetable)

Figure 30f: Road along the channel flanked by drumstick trees.

Figure 30g: A Bottle gourd (*Lagenaria vulgaries*) field.

30e

30f

30g

Figure 30h: Fodder and vegetables grown along the channel seen in the fore ground.

Figure 30i: Govar (*Cyamopsis tetragonoloba*) field along the channel

Figure 30j: A thick growth of chilli plant.

30h

30i

30j

Figure 30k: A field full of lemon (*Citrus limon*) trees along the channel

Figure 30l: Road leading to "J" point at Sarod with the channel, dried tobacco leaves and brinjal crop on the right.

30 k

30 l

side by the channel (from which the water is pumped into these fields) and the river Mini on the other side, which is highly polluted and totally unsuitable for animal life or human consumption. The genesis of the present study on "The environmental impact assessment along the channel as well as at its site of termination in the Mahi eastuary", is an offshoot of this backdrop. Since the effluent represents a heterogenous mixture of various inorganic and organic chemicals, specifically, metal contamination has been selected for scrutiny and evaluation.

The defined objectives of the present study are :

(1) Water quality assessment (both physical and chemical parameters with emphasis on metals) of the effluent along the channel collected from as many as 58 study points; 53 of the study points are along the channel, 1 at the point of termination, 2 from upstream of the estuary towards Mahi and two downstream of the estuary.

(2) Analysis of estuary sediment for metal content.

(3) Analysis of the soil with regard to heavy metal contamination along the channel corresponding to the above mentioned 58 study points.

(4) Analysis of metal content of the various vegetables, grains and other crops grown in the effluent irrigated lands.

(5) Analysis of histopathological alterations in the tissues of a common fish found in the estuary i.e. the mud skipper *Boleophthalmus dussumieri* (cuvier) and accumulation of metals in selected tissues of this fish.

(6) Analysis of hair of people living in the Nandesari industrial complex for some metals.

Studies outlined in objective 1, 4 and 5 have been carried out for 3 years, during 1990-93 and, the studies under objectives 2, 3 and 6 have been conducted during 1992-94.