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Working Papers No. 100

August 1992

Lush Fields and Parched Throats: The Political Economy of Groundwater in Gujarat

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The Political Economy of Groundwater in Gujarat

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Setu: Centre for Social Knowledge and Action (Ahmedabad)

July 1992

ACKNOWLEDGMENTS

This study is motivated and informed by my first-hand experience of social action in the rural areas of Sabarkantha district (North Gujarat) during the period 1985-90, which included a severe drought. I would like to thank my co-workers in Shramjivi Samaj, especially Karsanbhai, Ramilaben, Nainaben, Heerabhai, Chandrakanth and Mohanbhai both for their companionship during this period and for their contribution to this research. I am also grateful to Khetabhai Solanki, who helped to collect the village data used in the "case study" included in this paper.

Access to secondary data sources was greatly facilitated by the generous cooperation of the Centre for Social Knowledge and Action (Setu, Ahmedabad), the Centre for Social Studies (Surat), the Indian Institute of Management (Ahmedabad), the Institute of Rural Management (Anand), the Indian Law Institute (New Delhi), the Institute of Economic Growth (Delhi), and the Delhi School of Economics. Comments and suggestions from L.K. Atheeq, Amiya Bagchi, V. Bhallabh, Robin Burgess, Rema Devi, B.D. Dhawan, S. Kolavalli, Richard Palmer-Jones, Ashok Panjwani, Girish Patel, Jean-Philippe Platteau, Somshekhar Reddy, Emma Rothschild, Esha Shah, Ghanshyam Shah, Chhatrapati Singh, Madhura Swaminathan and Achyut Yagnik have been extremely useful. Special thanks are due to Mike Scorer for producing the maps with great skill. I am grateful to WIDER for agreeing to circulate this study in its Working Paper series.

My colleagues and friends in Setu have helped in many different ways. I would particularly like to thank Varsha Bhagat, Rohit Jain, Ashok Shrimali and Achyut Yagnik for their unfailing moral support as well as for their helpful comments and suggestions.

There are few words in which I can express my sincere gratitude to Jean Drèze for his unwavering encouragement and patient advice in the course of this work. Aside from editing the draft, he has co-authored section 3.

While carrying out this research, I have benefited from extensive discussions with a number of individuals in the Central Ground Water Board (Delhi and Ahmedabad), the Ground Water Resource Development Corporation (Ahmedabad), the Gujarat Water Supply and Sewerage Board, NABARD, and Ahmedabad Municipal Corporation. I should mention that I have been greatly impressed and touched by their genuine concern and seriousness. More than once my heart went out to them as I witnessed how the indifference of the bureaucracy to their sincere efforts and insights forced them to remain helpless spectators to the ever-worsening and irreversible destruction of groundwater resources in Gujarat. I am most grateful to them all for their cooperation.

The great mission of the Utopia is to make room for the possible as opposed to a passive acquiescence in the present actual state of affairs. It is symbolic thought which overcomes the natural inertia of man and endows him with a new ability, the ability constantly to reshape his human universe.

Ernst Cassirer: An Essay on Man

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ABSTRACT

Groundwater resources in Gujarat (India) have been depleting at an alarming rate in recent years. The most visible symptom of this phenomenon is the decline of water tables in large parts of the state. The scarcity of groundwater is most severe during drought years, when even drinking water is often hard to obtain, but is not confined to those years.

The depletion of groundwater resources in Gujarat cannot be explained by declining rainfall levels. Rather, it is the rapid spread of energised water extraction mechanisms (one aspect of recent transformations in agricultural technology) that has led to enormous increases in draft. Overexploitation and inequity are two closely related features of current groundwater utilisation patterns.

While a variety of measures can be taken to reduce groundwater depletion, most of them have severe limitations due to the current structure of property rights, the unequal distribution of political power and the ineffectiveness of the state bureaucracy. Four types of measures can be distinguished: state regulation of the private sector, positive involvement of the public sector, community management and redefinition of property rights. One particular form of intervention, based on a combination of these different approaches, is suggested in this paper as a useful short-term measure. Ultimately, however, radical changes in property rights are needed to deal adequately with this aspect of the current environmental crisis in Gujarat.

LUSH FIELDS AND PARCHED THROATS:
The Political Economy of Groundwater in Gujarat

INTRODUCTION

The years 1985-88 will be remembered in Gujarat for a long time as "dry years" or "thirsty years". These will be harsh memories: unending stretches of parched land, ceaseless search for water, back-breaking labour on relief work sites, the scorching heat, exhaustion, anaemia, and even death in the shape of hundreds of decaying skeletons of cattle lying on the wayside.

And yet, breaking this sepulchral landscape like a mirage, there were lush fields with healthy stalks and shiny leaves, swinging in a casual breeze while fresh water flowed beneath, tickling their roots. Clear water through which one could see fertile soil, unaffected by the surrounding desolation, rich with the promises of bountiful yields. But the dream turned sour when one observed not only that the neighbouring field was barren but also that its owner and her family hardly had enough water to drink. Their own well was rapidly drying up, even as their richer neighbours were reaching deeper and deeper to extract groundwater. And as the water table went down, their dependence on their neighbours for water kept increasing.

These years were also years of fierce debates about the use of water resources in India. Many meetings, seminars and conferences were held around this issue. Grassroots action groups voiced the needs of the poor and tried to organise themselves and the people for the just implementation of government water schemes. At the national level, the National Water Policy was born.

One of the debates in question concerns the use of groundwater resources. This issue has been discussed for many years, but only became a matter of intense public debate during the recent period of acute water scarcity (not only in Gujarat, but also in many other parts of India). The discussion drew attention to India's vast groundwater resources, and some argued that these resources were mostly unharnessed and untapped. Groundwater experts and planners saw in them a latent potential for irrigation, development, increased food production and mitigation of the drinking water crisis. At the same time, warnings were voiced that in certain areas (especially in states like Gujarat) the groundwater table had reached a dangerously low level. The discussion also raised questions about social and economic equity in the distribution of water resources, as well as about the role played by water markets, state intervention and other regulatory mechanisms. At the same time, a number of deeper questions received insufficient attention: Who owns groundwater resources? Who benefits from their use? Who causes and who suffers from their overexploitation? How can we make sure that these resources are utilised to meet real needs rather than to enrich a privileged minority?

This ongoing debate, as well as the personal experience of rural life under drought conditions in Sabarkantha district (North Gujarat), motivate the present study. The study focuses on two alarming aspects of present water utilisation patterns in Gujarat: overexploitation and inequity. While the over-exploitation aspect has been investigated from macro data, the inequity aspect, in the absence of adequate secondary data, has been examined at the village level.

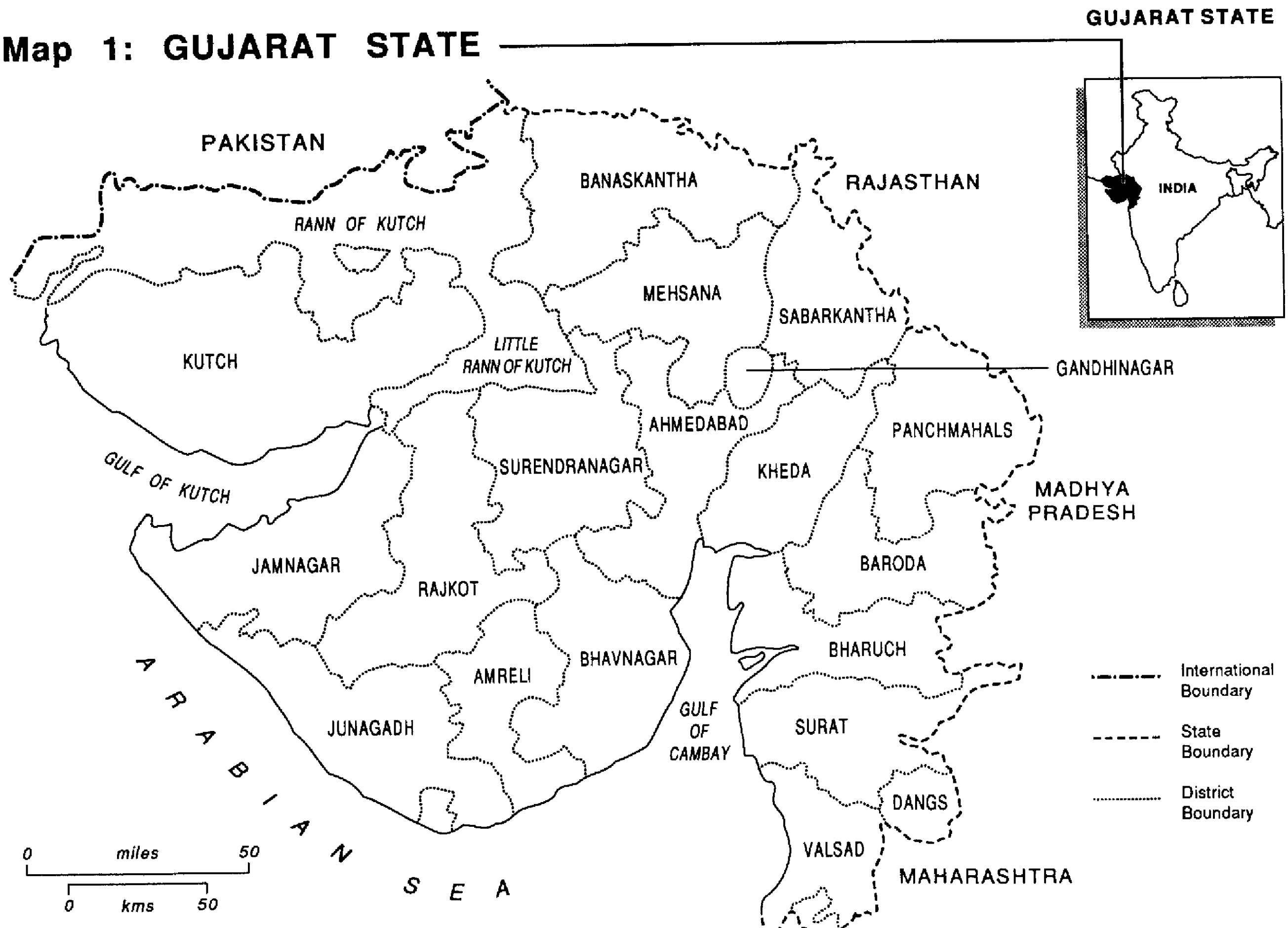
The study is divided into three sections. The first section discusses the nature of the current crisis of groundwater scarcity in Gujarat. Special attention will be paid to the relationship between groundwater scarcity and drought, and to the mutually reinforcing problems of overexploitation and inequity. The second section contains a case study of groundwater use in eight villages of Sabarkantha district, with particular emphasis on the problem of inequity. The third section examines alternative regulatory mechanisms for preventing the overexploitation of groundwater resources in Gujarat.

1. DROUGHT, RAINFALL AND GROUNDWATER

1.1. The Changing Nature of Droughts

Drought is not a new phenomenon in Gujarat; it has had an important place in both the written and the oral history of this region. However, the nature of droughts and their impact on rural life are quite different today from what they used to be in the past. This

Map 1: GUJARAT STATE



Source: Ground Water Resource Development Corporation, Ahmedabad section examines this important development, and its relevance to the issue of water scarcity.

History of Droughts and Famines in Gujarat

The earliest authentic records of scarcity and famine available for the state relate to the 17th and 18th century. Very scant information is available for earlier periods. Appendix 1 gives a broad picture of the history of droughts and famines in Gujarat. We can observe that, in most cases, famine seems to have followed a massive crop failure resulting from drought, or, in some years, from pests or invasions of locusts, rats and caterpillars.

Loveday, while talking of famines in India, observes that, between the years 297 and 1907, the less severe famines have tended to recur in cycles of five years, and the more severe ones in cycles of fifty years.[1] Rough estimates worked out by him showed that it was towards the middle and the end of each century that the most disastrous famines visited India. He advanced the hypothesis that, after an exceptional period of drought, a time of comparative prosperity generally followed, varying in length from forty to fifty years.

For Gujarat specifically, we find that years which have been marked as "severe famines" are 1631, 1696, 1718, 1731, 1747, 1791, 1812, 1899 and 1901. Of these, famines which are still remembered today with dread because of their exceptional impact on mortality are Satyasyo (1631), 1718, Sudtalo (1791) and Chappaniyo (1899-1900).[2]

As can be seen from Appendix 1, large-scale starvation and mortality have been commonly reported during the Mugal and Maratha periods, and to a lesser extent during the British period. No such events have occurred in the post-independence period. This suggests that, partly as a result of public intervention, the main damage caused by drought is no longer a sharp increase in mortality. On the other hand, the hardships caused by shortage of water

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1. Loveday (1914), pp. 25-27.

2. The local names of these droughts, in many cases, reflect the date of their occurrence in the Hindu calendar. The numbering of years in the Hindu calendar (known as "Vikram Samvat") is ahead of the British calendar by 56 years. Thus, the year 1956 in the Hindu calendar witnessed a famine remembered as "Chappaniyo" (*chappan* means 56 in Gujarati).

and fodder are assuming increasingly serious proportions. This important aspect of the history of drought and famines in Gujarat will be reexamined further in this section.

At this point, it may help to recall why drought often led to famine in the pre-independence period, and how famines have been prevented since independence. On the former question, Baird Smith, in his famous report on the famine of 1860-61, aptly described Indian famines as "rather famines of work than of food". In other words, the reason why droughts often precipitated famine in pre-independence is not so much that they reduced the availability of food, but rather that they led to a dramatic disruption of economic activity and employment (especially in the rural areas). The Famine Commission of 1880 described this process in the following words:

> "... as a general rule, there is an abundance of food procurable, even in the worst districts in the worst times; but when men who, at the best, merely live from hand to mouth, are deprived of their means of earning wages, they starve, not from the impossibility of getting food, but for want of the necessary money to buy it".

Following this diagnosis, the relief policy embodied in the Famine Codes (introduced towards the end of the 19th century) put greatest emphasis on the creation of employment through relief works. To this day, the large-scale provision of wage employment through public works remains the main plank of famine prevention during periods of drought. Since independence, strong political incentives to respond to crises have ensured that this strategy is usually invoked with sufficient speed and commitment to avert a disaster.[3]

It is interesting that while pre-independence accounts of droughts and famines abundantly mention hunger and starvation deaths, fodder scarcity is only occasionally discussed, while water scarcity is hardly ever mentioned.[4] All sorts of descriptions can be

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[3]. Even in the pre-independence period, this strategy was pursued on a number of occasions, with mixed results. For a detailed discussion of famine prevention in India before and after independence, see Drèze (1990).

[4]. Water scarcity is clearly mentioned for the first time by the Famine Commission of 1901, which states that on account of the failure of water supply in the Princely States, people were often left with no alternative but to emigrate to British territories during famines. The description of the drought of 1911 in Bharuch district also refers to the distress of the people

found of how people coped with hunger (e.g. by eating roots and seeds), but there is no corresponding account of the survival strategies they adopted to cope with water scarcity.

This observation applies, for instance, to Bhailalbhai Patel's brilliant account of the Chhapaniyo drought (1899-1900).[5] In his autobiography, Bhailalbhai Patel (top politician in Gujarat, leader of the opposition in the 1950s and 1960s, and engineer of considerable merit) gives a vivid picture of the impact of drought on people's lives in his own village in Baroda district. The failure of crops was followed by the sale of milch animals and later of almost every asset in the house, including parts of the house itself (e.g. windows and door frames). Indebtedness and begging sharply increased. The author also describes heart-rending scenes of countless bodies being dumped in a local well, while human skeletons could be found on the waysides and fields even long after the end of the drought.

Bhailalbhai Patel also mentions large-scale land alienation during the famine, especially in the state of Baroda where land revenue had not been remitted (unlike in most places under British jurisdiction). The Gaekwad government chose to adopt strict measures for the collection of land revenue. Those who could not pay were imprisoned for a few days, while the land of those landlords who were living in the cities was auctioned. Bhailalbhai's own family property of 200 "vighas" was disposed of in such an auction, at the miserable rate of 25 paise per vigha (i.e., 50 rupees in all).

There is, in Bhailalbhai's narrative, no corresponding account of hardship caused by groundwater scarcity. In fact, quite interestingly, in his description of how "the land of the landlords was thrown away at a pittance", Bhailalbhai uses the revealing expression "panine mule". This popular Gujarati expression, which can be literally translated as "at the cost of water", conveys the fact that the land had been sold for a sum so low that it was hardly worth counting. The use of this metaphor is consistent with the continued availability of groundwater during pre-independence droughts in Gujarat, in sharp contrast with the present

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on this count. But it is only from the drought of 1960-61 onwards that consistent mention is made of the problem of water scarcity - see Government of Gujarat (1976), Gujarat Relief Manual, pp. 13, 19-24.

[5]. Bhailalbhai Patel (1970), Bhaikakana Sasmarno ("The Memoirs of Bhaikaka").

situation.[6]

Water scarcity and relief policy

Interestingly, the continued availability of groundwater during droughts in pre-independence India went hand in hand with a strong enthusiasm for the construction of water extraction mechanisms in times of drought. The building of water extraction structures is mentioned as early as 1343, when Mohammed Tuglak made advances from the treasury for the digging of wells during a famine. Akbar also had canals made for the rich and the poor alike. The historical records give credit to the Muslim rulers for the construction of canals and to the Hindus for the construction of tanks and the digging of wells. Similarly, after the heads of state in Kutch, Palanpur (Banaskantha) and Kathiawar adopted a policy of "food for work" in 1812 (in replacement of the earlier "food distribution" approach), the relief works mainly consisted of construction of tanks, wells and roads. The post-mutiny period (from 1857 onwards) was marked with further developments in this direction, including the large-scale development of irrigation. In 1883, the government enacted the Land Improvement Act with the object of encouraging works of improvement of land and relieving the distress of poor cultivators in times of famine. This was done by providing assistance to the *ryots* for financing permanent land improvements, particularly the digging of wells and the construction and repair of tanks and water channels for irrigating land. In the Chhapaniyo drought of 1899-1900, one of the important relief measures involved was the digging of wells. This was also the case in Kheda district during the drought of 1918-19, where the opening of relief works was deemed unnecessary but on account of massive crop failure the government liberally provided *tagavi* loans for deepening of wells.

We can thus see that traditional relief policies have included a sharp keenness to build water extraction mechanisms. The motivation for this approach was partly that water-related works offered a convenient way of generating large-scale employment, and partly that expanded irrigation was a means to increase food production and to reduce vulnerability to

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[6]. Bhailalbhai does mention the existence of a surface-water drought, and of increased dependence on groundwater for water needs. See J. Gupta (1988) for further discussion.

future droughts. In both cases, the preoccupation of these policies was overwhelmingly with averting starvation and mortality, rather than with water scarcity as such. This was so because groundwater scarcity was not a problem even in times of drought (indeed, as we saw earlier, pre-independence accounts of droughts make little mention of the depletion of groundwater). This happy state of affairs, unfortunately, started changing dramatically in the 1960s, when water scarcity increasingly emerged as one of the most alarming aspects of drought in Gujarat.

Emergence of water scarcity

Acute water scarcity was noted during the drought of 1960-61 in Gujarat, and also during the subsequent droughts of 1961-62 to 1968-69 (when drought occurred year after year in one part of Gujarat or another), 1972-73, 1974, 1979 and 1985-88. The number of villages without adequate access to water, or "no source" villages, rose from 3,844 in 1979 to 12,188 in 1986.[7] In 1987, as many as 16,351 villages out of a total of 18,114 were classified as "no source" villages.[8]

Drought relief measures are increasingly geared to this growing problem of water scarcity. The public supply of water through tankers first occurred during the drought of 1960-61, in the coastal tracks of Dhanduka taluka of Ahmedabad district and the Bara tract of Bharuch district. For subsequent drought years, one consistently reads about water being supplied by tankers and bullock-carts, wells being dug or deepened, bores being sunk, village tanks being deepened or repaired, *tagavi* loans being given for diesel engines, and water being supplied to cattle by hiring *koshias*.[9] During the drought of 1972-73, drilling rigs were

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7. A "no source" village is a village with no public well within a distance of 1.6 km, or where the public well dries up in the summer, or where the water level is more than 15 m deep.

8. Government of Gujarat (1987), Memorandum to the Government of India on Scarcity, 1987-88, Revenue Department. The total number of inhabited villages in the state is as per the 1981 census.

9. In Gujarat, the person hired to lift water from the well through the traditional *kos* (i.e., the leather bag pulled by bullocks) is known as *koshia*.

imported to drill tubewells, and during the drought of 1985-88, the state went so far as to transport water to Rajkot by train across a distance of more than 250 km!

The growing seriousness of the water crisis in Gujarat can also be gauged from the sharp rise in the allocation of funds to drinking water supply in the relief budget of each consecutive drought year. The provision of drinking water has now become one of the principal planks of the government's relief policy.

In 1985-86, the government spent Rs 87 crores on supplying drinking water to villages and towns by various means. But this left the problem as acute as ever, for a repeat performance had to be made in 1986-87 and again in 1987-88. The new sources that had been created were reported to have dried up. During the first seven months of 1987-88, the government incurred an expenditure of Rs 11,500 lakhs (115 crores) on drinking water supply schemes (see Table 1), including both "short-term" measures like deepening of wells and supply of tankers and "long-term" measures such as installing deep tubewells and water pipes to transport water over long distances. In the three years 1985-88, as many as 36,901 deep tubewells were constructed, and a mammoth sum of Rs 248 crores was spent on these relief operations. The number of bores drilled increased year after year during the drought, from 6,612 in 1985-86 to 8,125 in 1986-87 and 11,247 in 1987-88.[10]

One can therefore argue that, while starvation deaths are now rare in Gujarat (the same cannot be said of Orissa or Rajasthan), drought still plagues this state in different - and no less serious - manifestations. In addition to the traditional threat of a "famine of work", there is now an acute need to deal with the threat of a "famine of water".

The significance of the water crisis does not end there. As will be seen further on, the water crisis is no longer confined to drought years. The depletion of groundwater

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[10]. It is ironic that, even as water resources were being depleted during the drought years 1985-88, government reports triumphantly announced how "the efforts to maintain water supply during the current drought year has brought to notice considerable information about adequacy of the groundwater reserves to meet the requirement of water supply", including "the large groundwater reservoirs underlying the surface water reservoirs in the Saurashtra area" (cited in Phadtare, 1988: 87, 93).

TABLE 1

RELIEF OPERATIONS RELATED TO DRINKING WATER SUPPLY DURING THE 1985-88 DROUGHT

Category	Number of villages/towns covered				Expenditure incurred (in Rs lakhs)				
	1985-86	1986-87	1987-88[a]		1985-86	1986-87	1987-88[a]		1985-88[b]
PLAN									
Deep tubewells	4479	5228	7450	(7230)	2012	1926	3003	(2763)	6701
New wells	633	277	737	(111)	220	95	299	(68)	383
Urban centres	24	17	29	(22)	2191	1280	6166	(3185)	6656
Other	1793	1041	2222	(1831)	3412	761	4476	(3156)	7329
NON-PLAN									
Deepening of wells	3351	2967	2842	(1515)	428	253	368	(NA)	(NA)
Tanker supply	-	1841	3071	(2677)	393	335	1176	(NA)	(NA)
Conservation of reservoirs	-	-	-	(-)	16	-	100	(NA)	(NA)
Water supply to cattle camps	-	-	-	(-)	-	-	100	(NA)	(NA)
TOTAL PLAN	6929	6563	10438	(9174)	7835	4062	13944	(9172)	21069
TOTAL NON-PLAN	3351	4808	5913	(4192)	837	588	1744	(2328)	3753
GRAND TOTAL	**10280**	**11371**	**16351**	**(13366)**	**8672**	**4650**	**15688**	**(11500)**	**24822**

[a] These are **estimated** figures (from the Master Plan 1987-88). The figures in brackets indicate actual achievements upto 31.7.88.

[b] Actual expenditure incurred upto 31.7.88.

Source: Government of India (1989): **The Drought of 1987: Response and Management**, Volume II (New Delhi: Ministry of Agriculture).

resources affects the livelihood of the rural population on a permanent basis.

1.2. Trends in Rainfall

The emergence of groundwater scarcity in Gujarat, and the increasing frequency of droughts, are often blamed on an allegedly declining trend in rainfall. This "explanation" is convenient for those in power, since it absolves them of any responsibility for the current crisis. The claim that a declining trend in rainfall is the source of increasing groundwater scarcity in Gujarat, however, has a very weak factual basis.

Indeed, a number of earlier studies of rainfall data for different parts of India have seriously discredited the notion of a declining long-term trend in rainfall.[11] A similar conclusion emerges from a simple analysis of rainfall data for Gujarat.

Figures 1 and 2 show annual rainfall levels over the 1951-90 period for Gujarat, and over the 1901-90 period for Sabarkantha district, as well as five-year moving averages.[12] It is easy to see that, prior to the 1985-88 drought, there was no noticeable trend in rainfall over these periods in either of the two regions.

This impression is confirmed by simple regression analysis. A linear regression of rainfall on time for the period 1951-85 (i.e. the 35 years preceding the 1985-88 drought) produces a small positive coefficient in the case of Gujarat, and a small negative coefficient in the case of Sabarkantha, neither of the coefficients being statistically significant. If 1990 rather than 1985 is taken as the terminal year, the time coefficient is negative both for Gujarat and for Sabarkantha (as one would expect since the reference period ends with a prolonged drought), but even then the coefficients are small and statistically insignificant. If 1901 rather than 1951 is taken as the base year, the results for Sabarkantha remain largely unchanged (see

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[11]. See Mooley and Parthasarthi (1984) and Olsen (1987), among others.

[12]. For want of official information on rainfall for Gujarat as a whole, the all-Gujarat rainfall figures have been obtained as unweighted averages of the district figures. These were available only from 1951 onwards.

FIGURE 1: ANNUAL RAINFALL (mm) IN SABARKANTHA DISTRICT, 1901-90

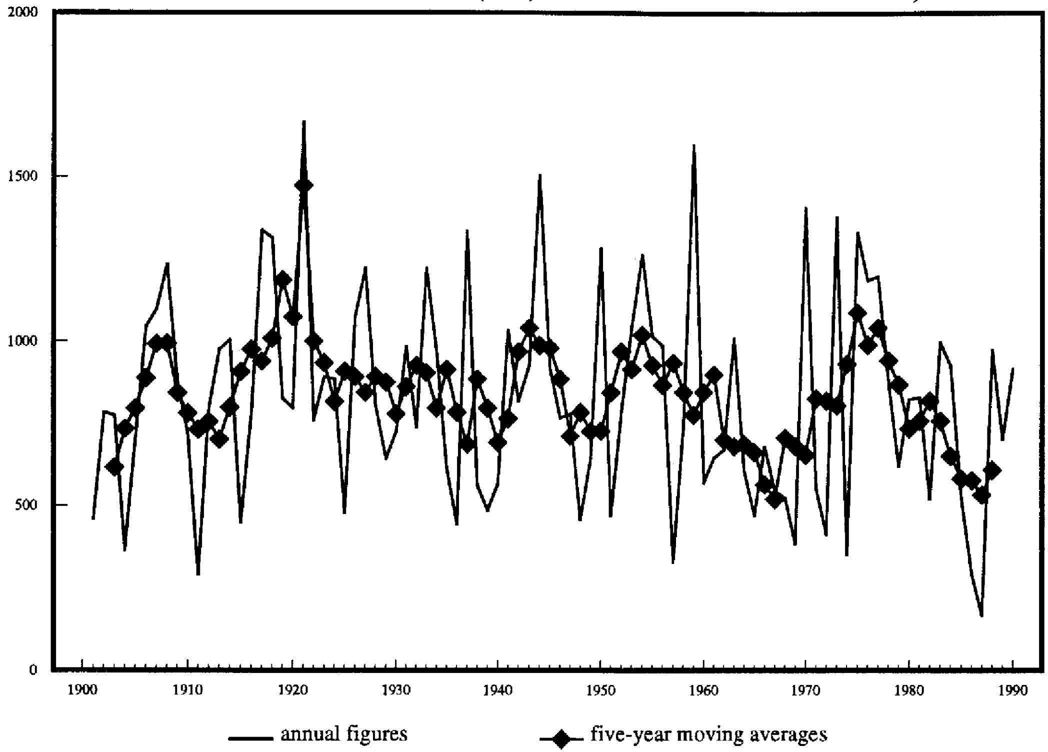

FIGURE 2: ANNUAL RAINFALL (mm) IN GUJARAT, 1951-90

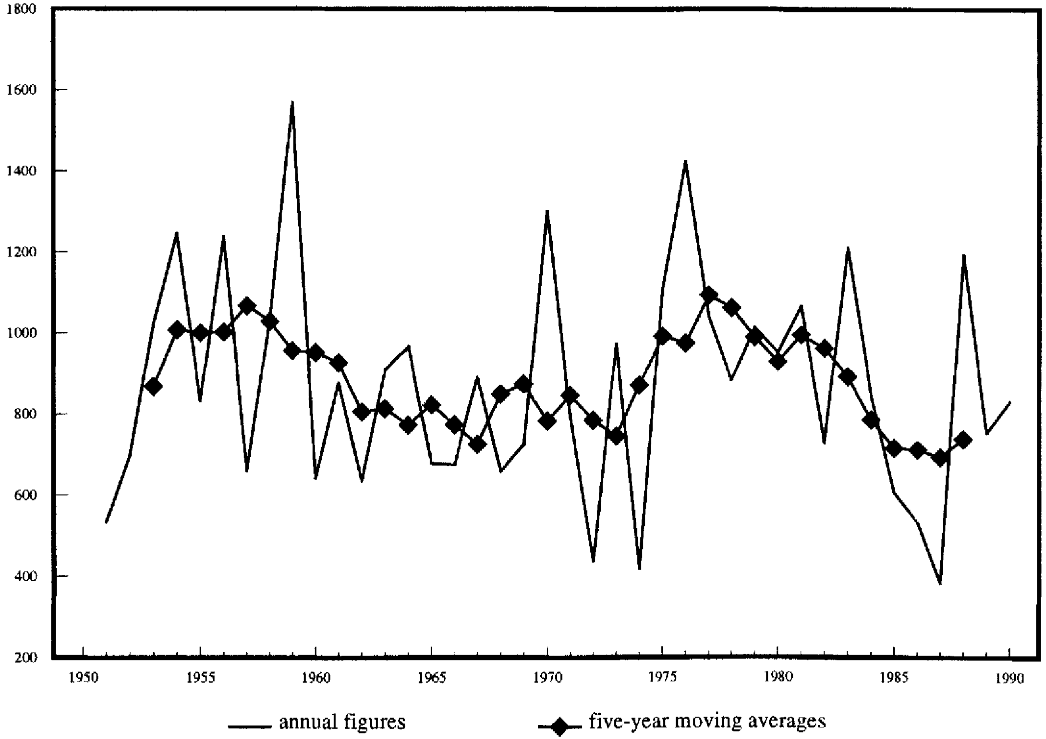

TABLE 2

**TRENDS IN RAINFALL:
RESULTS OF A LINEAR REGRESSION OF RAINFALL ON TIME**

Area and period	**Time coefficient**	**t-ratio**
Gujarat, 1951-85	0.73	0.16
Gujarat, 1951-90	-1.87	-0.49
Sabarkantha, 1951-85	-0.30	-0.05
Sabarkantha, 1951-90	-3.11	-0.66
Sabarkantha, 1901-85	-0.60	-0.42
Sabarkantha, 1901-90	-1.26	-0.96

Note: The "time coefficient" indicates the trend change in rainfall, in mm per year. As the last column indicates, none of these coefficients are statistically significant at the 5% level. The results are based on data presented in Appendix 2.

Table 2 for details).

We can look at the issue of trends in rainfall from another angle by considering the "frequency of failure" of rainfall in Sabarkantha district in different periods. As Table 3 shows, there has been no noticeable increase in the frequency of failure of rainfall in the recent past. In fact, in this respect the two decades since 1970 have been rather favourable.

Even if there is a declining trend in rainfall, it is clear that this trend is only a slow and insignificant one. The sharp increase in the area and population experiencing water crisis in Gujarat in recent years cannot be linked primarily to the precipitation factor. As will be seen further on, the driving force behind increasing groundwater scarcity in Gujarat is not the decline of groundwater "recharge" through rainfall, but rapidly growing levels of "draft", themselves linked with the rapid expansion of modern water extraction structures.[13]

1.3. **Indications of Groundwater Scarcity**

What evidence is available to support the widely-held belief that groundwater resources in Gujarat are being dangerously depleted? A lot of secrecy surrounds this subject, due to its politically sensitive nature.[14] Even the most basic facts (e.g. data on water tables), while readily available in systematic form and widely used within government agencies, are not easily available to the public. Nor have the mainstream media taken enough interest in this subject to get hold of these concealed facts.

This section makes extensive use of a recent report by P.N. Phadtare, former director of the Central Ground Water Board (West Central region). This very informative document (Phadtare, 1988), which contains the latest available information on the geohydrology of Gujarat, has itself not been published so far. In spite of its officially "confidential" nature,

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[13]. This is also one of the major conclusions of a recent scientific report of the Central Ground Water Board (Government of India, 1991).

[14]. Most of the relevant data have the label "For Official Use Only" and are therefore covered by the Official Secrets Act.

TABLE 3

FREQUENCY OF FAILURE OF RAINFALL IN SABARKANTHA DISTRICT

PER 10-YEAR PERIOD

Period	Number of years below normal	Number of years above normal
1901-1910	6	4
1911-1920	4	6
1921-1930	4	6
1931-1940	6	4
1941-1950	4	6
1951-1960	5	5
1961-1970	8	2
1971-1980	4	6
1981-1990	5	5

PER 5-YEAR PERIOD

Period	Number of years below normal	Number of years above normal
1901-1905	5	0
1906-1910	1	4
1911-1915	3	2
1916-1920	1	4
1921-1925	2	3
1926-1930	2	3
1931-1935	2	3
1936-1940	4	1
1941-1945	0	5
1946-1950	4	1
1951-1955	2	3
1956-1960	3	2
1961-1965	4	1
1966-1970	4	1
1971-1975	3	2
1976-1980	1	4
1981-1985	2	3
1985-1990	3	2

Source: See Appendix 2.

this document is extensively used and cited in this section, in the belief that a more open information system is an essential prerequisite of effective public action in this field. This section also draws on unpublished data obtained from the Central Ground Water Board (Ahmedabad) and the Ground Water Resources Development Corporation (Ahmedabad).

The three main manifestations of increasing groundwater depletion in Gujarat are (1) the decline of water tables, (2) salinity ingress, and (3) the increase in fluoride content.[15]

Decline of water tables

The decline of water tables is the most perceptible and widespread of the three manifestations of groundwater scarcity mentioned above. Officials dealing with the subject are particularly concerned about the tapping of resources which are beyond the reach of seasonal recharge, and are therefore most vulnerable to depletion. Newspapers have announced shocking reports like the water table in parts of Mehsana district reaching a depth of 1200 feet.[16] Less spectacular, but still alarming, is the rapid decline of groundwater levels reported in many districts of North Gujarat, Saurashtra and Kutch.

In 1988-89, the regional office of the Central Ground Water Board (CGWB) in Ahmedabad initiated district-wise reappraisal surveys in districts which were systematically covered by earlier surveys. These district-wise reports highlight the occurrence of large-scale groundwater overexploitation during the last two decades (Phadtare, 1988).

Phadtare (1988) reports official analyses of historical groundwater level data from the

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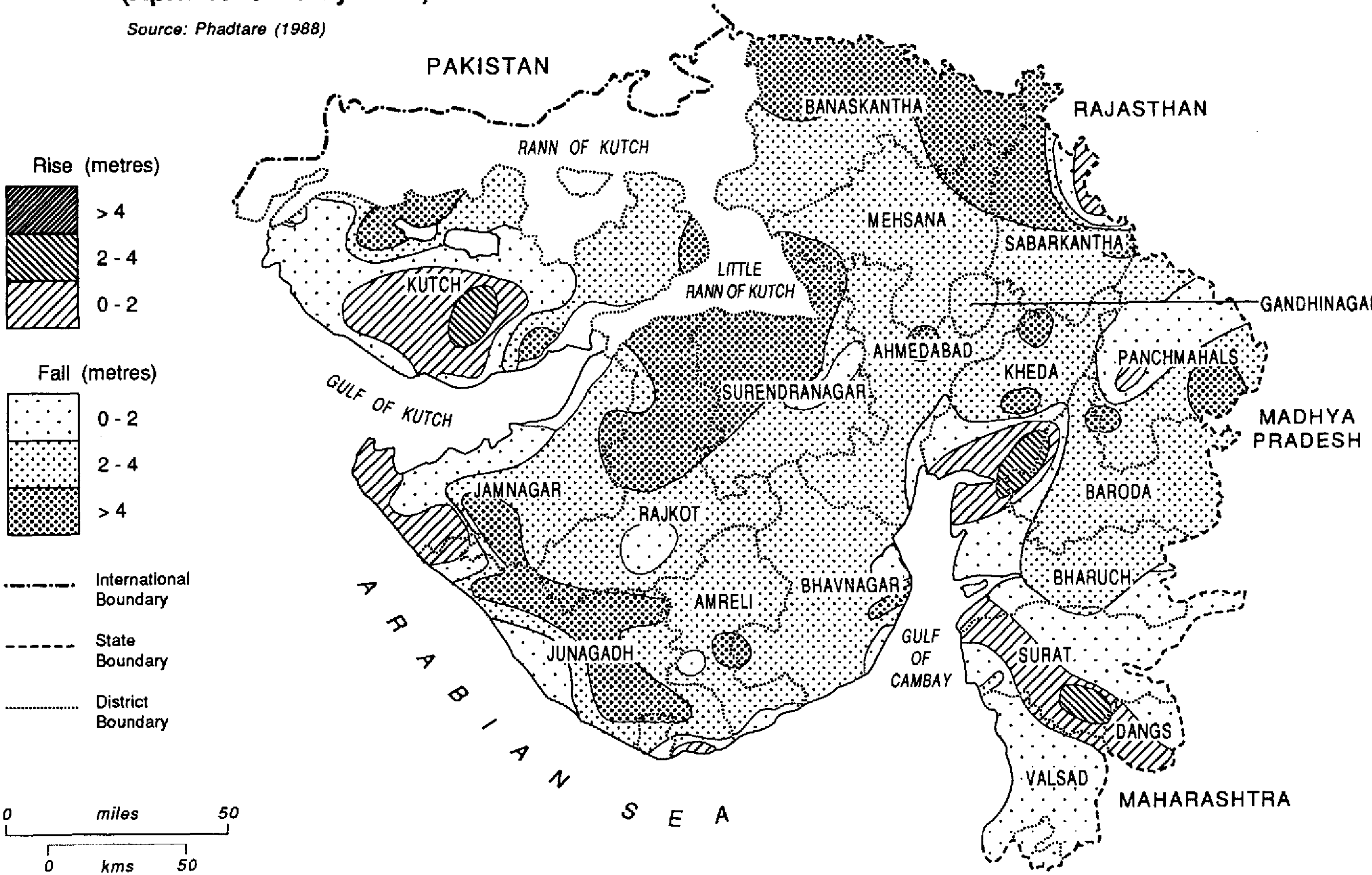
[15]. Aside from being indications of groundwater depletion (as explained further in the text), rising levels of salinity and fluoride content result in a lower quality of groundwater. Hence, the scarcity of groundwater increases not only in a quantitative but also in a qualitative sense.

[16]. An UNDP project carried out in 1971-74 already found the aquifers down to 225 m to be overexploited. According to Phadtare (1988) and Bradley and Phadtare (1989), overexploitation and well interference have caused dramatic declines in water tables in large parts of Mehsana. Recent information suggests that most of the phreatic aquifer system in Mehsana has dried up (personal communication from the Gujarat Water Resources Development Corporation).

Map 2: AREAS OF RISE AND FALL IN GROUNDWATER TABLE

(April 1979 - May 1987)

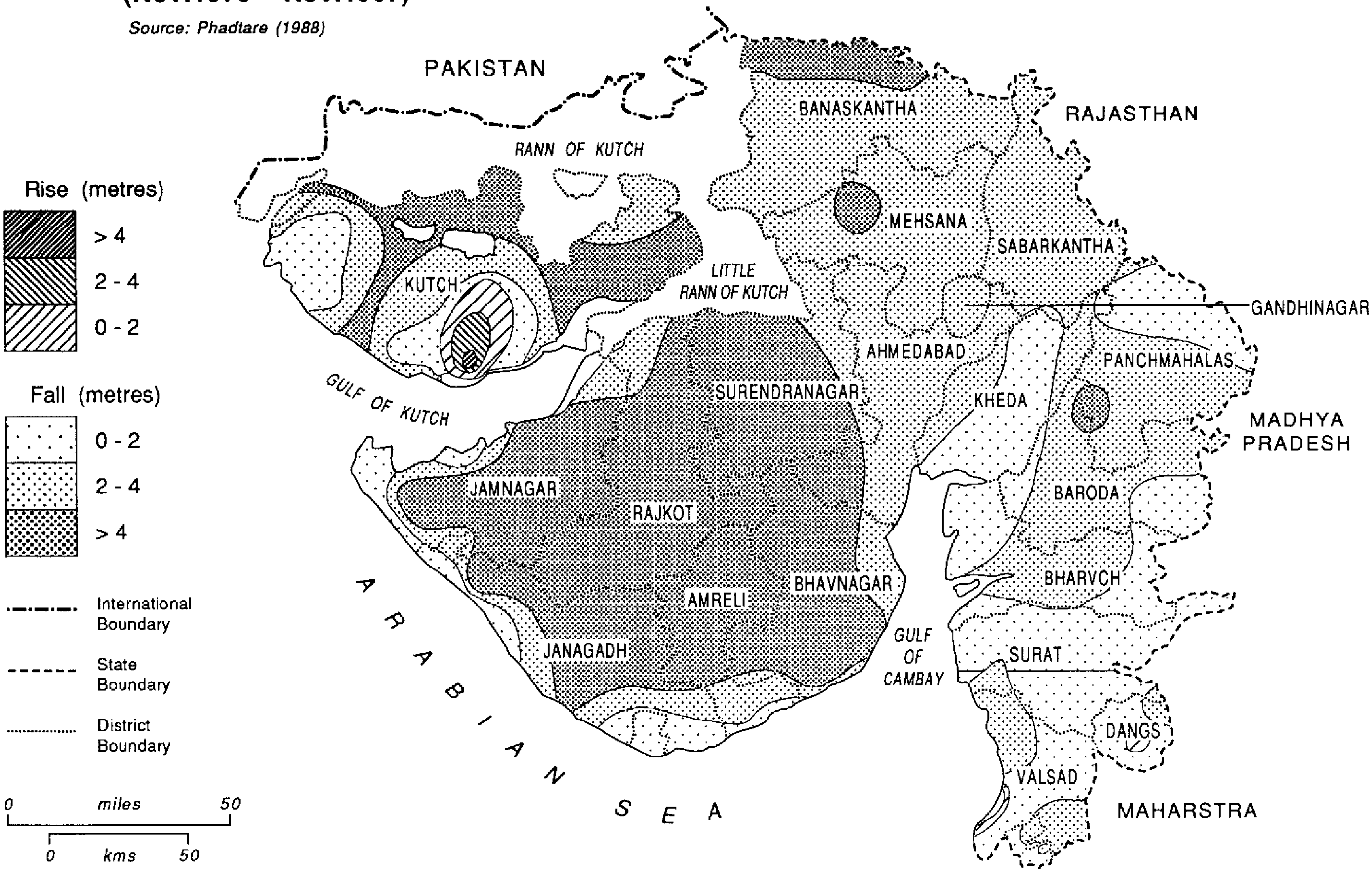
Source: Phadtare (1988)



Map 3: AREAS OF RISE AND FALL IN GROUNDWATER TABLE

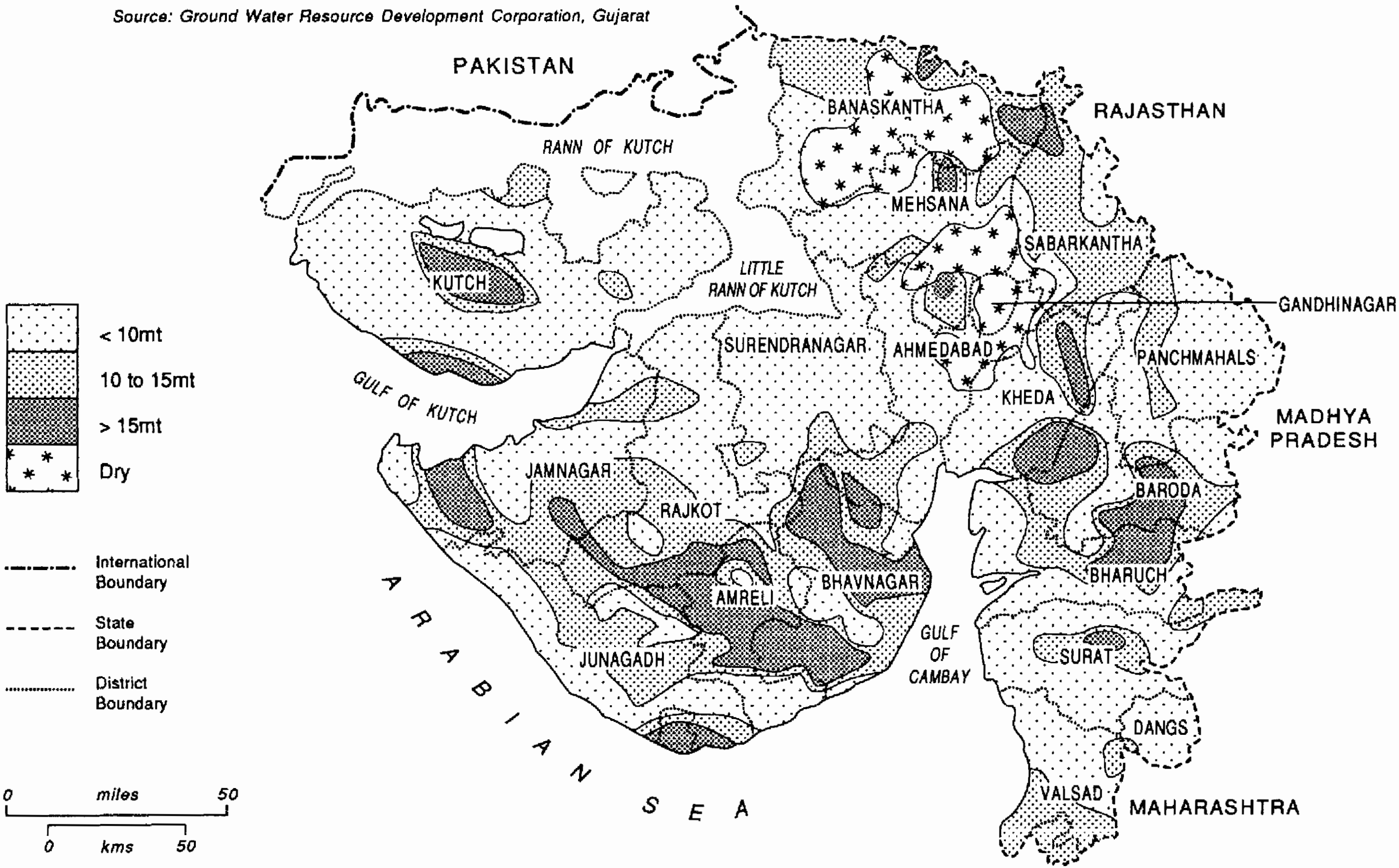
(Nov.1979 - Nov.1987)

Source: Phadtare (1988)



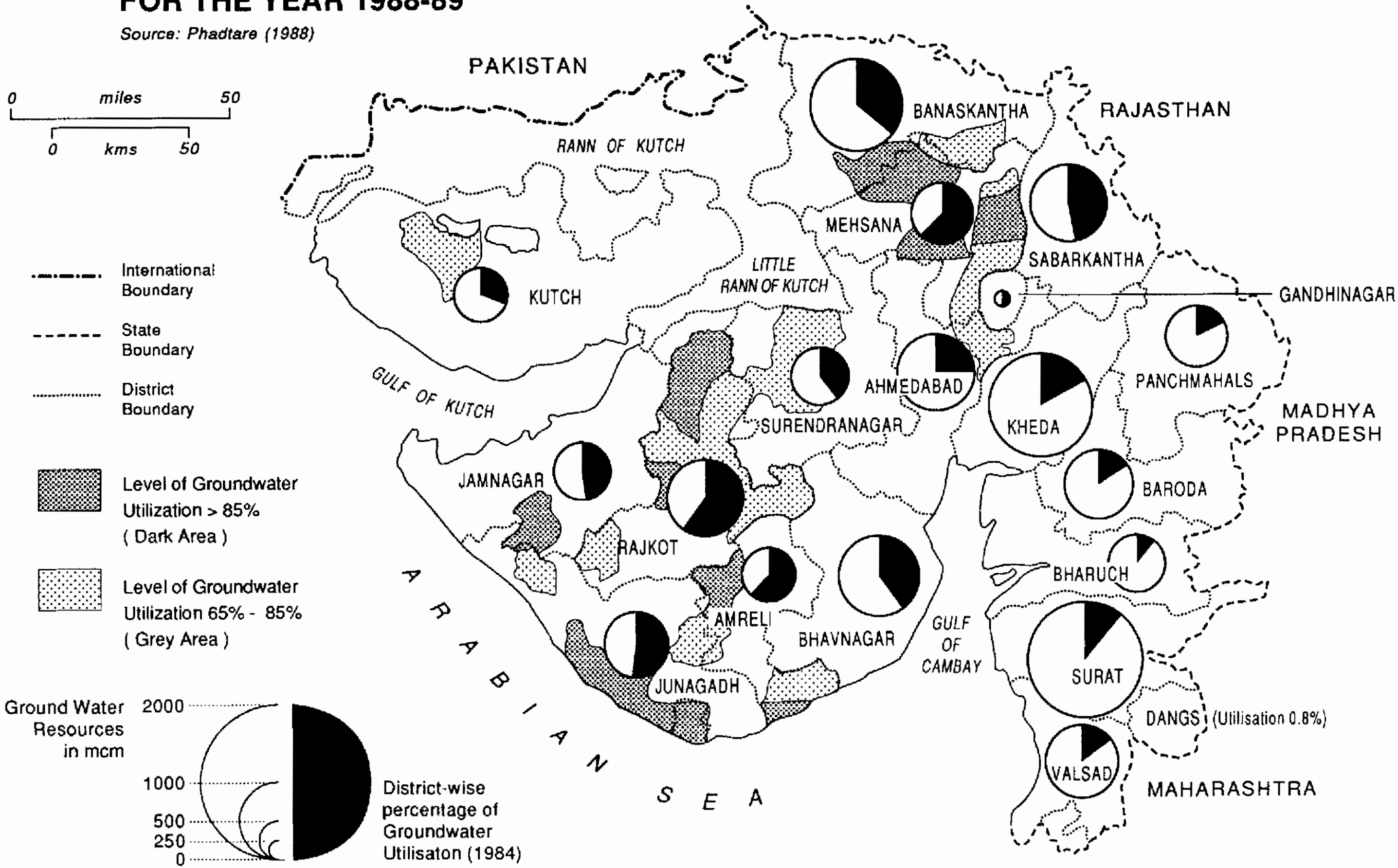
Map 4: CONTOURS INDICATING DEPTH TO WATER LEVEL,
(UNCONFONED AQUIFER May 1989)

Source: Ground Water Resource Development Corporation, Gujarat



MAP 5: GREY AND DARK AREAS BASED ON LEVEL OF GROUNDWATER UTILISATION FOR THE YEAR 1988-89

Source: Phadtare (1988)



National Network of Hydrograph Stations (established by CGWB). On the basis of hydrographs and the long-term trend of groundwater level, the declines or rises in water levels were calculated for 1979 to 1987. The results are presented in Maps 2 and 3 (see also Map 4). Map 2 shows changes in pre-monsoon groundwater levels between April 1979 and May 1987, while Map 3 shows changes in post-monsoon levels between November 1979 and November 1987. Among the 8 years under examination, three were drought years (1979-80, 1985-86 and 1986-87). These maps clearly show that there is an overall decline of water levels in almost all regions. In most of the state, water levels have fallen by more than 2 metres over this short period. In many areas, they have fallen by more than 4 metres.[17]

The decline of water tables that can be observed in Maps 2 and 3 is partly attributable to the drought conditions that prevailed in 1987 (the terminal year in the comparisons). Indeed, Phadtare's own report clearly shows how water tables tend to decline quite drastically in drought years (see Tables 4, 5 and 6).[18] The main reason for this phenomenon, of course, is that during drought years recharge is practically nil while drafts continue to take place.

Having said this, one should not fall prey to the temptation of concluding that the recent decline of water tables is a short-term, drought-induced phenomenon. There is, in fact, much evidence of a long-term decline in water tables in most areas of Gujarat; while the downward trend has a tendency to accelerate during droughts, it is not confined to drought years alone. For instance, a simple regression of water level on time for the period 1981-90 brings out a declining trend in 87 out of 96 observation wells used by the Central Ground

[17]. The Government has classified different areas as "White", "Grey" and "Dark", according to their level of "groundwater utilisation"; dark areas being the most vulnerable to depletion. According to official figures there were 6 dark talukas in Gujarat in 1984 (Kodinar, Veraval, Mangrol, Sidhpur, Patan, Mehsana), all situated in Saurashtra and Mehsana. The projected number of talukas for 1989 is as high as 10. See Map 5 for further details of the location of white, grey and dark areas in Gujarat.

[18]. Tables 5 and 6 do not include South Gujarat. The latter region receives rainfall between 800 and 2000 mm, and is assured of 50% of the total precipitation each year on account of being near to the sea and in the shelter of the Western Ghats. However, due to the highly steep topography in Dangs, most of the rainwater goes as runoff and people face drinking water crises in the summer.

TABLE 4

GROUNDWATER RESOURCES DURING DROUGHT YEARS

Year	Rainfall (mm)	Groundwater recharge (mcm)	Groundwater draft (mcm)	Average decline between May 1984 and May of the relevant year (metres)
Saurashtra (Average annual rainfall: 550 mm; area: 64,339 sq kms)				
1984	506	6,426 (surplus)	3,737	-
1985	291	3,400 (overdraft)	3,830	1.3
1986	398	4,650 (marginal surplus)	3,925	2.5
1987	140	1,635 (overdraft)	2,757	5.0
Kutch (Average annual rainfall: 350 mm; area: 45,652 sq kms)				
1984	335	803 (surplus)	282	-
1985	222	509 (surplus)	289	1.3
1986	164	422 (marginal surplus)	296	2.5
1987	40	96 (overdraft)	148	5.7
North Gujarat (Av. annual rainfall: 625 mm; area: 37,870 sq kms)				
1984	706	4,535 (surplus)	2,292	-
1985	381	2,764 (marginal surplus)	2,063	1.5
1986	299	2,169 (overdraft)	1,856	3.3
1987	175	1,269 (overdraft)	1,763	4.5

Source: Phadtare (1988).

TABLE 5

HIGH AVERAGE WATER LEVELS (w.l.) IN AUGUST AND LOW AVERAGE WATER LEVELS IN DROUGHT-AFFECTED AREAS OF GUJARAT DURING 1984-88

District	Average w.l. in Aug 1984 (m. bgl)	Average decline compared to August 1984 level (metres)				Average w.l. in May/June 1984 (metres bgl)	Average decline compared to May/June 1984 level (metres)			
		1985	1986	1987	1988		1985	1986	1987	1988
Saurashtra										
Amreli	8.8	2.5	2.3	5.0	1.7	7.3	0.5	8.3	6.7	8.8
Bhavnagar	5.9	4.1	5.1	7.0	2.7	9.7	1.7	3.8	5.4	7.0
Jamnagar	6.6	1.5	3.1	6.5	+0.9	8.8	1.7	2.6	4.1	5.1
Junagadh	7.5	2.4	2.5	6.2	0.5	10.6	2.4	3.2	3.6	5.6
Rajkot	5.4	1.8	4.0	4.4	+2.3	9.3	0.3	1.1	3.4	2.4
Surendrnagar	5.3	3.1	4.1	6.7	2.3	7.3	1.5	5.0	6.3	5.8
AVERAGE	6.6	2.6	3.5	6.0	0.7	8.8	1.3	4.0	4.9	5.8
Kutch										
AVERAGE	7.7	0.3	1.4	1.6	1.6	8.8	3.0	1.2	2.8	3.0
North Gujarat										
Ahmedabad	3.8	0.9	1.2	2.8	1.5	7.9	0.1	1.5	+0.1	0.4
Banaskantha	9.7	1.4	1.3	4.8	3.4	12.0	1.0	+0.6	0.9	+1.9
Gandhinagar	15.0	1.0	1.9	-	-	15.3	0.6	1.3	-	1.5
Mehsana	5.8	2.2	4.7	5.3	3.6	10.7	+0.5	0.5	1.4	2.9
Sabarkantha	7.7	2.5	4.0	7.8	1.2	12.1	0.0	0.1	1.5	3.2
AVERAGE	6.9	1.6	2.6	5.2	2.4	11.6	0.2	0.6	1.1	1.2

Source: Phadtare (1988).

TABLE 6

DROUGHT AND WATER LEVELS

District	Average water level (May) (metres)	
	1984	1987
Ahmedabad	15	17
Amreli	17	27
Banaskantha	18	22
Baroda	6	9
Bharuch	9	11
Bhavnagar	20	33
Dangs	8	8
Gandhinagar	15	17
Jamnagar	18	20
Junagadh	11	21
Kheda	12	15
Kutch	21	32
Mehsana	27	29
Panchmahal	13	16
Rajkot	4	12
Sabarkantha	10	21
Surat	13	14
Surendrnagar	8	11
Valsad	8	9

Source: Unpublished data obtained from Gujarat Water Supply and Sewerage Board, Ahmedabad. There appear to be some discrepancies between these figures and those reported by Phadtare (see Table 5), which may be due to different methodologies (e.g. different averaging formulas). However, both sources reveal a clear picture of decline in water levels.

Water Board (Ahmedabad) in its assessment of recent trends in water tables. The total decline of this 10-year period, calculated for each well on the basis of the observed time trend, is larger than 4 metres for nearly 50 per cent of these wells. Further details are provided in Table 7.

Salinity ingress

Gujarat has the longest coast line in peninsular India. Besides the 1400 km coast line, there is an additional ancient shore line of 250 km along Rann of Kutch. This coast line, with its creaks and tides which invade the coastal plains upto 4 to 6 km from the sea coast, is the main front of salinity ingress. The normal coastal salinity is also accompanied by inherent salinity of the marine sedimentary formations. Today, the problem of salinity ingress is more widespread than ever before.

Salinity has now invaded as far as 7 km inland from the coast into the aquifer system. The normal water flow is from inland towards the coast, but due to overexploitation of groundwater in the adjoining coastal plains the flow has now reversed. Salinity in shallow depths is found in 34,625 square km, with adverse effects on the phreatic aquifers. Salinity below 200 metres of depth is observed over an area of 34,000 square km.

This problem is further aggravated by the inherent salinity of the thick coastal tertiary and alluvial formations deposited under marine conditions. Due to this, the possibility of getting fresh waters from aquifers within explorable depths is lost. Only the upper beds in these formations, which receive constant replenishment monsoon after monsoon, have moderate fresh water storages (this is an effect of flushing of saline waters during monsoons).

Today, many districts show an alarming incidence of salinity (see Map 6). The problem of salinity is partly a natural phenomenon, but to an increasingly large extent it is also the result of groundwater overexploitation. A brief region-wise review of the facts may

TABLE 7

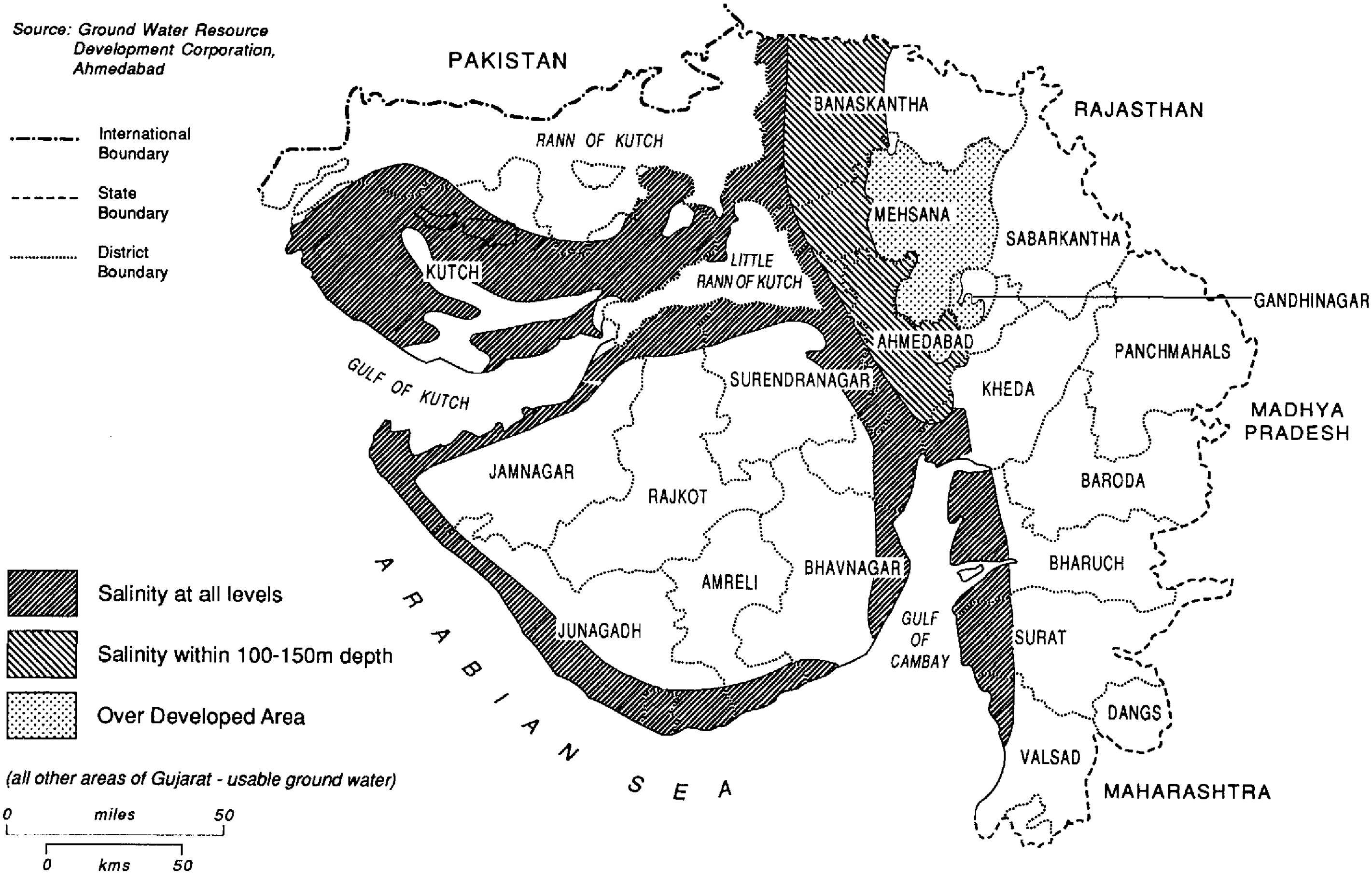
TRENDS IN WATER TABLE (1981-1990) IN 95 OBSERVATION WELLS

District	**Number of Observation Wells**	**Number of wells showing declining trend in water table**	**"Trend decline" in water table over ten years, in metres** (unweighted average over observation wells)
Ahmedabad	1	1	2.75
Amreli	9	9	9.53
Banaskantha	9	9	8.25
Bhavnagar	8	8	5.53
Bharuch	2	2	2.31
Dangs	1	1	1.10
Jamnagar	10	10	5.61
Junagadh	16	14	8.48
Kheda	3	3	3.13
Kutch	9	9	5.74
Mehsana	5	4	0.48
Panchmahals	4	1	-2.27
Rajkot	4	3	7.23
Sabarkantha	4	3	1.16
Surat	3	2	1.74
Surendranagar	5	5	7.39
Valsad	2	2	2.19

Source: Unpublished data obtained from the Central Ground Water Board (Ahmedabad).

Notes: (1) The time trend is obtained from a simple regression of water level on time. (2) The "trend decline" (last column) is the decline over ten years that corresponds to this estimated time trend (e.g. if the time trend estimate indicates that the water table is declining at the rate of 0.3 metres per year, then the trend decline over 10 years is 3 metres).

Map 6: INCIDENCE OF SALINITY IN GUJARAT



help to highlight this dangerous trend.[19]

Saurashtra: Salinity in Saurashtra is observed on a large scale even in the miliolite limestone region (these limestones are very useful aquifers as they are the repositories of potable groundwater in the otherwise saline coastal belt of Saurashtra). Today, a tract about 4 to 7 km from the coast, covering an area of about 900 square km, suffers from salinity ingress due to overexploitation. Other pockets of Saurashtra like Junagadh, Jamnagar, Bhavnagar and Surendranagar have to deal with the same problem. Under the Exploratory Drilling Programme, between 1959 and 1967, 24 wells were drilled in the coastal tertiary area of the four districts mentioned above. All these wells had to be abandoned due either to highly saline formations or to the existence of basalt at shallow depths. The groundwater in vast tracts around Surendranagar and Wadhwan towns in Surendranagar district is saline at all depths. In addition, any excessive extraction in the shallow aquifer causes upcoming of saline water from depths.

Kutch: In the Kutch areas, due to high topographic gradients, salinity ingress is restricted to the narrow coastal strip and the low lying Bani plains. But the marine formations which are present all around have inherent salinity due to which, except for the central uplands, 60% of the district is saline. There is brackish water below the depth of 150 m, under confined conditions. There is a possibility of upcoming of salinity if the water levels continue receding on account of accelerated rate of overexploitation.

North and Central Gujarat: The saline aquifers of Saurashtra and Kutch are also affecting tracts of North and Central Gujarat. The alluvial deposits in these regions are showing deterioration of quality both depthwise and from east towards west. The salinity ingress from deeper saline aquifers and western saline areas bordering Rann of Kutch is due to progressive declines in water levels ranging from 1 to 21 metres during the last two decades, caused by overexploitation. The most affected area is around Mehsana city. A vast low-lying tract in Central Gujarat, that is the area separating North Gujarat from Saurashtra

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[19]. What is true for Gujarat holds true at the national level also. India is being criticised for allowing large-scale damage of good land by salinisation. The damage rate in India is 36% as compared to Pakistan's 20% and China's 15% (Unna, 1989).

and Kutch, has saline water at all depths and pockets of brine (salt-saturated water) at very shallow depths. This is causing sub-surface outflow of highly saline water in the adjoining alluvial areas of North Gujarat, as well as in areas with semi-consolidated and alluvial formations in Saurashtra and Kutch.

South Gujarat: Salinity ingress is very limited along the South Gujarat coast, where the country rock is unpermeable basalt. The deeper aquifers in Surat and Bharuch districts beyond 90 metres of depth are saline.

Increase in fluoride content of groundwater

Fluoride is one of the salts found in water. In recent years, the fluoride content of groundwater has been increasing at a very fast rate due to the recession of water levels.[20] This has caused problems of domestic water supply as well as fluorosis. The stiffening of limbs in some form or the other is the main physical disability (discernible in both human and cattle population) caused by fluorosis. Besides, fluorosis is known to have deleterious effects on the teeth, the kidney, the heart and the nervous system; it can also cause foetal damage. Fluorosis is irreversible and cannot be cured once it has affected the body.[21]

The permissible limit of fluoride is around 1.0 ppm (parts per million), although levels of up to 1.5 ppm are usually considered as "tolerable". But the fluoride content of groundwater has crossed the permissible limit, often by shockingly large margins, in hundreds of villages in Gujarat. In Mehsana, 623 villages out of a total of 1,081 are affected by excess fluoride. Studies indicate its presence in all the aquifers down to the depth of 100 metres in almost the entire district, due to which, today, drinking water needs to be imported from the neighbouring districts. The worst case of fluoride excess in Gujarat is reported from Lathi

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[20]. The depletion of groundwater, with a roughly unchanged amount of salts, leads to an increase in the concentration of salts in water. No doubt, there can be other causes of increasing fluoridisation, but these are beyond the scope of the present paper.

[21]. Gujarat, Rajasthan and Maharashtra are the states most seriously afflicted by excess fluorides in India. According to recent estimates, over 25 million people are affected in the country (Gujarat Water Supply and Sewerage Board, Gandhinagar, n.d.).

Leelia in Amreli district, where fluoride content is as high as 37.5 ppm. The fluoride problem has recently spread to more and more districts, including Sabarkantha (see Map 7).[22]

It is worth noting that fluoride is only one of the salts of importance, and that the so-called "total dissolved salts" (TDS) levels in Gujarat have also shown highly disquieting trends in recent years. As Maps 8 and 9 clearly show, the areas where the "permissible limit" of 1500 ppm (defined by the World Health Organisation and the Indian Council of Medical Research) is exceeded have enormously expanded between 1970 and 1989.[23] In many areas, even the "tolerable limit" of 3000 ppm is now grossly violated.

Concluding Remarks

The evidence of increasing groundwater scarcity in Gujarat arising from data on water tables, salinity and fluoride remains quite fragmentary. This, as was discussed earlier, is to a large extent a reflection of the suppression of information on this whole issue. However, the available information points clearly to the existence of a massive and increasing problem of depletion of groundwater resources. The picture is incomplete, but it is already grim enough to deserve urgent concern.

1.4. Causes of the Current Crisis

Gujarat is facing an acute and growing problem of water scarcity, which reduces many aspects of the quality of life for the rural poor. During the last decade, water extraction through dug wells and handpumps has become increasingly difficult, the water table has receded and groundwater has become inaccessible for those who cannot afford modern

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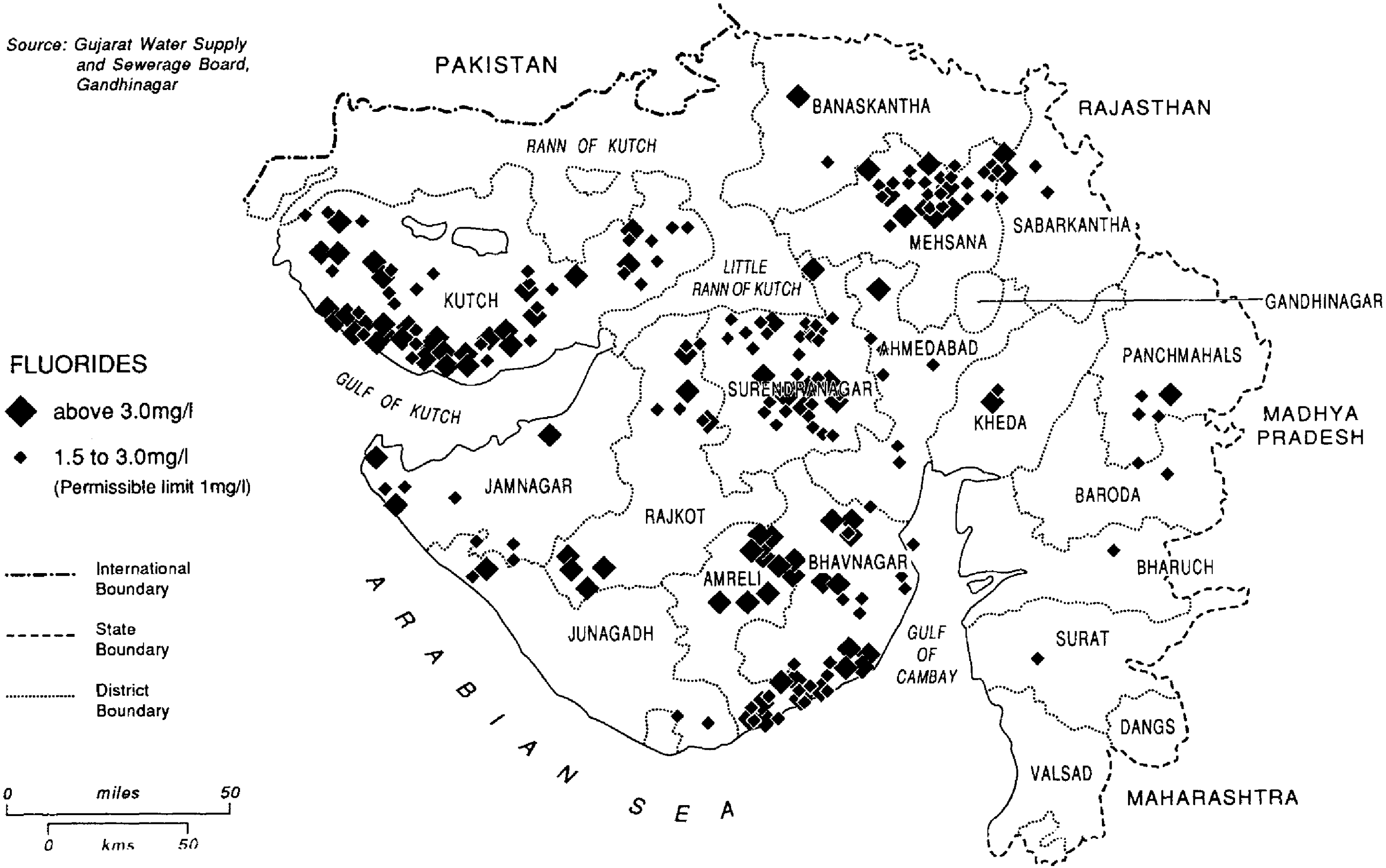
[22]. For a detailed discussion of the extent, causes and consequences of fluoride infiltration in fresh water zones (in Gujarat and neighbouring states), see S. Dhawan (1988), Mahadevan (1990), Nath et al (n.d.) and Phadtare (1988).

[23]. These two maps are based on readings by the Ground Water Resources Development Corporation from its observation wells. As a result, areas with no observation wells have been left blank in the maps.

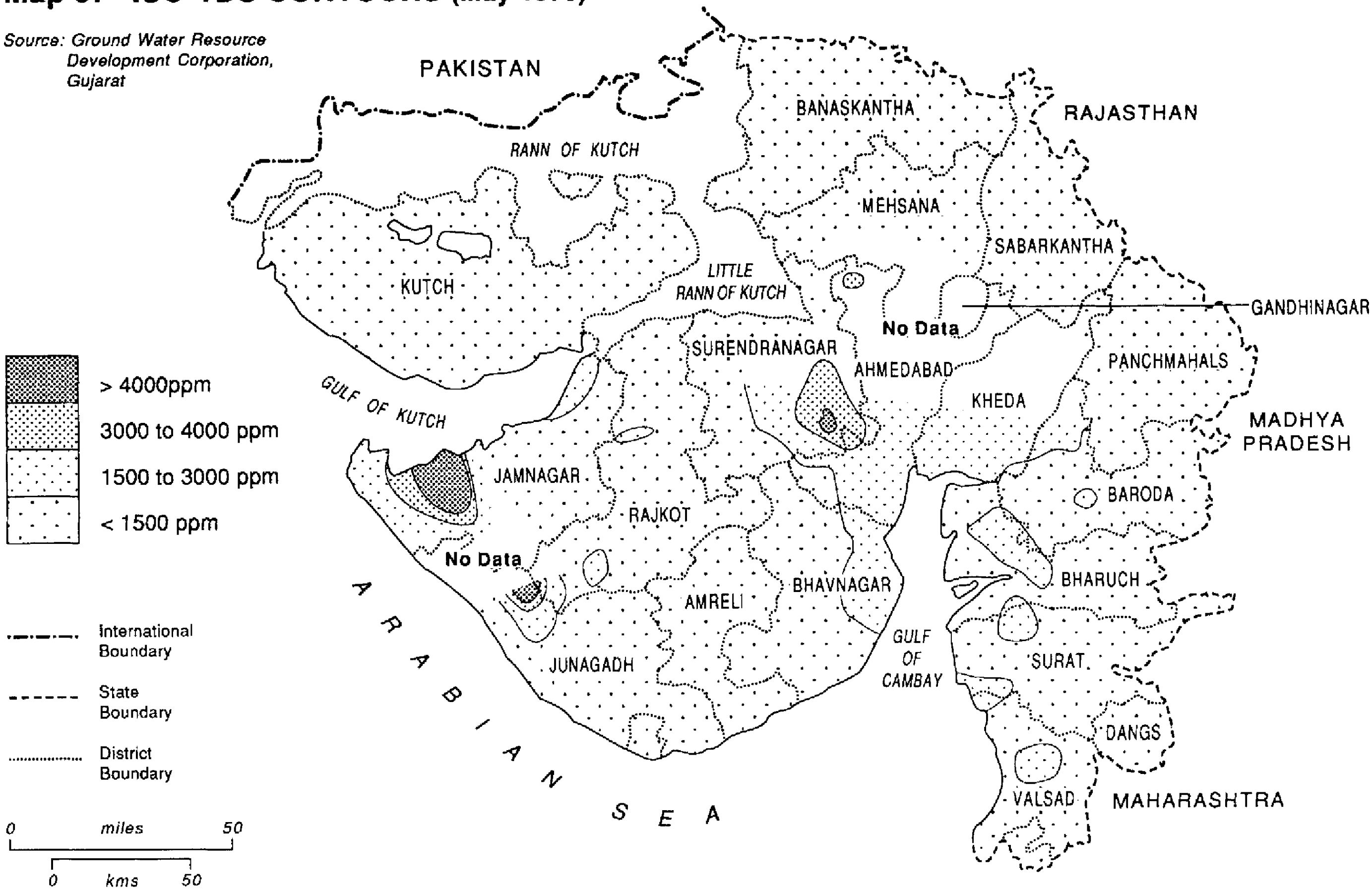
Map 7: DISTRIBUTION OF FLUORIDES, 1988



-16a-

Map 8: ISO-TDS CONTOURS (May 1970)

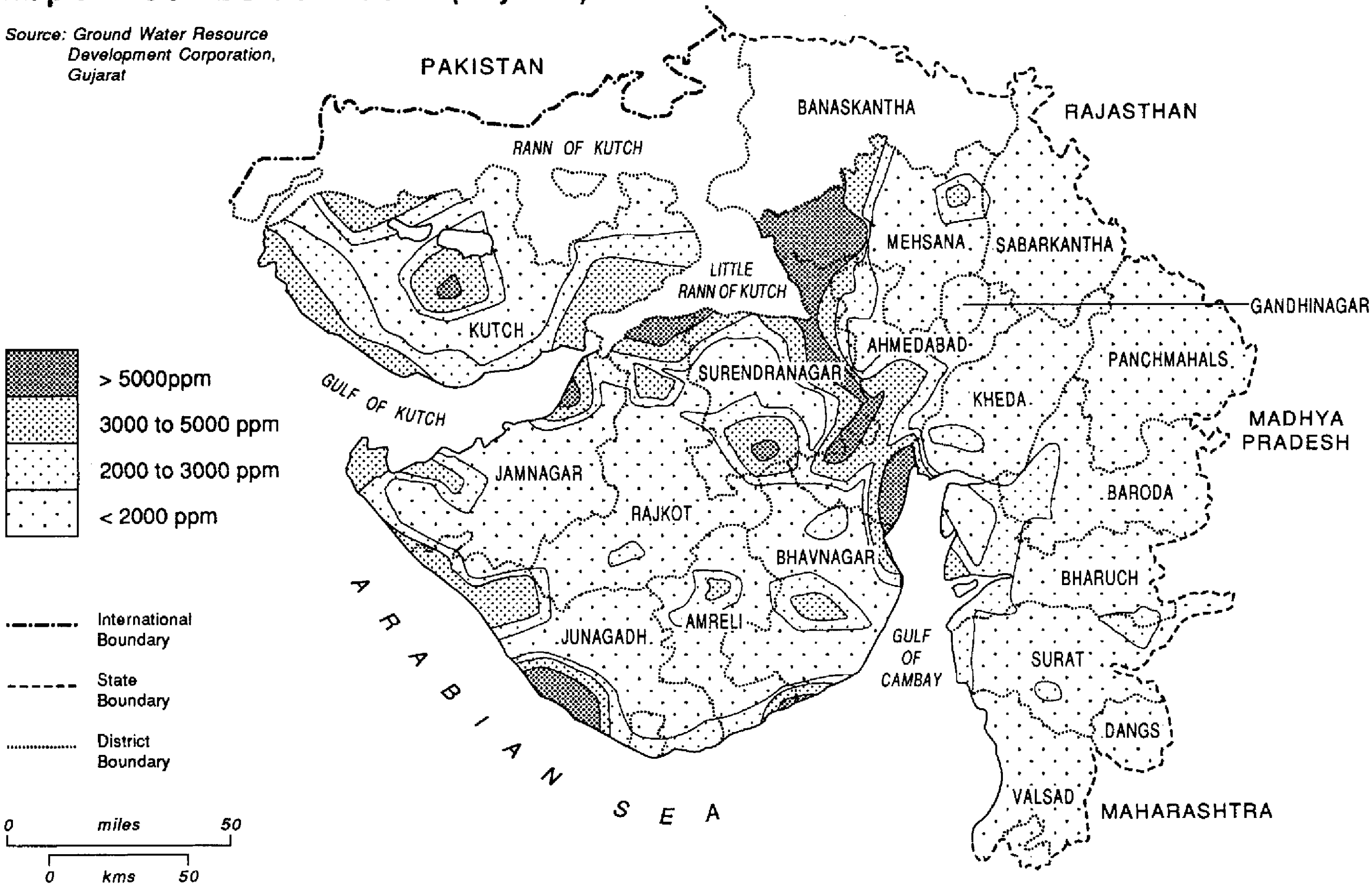
Source: Ground Water Resource Development Corporation, Gujarat



-16b-

Map 9: ISO-TDS CONTOURS (May 1989)

Source: Ground Water Resource Development Corporation, Gujarat



extraction devices. This is more the rule than the exception, not only in a drought year but also during non-drought years (especially during the summer months).

Broadly speaking, one can distinguish two (interrelated) causes of this accelerating depletion of groundwater resources. First, the depletion of groundwater can be seen as one aspect of a broader ecological crisis, involving particularly the disruption of the hydrological cycle. Second, there are important economic forces leading to the direct depletion of groundwater resources, especially the indiscriminate expansion of modern water extraction devices and of water-intensive crops in areas of groundwater scarcity. These two causes of groundwater depletion will be dealt with in sections 1.4.1 and 1.4.2, respectively.

These ecological and economic processes, of course, themselves have deeper causes, relating to the structure of property rights and the way the society is organised. Some of these more basic political issues will be examined in section 3.

1.4.1. **Groundwater Depletion and the Environmental Crisis**

The Hydrological Cycle

The term "hydrological cycle" refers to the continuous circulation of the earth's moisture through evaporation and precipitation. It is this cycle which makes water a "renewable" resource.

The excessive pumping of groundwater not in proportion to the recharge rate can disrupt this cycle and lead to the depletion of this otherwise renewable resource. The recharge rate depends on the extent of rainfall (discussed in the preceding section) and on the rates of percolation and run-off.

The rate of percolation depends chiefly on the characteristics of the soil. Coarse sandy soils permit fast percolation, while fine clayey soils permit very slow percolation; there exist all grades of intermediate varieties. Besides soil permeability, the rate of percolation also depends on the size of the resource already available. In waterlogged areas, where the water table is very close to the ground surface and where there is little empty space underneath, very little water can sink in.

The extent of run-off depends on the depth, porosity and compactness of the soil and the underlying material, the steepness and configuration of the surface, and the character and density of the vegetation. If there is adequate plant cover, litter and humus on the earth's surface, the force of the rainfall gets reduced and so does its power to dislodge mineral soil particles. In the absence of plant cover, the run-off rate is accelerated. In Gujarat, denudation has played an important role in accelerating run-off and reducing groundwater recharge.

Just as denudation is a cause of increasing water scarcity, the disruption of the hydrological cycle itself contributes to the disappearance of forests. The latter problem should be a cause of deep concern in its own right.

Trees and Water

What exactly is the role performed by trees? As mentioned above, the presence of plant cover helps to increase the percolation of rain water into the ground. The soil water reservoir under a forest cover therefore tends to be preserved for a longer period as compared to barren land. Moreover, forests play an extremely important role in controlling floods by reducing or regulating water run-off, thus also reducing soil erosion and landslides.

> "From an uncut, unburned and ungrazed forest, rarely will any water emerge as surface flow even during heavy rainfall. Almost all water is transmitted downwards... According to one calculation, if the soils of India's forest area had good forests on them, they would have the capacity to store more than all the rainwater that falls in an average year on a temporary basis and more than half of it on a prolonged basis... Clear-cutting of forest can increase peak run-off from high intensity storms by 10 to 20 per cent... Once forest lands are denuded, soil loss can increase by as much as 400 times".[24]

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[24]. Agarwal and Narain (1987).

In addition, some experts believe that trees help in bringing rain, by cooling the warm air masses and thus supporting the process of condensation. This view, however, is a matter of some controversy. The Indian Meteorological Department denies any correlation between the two, but a few separate studies do show some correlation, especially in humid areas. A well-known study is that of Meher-Homji (1986), who on the basis of vegetation and rainfall studies of 29 stations for over 100 years has shown that, as a rule, the larger the area of deforestation, the larger the number of criteria showing diminishing tendency of rainfall and rainy days.[25]

The National Forest Policy (1952) has prescribed that, of the total land area, 33 per cent should be covered by forests. Official statistics of the Government of Gujarat show that the land under forests more than doubled between 1960-61 and 1980-81 (from 5.1% of the total land area to 10.4%).[26] But independent studies lend little support to this extraordinary claim. Satellite-based data released in mid-1984 by the National Remote Sensing Agency (NRSA) show, on the contrary, that Gujarat's forest cover shrunk by almost 50% between 1972-75 and 1980-82 (from 5.3% of the total land area to 2.8%).[27]

The experience of desertification has found deep expression in oral histories and local folklore. Umashankar Joshi, the celebrated poet, talks about his native village in Bhiloda taluka of Sabarkantha district as the most beautiful spot on earth with its dense forests, rich foliage and fresh water streams and rivers. But today, the hills at the edge of the Aravalli range are completely barren of vegetation.

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[25]. For a more detailed discussion, see Agarwal and Narain (1987), p.28. See also Meher-Homji (1988).

[26]. Government of Gujarat (1984), Gujarat Agriculture Compendium (Ahmedabad: Directorate of Agriculture). The figures are originally obtained from the Forest Department, Government of Gujarat. These misleading figures are due to the simplistic reporting system in the Forest Departments, which describes the forest wealth in terms not of tree cover but of the extent of the areas which stand notified under one section or another of the Indian Forest Act 1927, regardless of whether these areas possess any tree cover or not. Moreover, as Vohra (1989) rightly points out, "there is a tendency on the part of the Forestry establishment to take shelter behind these misleading figures".

[27]. These NRSA-based figures are taken from The State of India's Environment 1984-85 (New Delhi: Centre for Science and Environment).

The real brunt of this forest loss is borne by the poor villagers, especially tribals whose whole economy is dependent on this resource. Women not only have to walk longer distances for water, but also have to spend on an average 5 to 6 hours every two or three days on fuelwood collection. The growing scarcity of this resource, which is as precious as food or water, is one of the most alarming aspects of the environmental crisis in Gujarat.

The unscrupulous exploitation of forest resources for commercial and industrial purposes is a major cause of growing wood scarcity. However, it is not the least tragic aspect of this crisis that the poor are themselves being driven to participate in the destruction of the environment on which their own survival depends. Due to lack of any other gainful employment, many poor villagers in North and South Gujarat are forced to trade a head-load of wood for a small amount of cash, or in exchange for a pitcher-full of buttermilk on which the family survives for three to four days. Through this widely prevalent practice, the higher-caste rich farmers manage to maintain stacks of fuelwood for their needs in spite of the general scarcity. Meanwhile, the poor become helpless victims of this vicious circle of economic destitution and environmental destruction.

Government policies have failed to arrest this process. To a large extent, these policies have taken the negative form of attempting to "bar" people from the forests, instead of taking positive steps to promote alternative sources of energy and livelihood. The alleged success of official "afforestation" programmes is little more than a myth, given that it has been largely based on the large-scale promotion of ecologically suspect species such as eucalyptus. Further, in some cases government policies have directly contributed to the destruction of the environment, for instance through the submergence of rich forests following the construction of large dams.

1.4.2. **Groundwater Overexploitation**

The Emergence of Modern Irrigation in Gujarat

The large-scale development of irrigation in Gujarat, as in the rest of the country, began after 1951 (the year when planned development in India was initiated). Prior to 1951, in the country as a whole, the utilisation of groundwater for irrigated agriculture accounted for around 25 per cent of the total groundwater resources harnessed at that time. At the beginning of the planning era, the full potential of underground aquifers was not known. The availability of pumping equipment and the energy needed to operate them were also restricted.

However, once the realisation came that groundwater was an extremely cheap and "efficient" alternative to major and medium irrigation works, the exploitation of the groundwater potential began at an accelerated pace. The comparative advantage that groundwater has over other sources of irrigation has been described by the expert B.B. Vohra in the following words:

> "... groundwater requires no expenditure for storage and transport, and can be harnessed by the farmer with his own efforts - except possibly for a short-term loan - within a matter of weeks if not actually days, and can, therefore, be developed through the efforts of millions of private individuals on an infinitely wider decentralised front and practically in all parts of the country within a far shorter period of time than surface water. It also involves no environmental problems such as the submergence of good lands under storage and canals, and no evaporation and seepage losses which take away more than 50 per cent of the water released from reservoirs before they reach the farmers' fields. It also creates no problem of water-logging. Above all, it is a resource entirely under the farmer's control and requires no huge and corrupt bureaucracies before it can be put to work. It can thus be applied exactly when and to the extent required by the crop or land... No wonder that while it required an investment of Rs 15,026 crores during the years 1951 to 1985 to create a 'utilised potential' of 15.6 mha by the 'major and medium' route, at an average cost of around Rs 10,000 per hectare, groundwater development by over 10 million farmers created a 'utilised potential' of as much as 19.6 mha during the same period, without involving the Government in any direct expenditure... the total saving which has already been achieved by groundwater development during 1951-1985 works out to something like Rs 50,000 crores."[28]

The pace of development of irrigation in Gujarat in recent decades can be appreciated from Table 8. As the table shows, between 1960-61 and 1984-85 the percentage of gross area

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[28]. Vohra (1987).

TABLE 8

DEVELOPMENT OF IRRIGATION IN GUJARAT, 1960-85

Year	**Gross area sown** (square kms)	**Gross area irrigated** (square kms)	**Gross area irrigated as percentage of gross area sown**
1960-61	97,676	7,338	7.5
1965-66	101,881	10,722	10.5
1970-71	105,403	14,939	14.2
1975-76	105,494	17,091	16.2
1979-80	106,550	22,114	20.8
1984-85	111,457	29,494	26.4

Source: Bureau of Economics and Statistics, Government of Gujarat (from Phadtare, 1988, p.14).

irrigated to gross area sown nearly quadrupled.[29]

Table 9 shows the area irrigated by different sources from 1960-61 to 1983-84. It can be seen that, although the area irrigated by wells has slightly declined in proportionate terms (mainly due to the expansion of canal irrigation), groundwater irrigation through wells remains the major contributor (76.5%) to the total area irrigated.[30]

At the same time, a dramatic change has taken place within the "wells" category. In earlier times, irrigation through wells meant the use of *kos* and similar water-lifting devices, manually operated with the aid of bullocks. Today, however, well irrigation usually involves energised pumps. Thus, the dug wells or open wells of the sixties have increasingly given way to the tubewells of the seventies and eighties. The dramatic increase in area irrigated since the 1950s is undoubtedly due to the rapid expansion of these modern water extraction mechanisms. Indeed, as Table 10 shows, the number of energised tubewells and pumpsets in Gujarat has grown at a phenomenal rate in recent years, while that of dug wells has comparatively stagnated (see also Tables 11 and 12 below).

In sum, the development of irrigation in Gujarat, and particularly of groundwater-based irrigation, has been very rapid since the beginning of the planning era. Further, this expansion is overwhelmingly the result of the spread of energised water extraction mechanisms such as electric tubewells and diesel pumpsets. The current overexploitation of groundwater in Gujarat is closely related to these trends.

Role of Electrification

The massive expansion of modern water extraction devices in recent years has been

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[29]. The figures presented in Table 8 apply to Gujarat as a whole, and hide some important regional variations. While the percentage of gross irrigated area to gross sown area in districts such as Kheda, Mehsana and Gandhinagar is as high as 40 to 45 per cent, it is less than 7 per cent in Dangs and Panchmahals.

[30]. Data from individual districts such as Sabarkantha show a particularly high incidence of well irrigation. As per the Sabarkantha Gazetteer (1974), in 1968-69 wells accounted for as much as 95 per cent of the irrigated area.

TABLE 9

AREA IRRIGATED (square kms) BY SOURCE, 1960-84

Source	1960-61		1965-66		1970-71		1975-76		1980-81		1983-84	
Govt canals[a]	652	(9.5)	1393	(13.4)	2358	(17.2)	2844	(18.8)	3668	(18.3)	4892	(21.5)
Private canals	6	(0.1)	11	(0.1)	6	(0.04)	-		-		-	
Wells[b]	5677	(83.1)	8625	(82.8)	10831	(79.0)	11900	(78.6)	15884	(79.3)	17370	(76.5)
Tanks	128	(1.9)	296	(2.8)	372	(2.7)	252	(1.6)	409	(2.0)	407	(1.8)
Other sources	366	(5.4)	87	(0.8)	141	(1.0)	148	(1.0)	65	(0.4)	40	(0.2)
Total net area irrigated	6829	(100)	10412	(100)	13708	(100)	15144	(100)	20026	(100)	22709	(100)
Gross area irrigated	7338		10722		14939		17091		23344		27974	

[a] Including Panchayat canals.

[b] Including tubewells.

Source: **Statistical Abstract of Gujarat 1985-86** (Directorate of Agriculture, Government of Gujarat). The figures in brackets indicate the percentage distribution of net irrigated area by irrigation source.

TABLE 10

STATEMENT SHOWING THE GROWTH OF GROUNDWATER EXTRACTIONS STRUCTURES

Groundwater extraction structures	Number of structures in 1980	Number of structures in 1985	Percentage increase over five years
Dug wells	654.0	672.9	3%
Private shallow tubewells	2.5	4.5	80%
Public tubewells	2.2	3.9	77%
Electric pumpsets	202.9	294.1	45%
Diesel pumpsets	562.5	732.5	30%

Source: Government of India (1986), **Groundwater Development in India** (New Delhi: Ministry of Water Resources), Annexures IV to VIII, pp.36-40. All figures are in thousands.

partly due to the official encouragement given to groundwater exploitation, beginning with the Grow More Food campaign launched in 1953 at the all-India level.[31] Another important factor, however, was the electrification of villages, which led to the rapid energisation of pumpsets and tubewells. Electrification was particularly rapid in Gujarat, as Tables 11 and 12 indicate. We can see that while in 1960-61 only 823 villages were electrified, by 1985-86 this figure had shot up to 17,053 (out of a total of 18,114 villages). A corresponding increase was also observed in the number of pumpsets and tubewells which were electrified: in 1960-61, this number was a mere 5,401, but by 1985-86 it had jumped to 317,403. In other words, within this twenty-five year period, there was almost a sixty-fold increase in the number of electrified pumpsets and tubewells in Gujarat.

For diesel pumpsets, a steady growth can be observed until 1976. After that, the rate of growth seems to have slowed down. At the field level one observes that many of these pumpsets are not in use. This is sometimes the case because the dugwell on which a pumpset was installed has little or no water and the owner does not have the capacity either to deepen his dugwell or to get an in-well bore drilled. But, in some areas, it is also the result of a switch from diesel to electricity, the latter being often a cheaper source of energy.[32]

Interestingly, we observe that the largest proportionate increase (340%) in the number of electrified pumpsets and tubewells over a period of five years occurred in 1966-71. It must be recalled here that the late 1960s was also the period when the Green Revolution was gaining a foothold in Gujarat. This period was also one of frequent scarcity conditions. Drought was declared in all the districts of Gujarat in 1965-66, and in 16 out of 19 districts in 1968-69. The expansion of electrified pumpsets and tubewells was also rapid during the

[31]. The expansion of modern water extraction devices has not, of course, been confined to Gujarat. As early as 1971, as much as sixty per cent of groundwater lifted in India was extracted by modern methods (Dhawan, 1975:A-35). After 1971, the rate of expansion of tubewell irrigation has increased considerably, so much so that presently this source alone accounts for most of the extension of net irrigated area in the country. If, for once, minor irrigation compares favourably with major irrigation in terms of growth rate, it is due to the introduction of these modern techniques of groundwater exploitation (Sengupta, 1985:1929).

[32]. Some studies have found the cost per irrigation in the case of a tubewell operated by diesel to be about 3 times as high as that of an electric-operated tubewell (Shiva 1989:96).

TABLE 11

NUMBER OF VILLAGES ELECTRIFIED, DIESEL PUMPSETS AND ELECTRIFIED PUMPSETS/TUBEWELLS IN GUJARAT STATE

Year	Number of villages electrified[a]	Number of diesel pumpsets	Number of electrified pumpsets/tubewells[b]
1960-61	823	45,000	5,401
1965-66	1,844	112,400	15,240 (182%)
1970-71	4,087	371,100 (1972)	67,052 (340%)
1975-76	6,307	422,100 (1977)	121,854 (82%)
1980-81	12,515	NA	231,226 (90%)
1985-86	17,053	NA	317,403 (37%)

[a] Figures are inclusive of licensee's areas.

[b] In brackets, the percentage increase over the preceding five-year period.

Source: **Statistical Abstract of Gujarat State, 1985-86** (original source: Gujarat Electricity Board, Baroda). The figures correspond to the end of the relevant fiscal year.

TABLE 12

NUMBER OF PUMPSETS/TUBEWELLS ELECTRIFIED IN GUJARAT, BY DISTRICT

District	1979	1980	1981	1982	1983	1984	1985	1986	
Ahmedabad	9,845	10,512	11,521	12,130	12,472	12,757	13,262	13,944	(42%)
Amreli	7,333	8,229	10,352	10,975	11,201	11,540	12,108	13,063	(78%)
Banaskantha	8,307	10,228	12,531	15,351	16,300	17,213	19,268	22,001	(165%)
Baroda	9,644	10,299	10,574	10,943	11,290	11,646	12,009	12,479	(29%)
Bharuch	4,142	4,506	4,732	4,975	5,177	5,369	5,517	5,710	(38%)
Bhavnagar	9,921	11,857	14,136	15,749	16,662	17,407	18,997	20,872	(110%)
Dangs	13	13	13	13	14	16	16	17	(31%)
Gandhinagar	2,788	2,886	3,006	3,100	3,176	3,237	3,379	3,504	(26%)
Jamnagar	6,091	7,325	8,456	9,522	10,336	11,499	12,933	15,308	(150%)
Junagadh	21,918	24,972	28,573	31,112	32,275	34,226	37,204	40,583	(85%)
Kheda	12,394	13,327	14,306	14,910	15,233	15,572	16,111	16,758	(35%)
Kutch	9,687	11,268	12,244	12,786	13,173	13,483	13,959	14,630	(51%)
Mehsana	18,158	20,447	24,110	26,082	26,850	27,821	29,222	31,153	(72%)
Panchmahals	3,415	3,991	4,418	4,777	5,050	5,296	5,667	6,167	(81%)
Rajkot	11,372	13,184	14,851	16,262	17,031	18,211	19,899	22,917	(100%)
Sabarkantha	18,906	23,532	27,837	30,699	31,856	33,121	35,322	38,028	(101%)
Surat	8,454	9,320	10,503	11,244	11,679	12,209	12,931	13,803	(63%)
Surendranagar	5,594	6,228	7,515	8,528	8,892	9,420	9,981	10,836	(94%)
Valsad	9,816	10,729	11,548	12,457	13,087	13,719	14,602	15,630	(59%)
GUJARAT	177,798	202,853	231,226	251,616	261,761[b]	273,762[b]	292,387	317,403	(79%)

[a] In brackets, the percentage increase between 1979 and 1986.

[b] Figures inclusive of licensee's areas.

Source: **Statistical Abstract of Gujarat State**, various fiscal years (original source: Gujarat Electricity Board, Baroda).

last drought of 1985-88 (see Table 12). A positive relationship seems to exist between drought and the growth of water extraction structures. Describing the impact that these structures have during drought, Bandyopadhyay (1987) rightly states:

> "While drought is getting mitigated for the farmers growing cash crops, energized pumpsets are creating new drought for marginal and poor peasants by drawing down the water table to below their reach".

Private Profits and Government Subsidies

What are the reasons for the recent proliferation of pumpsets in general, and of electric pumpsets in particular? An obvious factor is that, with the present structure of incentives and property rights, energised water extraction mechanisms represent a far more lucrative technology than dug wells in most environments. One reason why it is important to recognise this factor is that, according to some authors, tubewells started expanding only after groundwater levels had already declined beyond the reach of dugwells and, accordingly, the expansion of tubewells should be seen as a consequence, rather than a cause, of groundwater scarcity.[33] This general view would be hard to reconcile with the fact that tubewells have mushroomed in most parts of the country in recent decades, even in regions (such as many parts of Punjab, Uttar Pradesh and West Bengal) where there are as yet no serious signs of groundwater scarcity. This comprehensive expansion of tubewells and other energised water extraction devices can only be explained by the highly profitable nature of these investments, particularly for farmers who own a lot of land and have access to cheap credit. While it may be the case that, in particular regions and periods, the expansion of water extraction mechanisms has followed the depletion of groundwater, in general these two phenomena are best seen as mutually reinforcing.[34]

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[33]. Reddy (1989:184), for instance, states: "... what has been forgotten is the fact that tubewells came onto the scene at a time when groundwater levels had already declined beyond the reach of dug wells. Therefore the large-scale sinking of tubewells in a region is a reflection of the declining groundwater levels in that particular region, rather than the other way round".

[34]. The profitability of groundwater is sometimes a reflection of the fact that access to surface water has been reduced through government intervention. In several districts of North Gujarat, the propensity of farmers to invest in water extraction mechanisms has indeed been

The profitability of investments in tubewells has been greatly enhanced by various government policies. These include highly subsidised electricity pricing (on which more in section 3), and liberal financial assistance.[35] Liberal provision of subsidised credit in agriculture began with the Five Year Plans. Since the formation of the state of Gujarat in 1960, agricultural credit has been mainly provided through the agency of the Gujarat State Cooperative Land Development Bank. As Table 13 indicates, an overwhelming proportion (more than 90 per cent) of the credit extended by the Land Development Bank is allocated to investment in modern water extraction devices. A large share of the credit channelled through more recent institutions and schemes such as NABARD and the Integrated Rural Development Programme also supports such investments, especially during and after drought years. In the absence of government support in these and other forms, the profitability of modern water extraction devices would have been greatly reduced.[36]

Cropping Patterns and Technological Change

The expansion of modern water extraction structures in Gujarat has to be seen as one aspect of the profound changes in agricultural practices that have taken place in recent decades. These changes, often referred to as the "Green Revolution", have involved a radical shift from traditional agriculture to modern cultivation methods based on an intensive use of new seeds, fertilizers and energised irrigation. The problem of groundwater depletion has to

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reinforced by the diversion of surface-water resources to other districts. This process has been particularly noticeable in Sabarkantha. Surface water has been taken away from this district (through medium and major irrigation projects such as Hathmathi, Meshvo, Guhai and Dharoi), not for the drought-prone neighbouring districts of Banaskantha or Panchmahals, but to satisfy the industrial and domestic water needs of cities like Ahmedabad and Gandhinagar, as well as for the development of irrigation in the richer district of Kheda. These diversions take place in violation of the riparian rights of the inhabitants of the supplying districts, who suffer from drinking water shortages as well as from inadequate irrigation facilities (refer, for instance, to the High Court case lodged by Gujarat Lok Samiti on riparian rights from the Dantiwada dam in Banaskantha).

[35]. See also Dakshinamurti et al (1973:104).

[36]. As will be seen in section 2, government assistance in Gujarat has been heavily biased in favour of large farmers, and investments in modern water extraction devices remain unaffordable for a majority of small and marginal farmers. Many of them also find the tubewells uneconomic or unviable in view of the small size of their holdings.

TABLE 13

AGRICULTURAL FINANCE ADVANCED TO CULTIVATORS DURING THE YEAR 1970-71

Purpose	**Amount** (Rs 000)	**Percentage distribution**
Sinking of new wells and repair of old wells	6,991	33.7
Oil engines, electric motors, etc.	11,942	57.6
Purchase of tractors	534	2.6
Other purposes	1,255	6.1
TOTAL	20,722	100.0

Source: Gujarat State Cooperative Land Development Bank (Ahmedabad).

be seen in this wider context.

A particularly important aspect of recent changes in agricultural practices is the modification of cropping patterns. The general tendency has been to shift towards crops (especially non-food crops) that involve a greater use of the inputs that have become more widely available, especially water and fertilizers. In Sabarkantha, this shift has taken the form of an enormous expansion in the relative importance of non-food crops, especially cotton (see Table 14).

There has been much discussion of the pros and cons of these recent changes in agricultural technology and cropping patterns.[37] On the positive side, it has been argued that these changes tend to lead to a substantial expansion of output and employment.[38] This argument is based on the fact that modern practices are not only more intensive in the use of inputs such as water and fertilizers but also typically more labour-intensive as well as more productive.

On the negative side, some analysts have questioned whether the expansion of output and employment have led to a reduction in poverty and an improvement in nutritional standards. Further, the destructive ecological impact of the Green Revolution has been consistently underlined.

An important aspect of this destructive impact is the loss of genetic diversity associated with the concentration on a limited number of crop varieties. To illustrate, in Sabarkantha district there used to be at least seven broad types of rice: *sutarsal*, *vari*, *kharsu*, *sathi*, *panjaria*, *sengda* and *sejani*. Many of these types have now disappeared. In the case of wheat and maize, too, a limited number of hybrid varieties have replaced a wide range of traditional types, some of which used to grow freely in the valleys of the North of the district even with very little water. Most alarming is the gradual disappearance of certain species of cereals which were quite widespread as recently as the turn of the century, such as *kang*

[37]. For a survey of this vast debate, see e.g. Lipton (1989).

[38]. See e.g. Hazell and Ramasamy (1991).

TABLE 14

AREA UNDER IRRIGATED CROPS: SABARKANTHA DISTRICT

Crops	**Area under irrigation (in '00 hectares)**				
	1950-51	1955-56	1960-61	1968-69	1983-84
Rice	9	7	9	7	53
Jowar	-	2	-	3	2
Bajri	-	2	2	28	57
Barley	8	3	3	7	14
Maize	62	49	51	66	111
Ragi	-	1	-	-	-
Wheat	179	240	226	272	428
Other cereals	24	3	10	8	-
TOTAL CEREALS	**282**	**307**	**301**	**391**	**665**
Gram	15	14	7	11	1
Other pulses	2	2	3	9	-
TOTAL PULSES	**17**	**16**	**10**	**20**	**1**
Other food crops	1	41	7	27	125
TOTAL FOOD CROPS	**300**	**364**	**318**	**438**	**791**
Groundnut	-	-	-	4	12
Sesamum	-	1	-	-	-
Rape & mustard	3	4	-	1	-
Castor	-	-	-	-	-
Cotton	1	88	134	168	670
Sugarcane[a]	3	4	2	10	6
Other non-food crops	11	8	5	13	132
TOTAL NON-FOOD CROPS	**18**	**105**	**141**	**196**	**820**
TOTAL AREA UNDER IRRIGATED CROPS	**318**	**469**	**459**	**634**	**1611**

[a] In the original sources, sugarcane had been counted as a "food crop". In the present table, it has been shifted to the non-food category.

Source: For the years 1950-51, 1955-56 and 1960-61: **Basic Agricultural Statistics** (Ahmedabad: Directorate of Agriculture, Gujarat State, 1968), pp. 54-57. For the year 1968-69: Government of Gujarat (1974) (original source: Directorate of Agriculture, Gujarat State). For the year 1983-84: **Statistical Abstract of Gujarat 1984-85**.

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(panicum italicum), *banti* (panicum spicalum), *bavto* (panicum frumentaceum), *kodra* (paspalum sceobiculatum) and *cheno* (panicum milaceum).[39]

The depletion of groundwater resources fits into this pattern of ecological destruction. By making vast groundwater resources widely accessible to affluent farmers, and through the promotion of water-intensive crops, modern technology and the Green Revolution have played a major part in the current crisis of overexploitation.

This aspect of the Green Revolution is one that has been somewhat neglected in the current controversy (with a few exceptions, e.g. Bandhyopadhyay, 1987, and Shiva, 1988). While ecological critiques of the Green Revolution have largely concentrated on the issue of genetic diversity, it is arguable that the problem of groundwater depletion is at least as important. This is particularly so in areas where groundwater resources are relatively limited and vulnerable to overexploitation, including large parts of Gujarat. Any assessment of the suitability of modern agricultural practices in these areas has to give ample recognition to this acute problem of groundwater depletion.

1.5. **Concluding Remarks**

In this section, we have examined the nature and significance of the emerging groundwater crisis in Gujarat. Before proceeding to a case study of this crisis in two talukas of Sabarkantha district (section 2), and to a discussion of what can be done to respond to it (section 3), it may help to recall the main insights that have emerged so far.

First, water scarcity is a relatively new and increasingly important aspect of droughts in Gujarat (section 1.1). In the past, droughts caused major famines while water scarcity was a relatively minor problem. Today, relief measures are by and large effective in dealing with the threat of starvation, but the growing problem of water scarcity remains largely

[39]. These varieties have more or less disappeared today. See Government of Gujarat (1974:269) and Campbell (1880:370-371).

unaddressed.

Second, contrary to what is often assumed, there is no evidence of a significant long-term decline in rainfall levels either in Gujarat or in Sabarkantha district. The emergence of water scarcity in Gujarat cannot be blamed on a declining trend in rainfall (section 1.2).

Third, groundwater scarcity in Gujarat is no longer confined to drought years, but is rapidly taking the form of a long-term trend (section 1.3). The most alarming signs of this crisis are the decline of water tables, the spreading of salinity, and the increase of fluoride levels in groundwater. If this trend continues at the current pace, large parts of Gujarat will soon succumb to the forces of desertification.

Fourth, the depletion of groundwater resources in Gujarat has to be seen in the context of a larger environmental crisis (section 1.4.1). The depletion of groundwater means not only that drinking water has to be fetched over longer and longer distances and that traditional wells dry up; it also means a dangerous and possibly irreversible disruption of the "hydrological cycle".

Fifth, a major cause of this disastrous trend is the overexploitation of groundwater, mainly as a result of the rapid spread of modern irrigation methods (section 1.4.2). The expansion of modern water extraction devices is one aspect of the recent transformation of Indian agriculture (sometimes described as the "Green Revolution"), involving more intensive cropping patterns and practices. The adverse consequences of this transformation on the management of groundwater resources in Gujarat have to be seriously considered, along with any possible gains that might arise through increases in productivity or labour demand.

Aside from this problem of overexploitation, we have had many opportunities to note how growing inequity in groundwater use is both a critical consequence and a major cause of overexploitation. This growing inequity compounds earlier economic inequalities based on land ownership, with the result that the agricultural community in Gujarat is increasingly sharply divided between a minority of prosperous farmers who monopolise most of the land <u>and</u> the water, and a majority of small farmers and agricultural labourers who are increasingly alienated from both of these means of production.

Inequity and overexploitation are, thus, the two ugly heads of the monster of groundwater mis-utilisation in Gujarat. In section 2 (where groundwater utilisation will be looked at "from the grassroots") the main focus will be on inequity, while section 3 (which discusses remedial action) concentrates primarily on overexploitation. But this is not to say that overexploitation will be ignored in section 2 or inequity in section 3. These two aspects of the current crisis are, ultimately, inseparable, in so far as their common cause lies in the anti-social appropriation of groundwater by a small minority of large farmers. They can be seen as two sides of the same coin.

2. A CASE STUDY

This section presents the main results of a case study undertaken in eight villages of Bhiloda and Idar talukas of Sabarkantha district in the summer months of 1988. The aim of the study was to understand the distribution of and access to groundwater in these villages. Two types of questionnaires were used: one with a sample of small farmers, and the other with a sample of big farmers. A few case studies of each category were attempted. Besides this, general socio-economic information on the villages was collected.

In addition to this survey of eight villages, use will also be made of official information on four villages of Idar taluka. This information was collected through a special well-to-well survey conducted by the respective *talatis*. One of these four villages, Bhadresar, is also among the eight villages of our own survey.

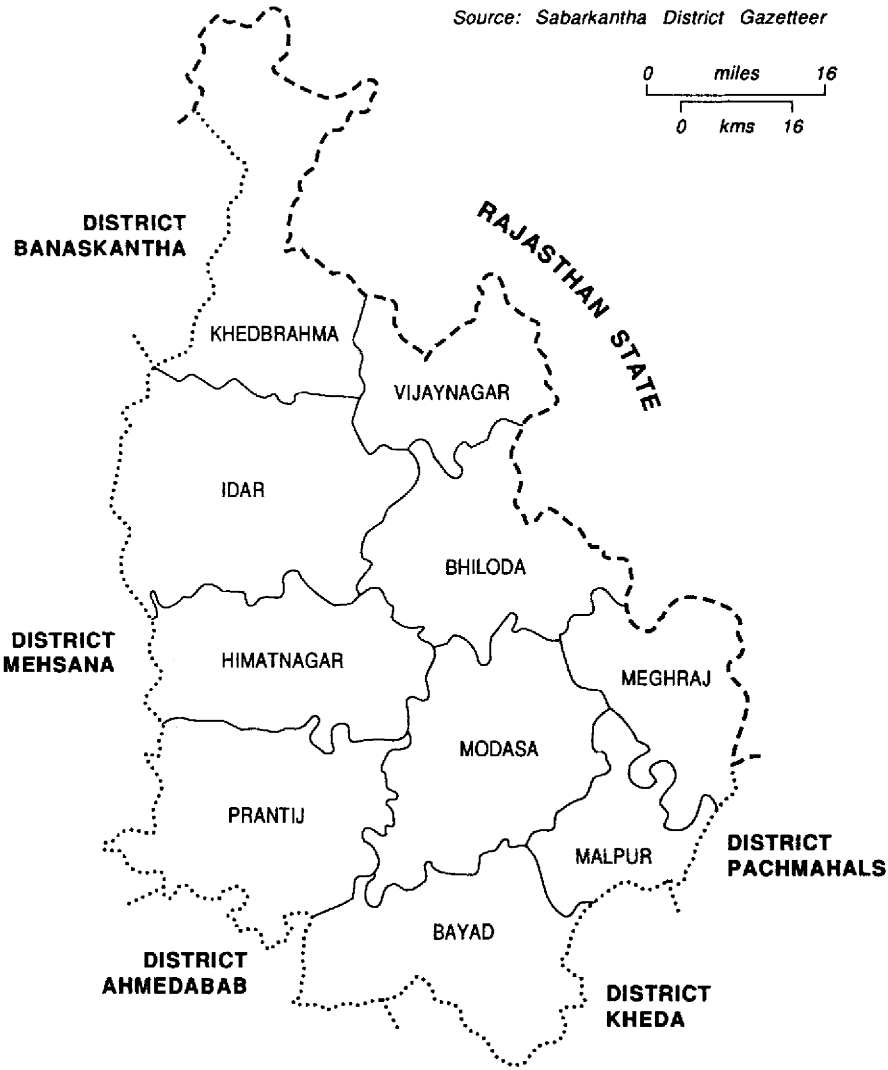
The emphasis of the field work was less on the collection of quantitative data than on a qualitative assessment of the situation prevailing in the study villages as well as on informal discussions with the people concerned. The presentation of this section reflects this bias.

The main focus will be on the question of inequity in access to groundwater, the problem of overexploitation being dealt with at length in section 3. However, as the concluding remarks of the preceding section indicate, there are important links between the problems of inequity and overexploitation, and even in this section the latter problem will not be altogether ignored.

2.1. Background

Sabarkantha district is situated in North Gujarat, and is adjacent to Rajasthan (see Map 10). There are ten talukas in the district, out of which four are under the Integrated Tribal Development Programme (ITDP), including Bhiloda taluka itself. More than 90 per cent of

Map 10: SABARKANTHA DISTRICT



the population of the district lives in rural areas.[40] The economy of Sabarkantha is dominated by agriculture, both irrigated and (mainly) unirrigated. Only a small part of the population is engaged in industrial activities or in the tertiary sector.

According to the 1981 Census, 8.6 per cent of the population of Sabarkantha consists of "scheduled castes", and 16.7 per cent of "scheduled tribes". The proportion of Muslims is very small. A large part of the land is owned by influential cultivating castes such as Patels, Kolis and Rajputs. Political power is also heavily concentrated among these communities. In fact, Sabarkantha is a stronghold of the farmers' lobby in Gujarat.

These broad features of the economy and society of Sabarkantha also apply in the eight study villages.

2.2. **Inequity and Groundwater Use**

Economic inequality is a persistent feature of rural India, but its manifestations and intensity do change from time to time. This observation applies to the ownership of water extraction mechanisms. As will be seen in this section, traditional inequalities in the ownership of dug wells have sharply increased with the acquisition of modern accessories such as pumpsets and bores.

In order to examine the "distribution" of water extraction mechanisms, we need some indicator of the economic status of different households or groups of households. Household income (or per-capita income) is frequently used for this purpose. However, household income is extremely hard to measure in rural India, and it varies enormously from year to year, so that the current income of a household may be a very misleading indicator of its long-term economic prosperity (especially in a drought year).[41] An alternative is to use land ownership as an indicator of economic status. This, perhaps, would have been the best

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[40]. In Gujarat, only Dangs has a higher rural/urban population ratio.

[41]. For a detailed discussion of this problem, see Drèze (1988).

approach in this context. However, given the difficulty of obtaining and interpreting land records, another route was adopted.

In this case study, we will begin by looking at the distribution of irrigation assets between different castes (or, when applicable, tribes). This indicator is obviously not very reliable if we are interested in the economic status of individual households. However, for the purpose of dividing households into broad groups of different levels of affluence, caste is an excellent indicator in the study area. For instance, it can be said with full confidence that, say, Patels represent a "rich" and influential caste in the study villages, while, say, Vankars (a scheduled caste) are extremely poor in comparison.

More precisely, the different castes encountered in the eight study villages can be divided into three broad groups, according to their level of economic prosperity.[42] First come the well-off, land-owning, well-educated, advantageously employed and politically influential caste groups, including particularly Patels, Rajputs, Barrots, Banias, Desais and Sonis.

At the other extreme are the scheduled castes (e.g. Bhambis and Vankars). Households from these castes are mostly poor, landless and illiterate. Many of them have also severely suffered from the loss of their traditional occupation (e.g. weaving in the case of Vankars).

An intermediate position is occupied by households from "other backward castes" (e.g. Thakardas) as well as from scheduled tribes. These households tend to own small amounts of land, and this has enabled them to rise somewhat above the position of scheduled castes in economic terms. However, their condition remains quite depressed. Over time, their holdings have become very small due to land fragmentation, and also, in the case of the Thakardas, due to large-scale alienation of land resulting from indebtedness. The labouring

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[42]. It should be stressed that this grouping is based on the economic prosperity of different castes, and not on their ritual status in the traditional caste hierarchy. Economic and ritual status are, of course, often closely related. But in so far as they diverge, our interest is in the former rather than the latter.

classes consist almost exclusively of households belonging to the last two of these three broad groups.

The distribution of irrigation assets between different caste groups is shown in Tables 15, 16, and 17, respectively dealing with dug wells, bores and pumpsets. While examining these three tables, it is useful to concentrate first on the village of Bhadresar. For this village, information is available for all water extraction structures, and detailed information on the caste composition of the population is also available. Three observations emerge clearly from the data relating to this village.

First, the ownership of water extraction structures is overwhelmingly concentrated among the privileged castes (especially the Patidar caste, including Patels and Desais). For instance, in Bhadresar all the bores are owned by these two caste groups, even though they represent only 23% of all households in the village.

Second, the inequity of ownership is more pronounced for modern irrigation devices (bores and pumpsets) than for dug wells. In contrast to their total monopoly of bores, Patels and Desais own "only" a little above half of the dug wells. The ownership of dug wells among other castes - even the poorer ones - is fairly widespread.

Third, in spite of this the distribution of dug wells is itself far from equitable. For instance, while the number of households per well is only 1.4 among Patels and Desais, it is as high as 30 among Vankars (a "Harijan" caste representing 90 households in Bhadresar).

For villages other than Bhadresar, we can see from Tables 15 and 16 that in these villages the privileged castes also have a virtual monopoly of water extraction devices. While precise information on the caste composition of these villages is not available, in terms of the four groups defined earlier the composition of these villages is similar to that of Bhadresar. The pattern of sharp and increasing inequalities observed in Bhadresar thus applies in those villages as well.

TABLE 15

CASTE-WISE OWNERSHIP OF WELLS IN FOUR VILLAGES OF IDAR TALUKA

Caste group	Number of wells owned by different groups				
	Bhadresar	Kapoda	Munjpur	Nadri	Total
Patel	76	66	-	144	286
Other privileged castes[a]	66	2	1	6	75
Thakarda	1	4	7	11	23
"Harijan"	8	-	4	13	25
Other disadvantaged castes[b]	7	7	8	12	34
Unspecified	2	-	-	-	-
TOTAL	160	79	20	186	445

[a] These include castes such as Barrot, Chauhan, Bhatt and Kolis. Individuals with the Desai surname (used both by some Patels as well as by Rabaris) have been included in this group for want of information on their precise caste affiliation. Among the study villages, the Desais are mostly found in Bhadresar.

[b] These include Turi, Ghanchi, Nayak, Kumhar, Pandaya, Talal, among others. A small number of Muslims have also been included in this group.

Source: Based on the survey conducted by the talatis of these villages in the last week of June and first week of July 1988.

TABLE 16

CASTE-WISE OWNERSHIP OF BORES IN THE STUDY VILLAGES

Caste group	Bhadresar	Choriwad	Mau	Messan	Munai	Naranpur	Takatuka	Umedpura	TOTAL
Patel	1	27	8	30	33	7	24	25	156
Other privileged castes	28	1	11	-	1	10	6	2	59
Thakarda	-	-	-	-	1	2	-	1	4
"Harijan"	-	1	-	-	-	-	-	-	1
Other disadvantaged castes	-	-	1	-	-	-	-	-	1
TOTAL	29	29	20	30	36	19	30	28	221

Source: Field survey, and survey conducted by the talatis of these villages in the last week of June and first week of July 1988. See the preceding table for details of the caste groups.

TABLE 17

CASTE-WISE OWNERSHIP OF DIESEL PUMPS AND ELECTRIC MOTORS IN BHADRESAR VILLAGE (IDAR TALUKA)

Caste group	Number of assets owned		Total number of households
	Diesel pumpsets	Electric Motors	
Patel	7	21	} 160
Other privileged castes[a]	20	99	}
Thakarda	-	-	100
"Harijan"	6	2	130
Other disadvantaged castes	1	6	150
TOTAL	34	128	540

[a] These predominantly include the Desais. See Table 15 for details of caste groups.

Source: Field survey, and survey conducted by the talatis of these villages in the last week of June and first week of July 1988.

Land and water

Inequalities in the ownership of water extraction mechanisms are closely related to inequalities in land ownership. The example of two villages, namely Munai and Mau of Bhiloda taluka, illustrates this statement.

In Munai village, the disadvantaged communities (including "low-caste" Hindus, tribals and Muslims) represent almost two thirds of the total population. Yet, only a minute proportion of the total cultivable land in the village is in their possession. There has been a continuous process of land alienation, especially among the Thakardas, many of whom have lost their land after mortgaging it to the higher castes.[43] Those who do own land, like the Bhambis and Vankars, own at most 2 to 2.5 acres. Moreover, this land tends to be of very poor quality, most of it being of the type locally known as *khada-tekra*, i.e. uneven land, good only for the cattle to graze on.

The same picture can be observed in Mau, as far as the Thakardas and the "Harijans" are concerned. Among the scheduled castes, the Bhambis, who have been traditionally landless, had to struggle for 7 long years for 40 acres of pasture land to be allocated to them for cultivation on a collective basis.

As was observed in the preceding section, the distribution of water in these villages is also very unequal, and follows a similar caste pattern. Thus, inequalities of land and water ownership are seen to compound each other.

We can further illustrate this point by contrasting the situation of Mohanbhai Shamalbhai Patel, a rich farmer of Choriwad village, with the predicament of Dhanabhai Madhabhai Vankar, a poor farmer in the same village. The former owns 16 acres of land and two bores with depths of 140 feet and 130 feet respectively. He shares one of the bores with a relative. The other bore was drilled a few months prior to the survey. He has incurred an

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[43]. In many cases they have also had to work without pay for the money-lenders over long periods to repay the balance of the loans that remained after they had lost all their land.

expenditure of Rs 50,000, from his own savings, to install these two bores. He was able to afford the investment on the second bore thanks to the large income he had been able to earn from the first bore. Further, since he had already purchased an engine of 7.5 HP to use the first bore, he did not have to buy another engine to use the second one. He grows three crops each year on his well-irrigated land. For 1987-88, the third consecutive year of severe drought in Sabarkantha, he reported an annual income much above Rs 100,000 from cultivation alone (not including other sources of income such as the sale of milk from as many as four buffaloes). Interestingly, the substantial income he earned from fodder crops in that year (Rs 5,000) came from sales to relief organisations running cattle camps for drought-affected farmers.

The fate of Dhanabhai during the same year is in direct contrast to this story of opulence amidst general hardship. During the drought, Dhanabhai's family was totally dependent on relief works for its survival. Dhanabhai and his wife both participated in relief works and earned approximately Rs 50-60 per week. There are five members in this family.

Dhanabhai owns 3.4 acres of land, and a well which is 38 feet deep. In the year 1986-87, when there was still a little water in his well, Dhanabhai had managed to grow a small seed plot, from which he earned Rs 900. However, he was not able to deepen his well since, unlike Mohanbhai, he did not have the necessary resources. As a result, his well dried up the next year, and he was not able to grow any crops. Further, his family had to depend on the neighbouring wells and bores for drinking water and other domestic needs.

One might expect that, during a drought, big landowners who derive their income mostly from agriculture might be among the worst-affected (in relative terms). This would be the case but for the inequitable ownership of irrigation sources. The possession of these irrigation sources gives large landowners a virtual monopoly of water and fodder resources during drought years. For many large farmers, a drought year is a boon year.[44]

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[44]. For a similar observation in the context of the 1970-73 drought in Maharashtra, see Brahme (1983) and Oughton (1982). In unirrigated areas, one does sometimes observe a larger proportionate decline in income for large farmers during drought years, reflecting their dependence on agriculture (see e.g. Desai *et al*, 1979).

"Water markets" and share-cropping

One factor that mitigates the inequality of access to groundwater is the fact that the owners of modern water extraction mechanisms often "sell" water to other people for irrigation purposes.[45] Some authors have even argued that these "water markets" make a major contribution to the equitable distribution of groundwater in Gujarat.[46] Poor farmers in the study villages themselves often acknowledged that this opportunity was important for them. However, their responses also highlight some important qualifications to the view that water markets work in an efficient and equitable way.

To start with, the sale of water gives rich farmers a further opportunity to enrich themselves. The rates tend to be high (upto Rs 20 per hour in the study villages), especially when the seller has some monopoly power. This is another source of increasing inequality and of greater dependency of the assetless on the more resourceful farmers. As a poor farmer from Naranpura concisely put it: "Right now, those who can afford the expenditure own these bores. Those who cannot have to depend on them."

Moreover, even though this system does give non-owners some access to water, many hardships are involved in this process. Some of these hardships were aptly described by a water buyer in the following words:

> "These landlords give access to water from their bores according to their will. They increase the rates during the time when the others need it the most, knowing that they do not have any alternative. The others have to literally beg them for water. Usually, water is given to them during the nights, since the landlords use the water for their own fields during the daytime. In this and other ways, a lot of exploitation takes place."

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[45]. Owners provide water either for cash (bhade) or in exchange for a share of the crop (bhage). The following remarks apply mainly to the former system. Share-cropping is separately discussed further in this sub-section.

[46]. See particularly Shah (1987, 1989) and Kolavalli and Chicoine (1987). "Water markets" are further discussed in section 3.1.

And this is not the end of the story. Sometimes, poor farmers do not have access to water at all, even on this basis. For instance, when irrigation activities are at a peak, pumpsets are often temporarily unavailable for hire. This can have a disastrous effect on the crop, if irrigation is urgently required.

For some, water is even permanently unavailable. In many villages, the poor and the scheduled castes tend to own land in particular areas (often areas of poor soils). In these areas, there would typically be few or no bores, and the bores of more affluent farmers would also be out of reach.

An important issue that closely relates to this whole question of water markets concerns the effect of groundwater development on share-cropping systems. In this respect, one crucial development deserves special mention. With the recent expansion of new water extraction mechanisms, and the accompanying spread of modern agriculture, cultivation has become more capital-intensive. Since most share-cropping contracts include the sharing of cash costs between tenant and landlord, this has made it increasingly difficult for poor and assetless households to take land on lease. Further, landlords prefer to lease their land to people who own pumpsets and other assets, since the ownership of these assets guarantees a relatively cheap and reliable access to their services. Those who own productive assets such as pumpsets are themselves increasingly keen to take land on lease (even though they often own substantial amounts of it themselves), so as to make full use of these assets. As a result of these mutually reinforcing factors, the poor are gradually losing the limited cultivation opportunities they used to have through share-cropping.[47]

Drinking water

One of the most important inequities relating to groundwater use concerns drinking water. This applies in both drought and non-droughts years. Even in non-drought years, access to drinking water is highly unequal. This arises partly from the uneven ownership of private water extraction mechanisms, and partly from the fact that the more powerful sections

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[47]. For a general discussion of this process, see Sharma and Drèze (1990).

of the population also gain a privileged access to "public" sources of drinking water.

During a drought, when the ordinary sources of drinking water of many poor people dry up, the situation is particularly critical. Although government relief policies officially include schemes for drinking water supply, in practice these schemes often end up helping the rich more than the poor. The more influential groups and individuals (particularly the *sarpanch*) usually succeed in getting the public handpumps installed near their own houses. When poor people (especially from "low" castes) try to get access to these handpumps, they often face hostility or even violence. When they get water at all, it is usually after a long time of queuing, while richer or higher-caste people jump the queue and leisurely fill their numerous *matkas* and buckets.

In one of the study villages, a newly-constructed public handpump had found its way in the higher-caste hamlet, in spite of it being much smaller than the lower-caste hamlets. When some of the women from the other hamlets braved the hostility of their neighbours and tried to get water from the "public" handpump, they were greeted with abuses, threats and stones. Some of them had their *matkas* broken. They obtained their rightful share of the water only after a long struggle against the rural elite and the bureaucracy.

In another village (Munai), the poor had to depend on private drinking water sources during the drought, because the public sources had all dried up. While the propertied classes were able to draw water from their own private sources, women from poor households had to walk a long distance in the fields to draw water from the well of a rich Patel farmer. The latter did not miss this opportunity to make them feel their dependence on him, and indeed he regularly threatened to discontinue his supply. In this case too, people had to organise and take their grievances to the *mamlatdar*. They held a rally and *dharna* outside his office, after which the mamlatdar granted their demand that public handpumps should be swiftly installed in the poor hamlets of Munai. The promises of the mamlatdar, however, only partly materialised.

These two stories are by no means stray cases. In fact, every Thursday (when, during the drought, the mamlatdar was available to hear public grievances through representatives), the office of the mamlatdar in Bhiloda was resounding with a cacophony of complaints, while a large crowd of anxiously expectant villagers crowded the compound. Many of these complaints related to lack of drinking water and unequal access to public sources.

2.3. Causes of inequity

How do rich farmers succeed in cornering the lion's share of water resources in Gujarat? In a sense, there is nothing new in this process, and it is just another example of how, in a capitalist economy, those who are well endowed to start with tend to be the winners in the competition for further accumulation. However, in order to appreciate the full extent of the inequalities involved, it is helpful to take a closer look at the different means through which, in the study villages, the "sukhi loko" (prosperous people) have virtually monopolised water resources.

Viability of holdings

Investments in modern water extraction mechanisms tend to be viable only for land holdings of substantial size. The small size of their holdings is a major reason why many poor farmers cannot make such investments. For instance, in the village of Munai, it was found that among 110 poor Thakarda households, only one owned a bore, and the reported reason for this state of affairs was that these households owned insufficient amounts of land to invest in bores.

The quality of land is also important. Investments in bores and tubewells are most attractive on flat, low-lying, fertile and stone-free lands, but in the study villages such lands were almost invariably owned by large farmers belonging to the "higher" castes. Most of the unlevelled or stony land (much less suitable for irrigation) was owned by poor farmers belonging to the disadvantaged castes.

In principle, the problem of insufficient holding size could be dealt with through collective ownership of bores or tubewells by poor farmers. However, such collective arrangements were virtually absent in the study villages. One frequent difficulty was that the holdings of poor farmers were located on unfavourable terrain, often at some distance from each other. But even where physical conditions were relatively favourable to collective arrangements, the ability of the poor to enter into such arrangements appeared to be extremely limited.

This observation is particularly interesting given that, among rich farmers, collective ownership of bores was not uncommon. In Takatuka and Munai, for instance, there were several cases of bores being owned collectively by a small number of affluent farmers (up to 8 of them, usually related to each other through kinship ties). By contrast, in the same villages small farmers of the poor Thakarda community were unable to enter into collective arrangements, even among brothers.

There are several possible reasons for this contrast. Poor farmers find it more difficult to contribute their share of expenses on a timely basis. They are less able to bear the risks involved in collective arrangements. Also, and perhaps most tragically, they have been sharply divided by the competitive struggle for survival.[48]

Credit

Investments in modern water extraction devices are very costly, especially in areas like Sabarkantha district where water tables are now very low. This can be concretely illustrated by the following account of the expenses recently incurred by a farmer of Takatuka to install a bore on his land:

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[48]. This is not to say that cooperation cannot be brought about through long-term social action. A living example is provided by Shramjivi Samaj in Bhiloda taluka, a trade union of landless and marginal farmers who organised themselves more than a decade ago in a major struggle for land. Today, 1334 acres of land that have been acquired through this struggle are being cultivated on a collective basis by eight agricultural cooperative societies. The activities of these societies have included cooperative construction of wells and acquisition of energised water extraction devices.

Item	Depth (ft)	Cost per ft (Rs)	Total cost (Rs)
Bore	175	45	7,875
PVC pipe	75	35	2,625
Iron pipe	125	40	5,000
7 HP motor			13,000
electricity connection charge			340
TOTAL			28,840

The cost of this bore was by no means exceptional, and it must also be borne in mind that since its installation a few years ago, prices have leapt up. Today, it is common for a bore to cost Rs 50,000 or more. Clearly, investments of this magnitude are impossible for most small farmers with limited borrowing opportunities, no matter how profitable these investments may be in the long run. For many large farmers, on the other hand, short-run installation costs are not an obstacle if long-run profitability is assured.

In fact, a surprisingly large number of bores have been installed by large farmers using their own income, without any need for borrowing. For instance, in the village of Naranpura, where information could be obtained on sources of funds for the 19 bores that had been "registered" with the panchayat, it was found that 18 of these 19 bores had been self-financed. The boldness of prosperous farmers in making large and risky investments can be further appreciated by noting that no less than 9 of these bores "failed".[49] A similar situation of heavy reliance on self-financing was observed in other villages as well (see Table 18).

It may be thought that the limited ability of small farmers to make large investments from their own funds is partly compensated by a privileged access to institutional credit. Indeed, many credit schemes are allegedly "targeted" to small farmers, and the government regularly claims to provide special assistance to the needy. The reality of credit practices, however, is quite different.

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[49]. The depth of most of these bores was between 200 and 250 feet. All except two were owned by farmers belonging to the "higher" castes.

TABLE 18

DETAILS REGARDING FINANCIAL SOURCE FOR THE CONSTRUCTION OF WELLS IN FOUR VILLAGES OF IDAR TALUKA

Source	Bhadresar	Kapoda	Munjpur	Nadri	Total
Bank loan	59	1	10	76	146
Own capital	99	77	10	90	276
Bank loan and own capital	-	-	-	14	14
Other sources	1	1	1	-	2
No information	1	-	-	6	7
TOTAL	160	79	20	186	445

Source: Field survey and bank records.

Indeed, in village after village it was found that almost all institutional loans for water extraction devices (from Dena Bank, Cooperative Societies, Land Development Bank, etc.) had been issued to large farmers, mostly of the Patel caste. While only a limited amount of information could be obtained from credit institutions, this bias emerges clearly enough from the available data:

Institution	Total amount issued[a] (Rs)	Total number of loans	Number of loans issued to Patels
Munai and Jhumsar (Coop Society)	4,34,190	34	31
Takatuka (Dena Bank and LDB)	96,000	6	6
Messan (LDB)	1,10,000	16	16

[a] Water extraction devices only (bores, wells, submersible pumps, etc.).

The regressive nature of institutional credit (at least when it comes to water extraction devices) arises partly from credit policies themselves. For instance, some banks require every applying borrower to deposit as much as one fourth of the amount to be borrowed before issuing the requested loan! Also, bank managers (who tend to be more concerned with the recovery of their loans than with the welfare of the borrowers) commonly prefer to lend to rich people in the dubious belief that they are more likely to repay. Clearly, such policies work to the advantage of large farmers.

In addition, the system works to their advantage in a number of other, more "subtle" ways: caste-based favouritism is common in credit institutions; large farmers have better "connections" with the sanctioning authorities; illiterate farmers are more vulnerable to cheating, etc. In fact, most of the poorer farmers in the study villages are not even aware of their eligibility for institutional loans.

Risk

A further reason why few small farmers invest in modern water extraction devices is that they have a limited ability to bear the risks involved. Besides the risks that have already been referred to (e.g. risks of breakdown of collective arrangements and of being cheated by credit institutions), a major risk is that a bore will fail to strike water.

As was mentioned earlier, the frequency of such failure in regions like Sabarkantha is high and increasing. In Malassa, we met a rich Rajput farmer who made as many as seven attempts to install a bore, and was successful only at the last attempt. Clearly, poor farmers cannot afford such a luxury. The prospect of investing a large sum of hard-earned money in a bore that may well fail deters many of them. Those who do take the risk sometimes bitterly regret it, as happened with Shamalbhai Bajubhai from Naranpura: "Brother, this boring has really broken us. The bore is 160 feet deep and cost us Rs 42,000. We have spent so much, but we have not been able to strike good water."

An additional risk of great importance is that of "well interference". Even if a poor farmer does succeed in installing a bore and striking water, there is a high risk that, seeing his success, big landowners with land in the vicinity will try to install their own - usually deeper - bores nearby. This results in the diversion of water towards their sources, possibly to the point of cutting off the bore of the small farmer from the dwindling aquifer.

Property rights

Well interference and related problems arise because, with the present understanding of property rights, there is no possibility of controlling the use of groundwater. Indeed, under the present law, the person who owns the land has an unlimited right to extract the underlying groundwater. Ultimately, a durable solution to the problems of overexploitation and inequity in groundwater use has to concern itself with property rights. We shall return to this question in section 3.

An illustration

The various factors that prevent small farmers from investing in modern water extraction devices are well illustrated by the case of Rambhai Nathabhai Thakarda, a small farmer of village Munai. Rambhai owns a little more than 3 acres of land and a well. Recently, three bores have been installed near his land, as a result of which his own well dried up (two of these bores are owned by Patels of the same village, while the third is owned by the Gram Panchayat of a nearby village).

Rambhai does not want to take the risk either of deepening his well or of investing in a bore, since the chance that he would be able to strike water is small. This is so since the submersible pumps of the three nearby bores are at an average depth of 120 feet. In order to be able to strike water, he would have to install a bore in the well with a minimum depth of 55 feet. Preferably the well would have to be at a distance of 1/2 km. All this would imply costs well beyond Rambhai's means.

When asked whether he had resisted the installation of the nearby bores, Rambhai replied in the negative. He felt sure that, had he done so, he would have been told that the Patels had every right to install bores on their own land at their own cost.

Rambhai knew nothing about loan schemes for installing bores, or about the government norm which clearly prescribes the minimum distance to be maintained between two wells. Hearing about this norm, he felt that injustice had been done to him. When it was suggested to him that he could file a case in the court, his reply was: "What's the use? The government or the court is most likely to say, 'you also dig a well or install a bore deeper than your neighbours!'. Beyond this, what can the government do?"

2.4. What people said

In conclusion to this case study, this section reports a few things that our respondents said about what can be done to remedy the present situation of overexploitation and inequity in the use of groundwater resources. To a great extent, these testimonies speak for themselves, and no attempt will be made to analyse them systematically. Indeed, given their personal and informal nature, it would be inappropriate to draw definite conclusions from these individual statements. However, taken together they do throw some interesting light on the problem of public action for the protection of groundwater resources. This problem is the theme of section 3.

Many small and marginal farmers were of the view that the government should install bores for public use and should not allow private bores. This would enable people from all castes and classes to share in the benefits of modern irrigation.

> "We had met the mamlatdar of Bhiloda regarding a bore. We had suggested to him that the government could install a bore which could be used for irrigation purposes by small and needy farmers, who would then have a share in the use of underground water. Right now, underground water is available only to the rich people who are able to utilise it." (A small farmer from Naranpura.)

Aside from the equity angle, public bores would enable a better spreading of risk over large groups of people:

> "I have not attempted to dig a bore, because the bores which have been tried in the vicinity of my field have failed. Hence, I do not want to take the risk. I feel that the government should install bores for irrigation purposes. This way, those who do not own bores could also get water. If the government is ready to do that, I do not mind giving my land for free. I have written to government offices in Ahmedabad and Baroda, but I have not received any reply yet." (Vithalbhai Barrot, a small farmer from Naranpura.)

> "If the government makes a bore for us and if we strike water, then we can, within a set period, return the money invested by the government (with interest). If we do not strike water, then naturally we will not be in a position to return the money." (Mohanbhai Jeevabhai Patel, a small farmer from Messan.)

With public ownership of bores, a better planning of their location would also be possible:

> "We do feel that bores which could be used by a collective and owned by the government should be encouraged instead of private bores. From such a government-owned bore, water could be bought by the individual farmers. The principle of equality of distribution could be kept in mind. The place of the installation of the bores could be such that it falls in the centre of a group of farmers. Initially, the expenditure of the bore could be borne by the government. After the drought, in a few good years the group of farmers could together return the amount to the government and the bore could then be of collective ownership." (A small farmer from Naranpura.)

One reason why many small and marginal farmers aspired to some kind of government intervention was that they had little hope of being able to discipline the large farmers on their own. For instance, Lallubhai Shankarbhai Ghant, of village Naranpura, felt that the bores of large farmers were definitely responsible for the drying up of wells, but he also felt that one could not resist them since they were digging the bores on their own land and with their own money. He felt that only external control exerted by the government would help, and that for this a regulation should be introduced.

In contrast to these constructive and imaginative responses from small and marginal farmers, many rich farmers were reluctant to discuss the problem of groundwater overexploitation. Those who spoke mostly showed a lack of concern for the problem, a reluctance to acknowledge their own responsibility for its emergence, and a negative attitude towards all forms of government interference.[50]

These viewpoints are well illustrated by the case of Lakhabhai Jethabhai Thakarda, who owns one bore of a depth of about 190 feet, from which he irrigates 6 acres of his land. Initially, Lakhabhai was very suspicious and refused to talk. When his reaction was sought regarding the new control of 45 metres, he replied: "What is the sense of a control of only

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[50]. Concerning the issue of government intervention, it should be mentioned that, at the time when the survey was conducted (April-May 1988), there was much discussion about a proposed government regulation aimed at controlling the construction of bores exceeding a depth of 45 metres. The history and present status of this regulation will be further discussed in section 3.

45 metres? We have been able to strike water at 190 feet. We had initially constructed a well which was 50 feet deep, but since we did not strike water, we had to dig a bore." When asked whether he had taken a permission from the government authorities, he argued: "There was no existing rule of this kind, so why should I take permission?". He further added: "How can I be said to have committed an offence? If there was a government regulation and I had broken it, then it could be said that I have committed an offence. In the absence of such a regulation I can dig as many bores as I want and whenever I feel like."

He was asked whether he did not feel that a bore as deep as his could affect the water table of the nearby wells. His reaction was: "I can install as many bores as I feel like on my own land. Am I digging on someone else's land? Are we preventing the others from digging if they want to?"

Asked whether he felt that the government would take concrete steps, he confidently felt that the government would not.

Generally, the big landowners felt that they were not "guneghar" (at fault), since they were not breaking any government rules or laws. They were installing the bores in their own land. How could this be said to be unlawful or reprehensible?

> "If the government had attempted to introduce a rule or law earlier, we would not have been able to dig this bore. But since the government has not made this law, we are not at fault, since we have not broken or resisted an existing law." (Galjibhai Jethabhai Bamania, a prosperous farmer from Naranpura who owns 7 acres of land and a bore approximately 190 feet deep.)

Attitudes of large farmers towards government intervention were resoundingly negative.

> "The government's limit is only 160 feet. If I happen to attempt a bore and it fails, then the government can make as many rules and regulations as it wants to, but I am ready to go as deep as 500 feet, and nothing will stop me. After that, if the government wants to punish me, let it do so." (Rambhai Patel of Takatuka.)

> "The government should not attempt to introduce any kind of regulation, because the more the farmers are able to produce, the more benefits to the government and to

society. Is it not?..... The government should not introduce any regulation which is detrimental to the interests of the farmers." (Raghjibhai Ramjibhai of village Bhadresar.)

"If any control is exerted now then whatever little greenery there is will also dry up. Whatever little the cattle can feed on now will become inaccessible. All will be harassed. Hence I feel that, at this juncture, no control should be exerted." (A farmer from Naranpura.)

An interesting aspect of the responses of large as well as small farmers, which emerges in several of the above statements, is that they attach some importance to the legality of the situation (the significance of this observation will be further discussed in the next section). Some went so far as envisioning the prospect of actual legal action on groundwater issues.

"Only the government knows the depth to which a bore should be installed in particular areas, and how to regulate this. We do not understand this. If the well of a small farmer dries up due to the installation of a bore nearby, then he can file a case and thereby stop the functioning of the bore." (Dhirubhai Sevarbhai Patel, a medium farmer of Munai.)

Some farmers, however, had difficulty in conceiving of a change in currently-accepted property rights. For instance, Dhanabhai Madhabhai Vankar, a small farmer from Choriwad, opined:

"Bijana kua ke bore par haq lage? Na lage!".[51]

[51]. "Can one have a right over somebody else's bore or well? No!"

3. THE POLITICAL ECONOMY OF GROUNDWATER[52]

This section is divided into two parts. The first recalls the various means of intervention that are available to prevent the overexploitation of groundwater resources. The aim here is not to give a detailed account of each of these means of intervention, which have been aptly discussed by a number of authors.[53] Rather, this brief interpretive review seeks to provide an overall perspective within which the different measures that have been proposed can be assessed. The second part puts forward a particular view of what is to be done if the impending tragedy of groundwater depletion in Gujarat is to be averted.

3.1. Preventing Overexploitation: Means of Intervention

Broadly speaking, it is possible to identify four types of intervention to prevent the overexploitation of groundwater resources.

The first type, which has received most attention, consists of state regulation of the private sector. In this case, the government attempts to introduce a set of rules or incentives that influence the behaviour of the private sector in the direction of a less anti-social use of groundwater resources. Within this category, one can make a further distinction between "direct" and "indirect" regulation. The former seeks to impose direct controls on the use of groundwater. The latter operates indirectly, through other variables such as electricity rates, crop prices and credit policies.

The second form of intervention concerns the positive involvement of the public sector in a reasoned use of water resources as a whole. Some examples are (1) the implementation of watershed programmes and the construction of tanks in order to encourage greater use of surface water; (2) the revival of certain forms of traditional and ecologically sound systems of collective groundwater use and conservation; (3) the channelling of groundwater resources

[52]. This section has been written in collaboration with Jean Drèze.

[53]. See Sengupta (1985), Bandhyopadhyay (1987), Shah (1987a, 1989), Shiva (1988), Agarwal and Narain (1989), Dhawan (1989b, 1989c, 1991), Reddy (1989), Singh (1991), among other recent contributions.

through public tubewells.

The third approach invokes community management as a tool of groundwater conservation. Here the aim is to enable the village community to make use of the information and control it possesses on local resources and individual behaviour in order to prevent the excessive depletion of groundwater.

The fourth type of intervention is concerned with redefining the structure of property rights within which the private sector, the state and the community operate. This is a more radical, but also more complex, approach to the protection of groundwater resources.

The remainder of this sub-section briefly examines the basic features of each of these approaches, and some of their respective advantages and shortcomings.

3.1.1. State regulation of the private sector

Indirect regulation

In theory, the best form of indirect state regulation would be the introduction of some kind of "water rates" applying irrespective of the way in which water is extracted. This would induce farmers to economise water, and the overall rate of extraction of water in a particular area could be controlled by increasing or lowering the water rates applying in that area. When water extraction mechanisms are publicly owned, this system is quite feasible. For instance, it prevailed in China prior to the economic "liberalisation" of the 1980s (Kramer, 1989). However, when, as in India, most water extraction mechanisms are privately owned, the collection of water rates is practically impossible in view of obvious problems of monitoring and corruption.[54]

In practice, only three important measures of indirect regulation have been given serious attention in India. These respectively relate (in roughly increasing order of

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[54]. For a graphic description of irrigation-related corruption in India, see Wade (1979).

effectiveness) to (1) credit policies, (2) cropping patterns, and (3) electricity pricing. Each of these forms of intervention deserves brief consideration.

Credit

In Gujarat, credit-related measures for the preservation of groundwater resources have mostly taken the form of limits on the granting of loans for water extraction mechanisms in areas of actual or potential groundwater scarcity. Different government rules apply for wells of a depth below and above 150 feet. For wells of a depth of less than 150 feet, there are no restrictions worth the name.[55] For wells of a depth larger than 150 feet, a "No Objection Certificate" is required to obtain a loan from the government.

A "No Objection Certificate" (NOC) can be granted after considering (1) the general state of groundwater resources in the area, (2) the rates of annual recharge and extraction, (3) the adequacy of spacing between wells, and (4) the density of wells in the area. Several changes have taken place since this regulation was introduced in 1967, and one cannot help noticing that the rules have often tended to become less and less stringent over the years, when the reverse was called for.[56] The most striking move in that direction came in 1982 with the introduction of the category of "special case" tubewells to be dealt with at the discretion of high-level GWRDC officials. A Government Resolution of 1986 (2 December) candidly states: "Wherever the tubewells fulfil the stipulated criteria, NOC would be accorded as per rules. And wherever the criterion is not fulfilled NOC would be granted as 'special

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[55]. According to a government resolution passed in 1963 (for dug wells), in order to obtain a government loan to dig a well of a depth of less than 150 ft, a farmer needs to observe area-specific spacing criteria fixed by NABARD, but no formal certificate is required. For wells lying within the command area of a government well, a "No Objection Certificate" (NOC) is needed in order to obtain an electricity connection; however, recent regulations stipulate that, if a farmer does not receive a reply within 30 days of applying for a NOC, the application can automatically be considered granted!

[56]. In Mehsana, for instance, a Government Resolution of 1975 distinguished between 3 zones: zone A, with a minimal distance between wells of 5,000 ft; zone B, with a minimal distance of 7,000 ft; and zone C, where tubewell construction was barred. However, the last two categories have recently been abolished. Similarly, in several districts (including Mehsana) the regulation of 1967 has been relaxed for "cooperatives of members belonging to economically and socially backward castes".

case'"! In Mehsana (the groundwater desert of Gujarat), 191 NOCs were granted before 1981; between 1981 and 1987, as many as 1591 NOCs were issued (of which 616 were "special cases").[57] According to a GWRDC official: "In the last few years, all cases have been 'special cases'. There have been no normal cases. Most of these cases are dealt with on political grounds. To this extent, a NOC is a mere formality."[58]

In sum, credit restrictions for the preservation of groundwater resources have made little headway in Gujarat. On the contrary, large amounts of subsidised credit have supported the expansion of water extraction mechanisms. This has contributed not only to the overexploitation of groundwater resources, but also (due to the distributive biases in credit allocation discussed earlier) to their inequitable distribution. To correct these excesses, government credit for water extraction mechanisms should either be abolished in areas of groundwater scarcity, or at least be restricted to small farmers.[59]

Cropping Patterns

Cropping patterns depend on a wide range of factors, some of which can be influenced so as to discourage the more water-intensive crops. Crop prices are an obvious example. However, the determination of support prices in India is more a matter of political pressures than of rational calculation, and the prospects of gearing these prices to the conservation of water are very remote. Alternative ways of promoting water-friendly cropping patterns need further investigation.

Sugarcane provides a good example of the scope for effective action in this domain. Preventing the further expansion of sugarcane cultivation in Gujarat is a priority measure as far as the protection of groundwater is concerned. Sugarcane cultivation has already caused

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[57]. Information obtained from a cyclostyled note on groundwater-related Government Resolutions in Gujarat (GWRDC, Ahmedabad).

[58]. Personal communication from a GWRDC official, Ahmedabad.

[59]. If and when licences are introduced to control the construction of water extraction mechanisms (as discussed further in the text), the possession of a licence could be made a condition of eligibility for institutional loans.

enormous damage to the groundwater resources of Maharashtra.[60] There is a danger that the same will happen in Gujarat if sugarcane cultivation is adopted on a large-scale in areas of groundwater scarcity. Among possible preventive measures, taxing sugar is an obvious option. However, a tax on sugar would be extremely unpopular, and is unlikely to be seriously contemplated by the government. A more realistic measure would be to ban the installation of sugar factories in water-scarce areas - where there are no sugar factories, sugarcane is rarely grown. The cultivation of sugarcane in areas of groundwater scarcity could itself be banned altogether.

Electricity Pricing

Perhaps the most powerful of all measures of indirect regulation relates to the pricing of electricity. The two main alternative pricing systems are flat-rate pricing, involving a fixed yearly charge per electric motor, and pro-rata pricing, under which the user pays for each unit of electricity consumed. It is well recognised that flat-rate pricing creates strong incentives against the conservation of groundwater, because once the flat charge is paid every extra unit of water extracted is "free". Pro-rata pricing, by contrast, imposes a cost on every extra unit of water extracted, and therefore induces farmers to economise water. From the point of view of water (and electricity) conservation, therefore, pro-rata pricing is clearly a superior system.[61]

In spite of this, Gujarat recently switched (in June 1987) from a regime of pro-rata pricing to one of flat-rate pricing. This happened as a result of a nearly three-year-long agitation led by the big farmers' lobby. According to the new system (as amended through

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[60]. See e.g. Dandekar (1986) for further discussion.

[61]. Pro-rata pricing can make water more expensive to extract not only for the owners of electrified water extraction mechanisms, but also (equally importantly) for all the farmers to whom these owners "sell" water. This is because the prices charged for the hiring of water extraction mechanisms tend to be related, at least in the long run, to operating costs (for empirical evidence, see Shah, 1989). There have, however, been instances where hiring charges have not come down in the short run in spite of a reduction in (marginal) electricity costs (this was observed after the switch from pro-rata to flat-rate pricing in 1987 in Gujarat; see The Sandesh, 1987, November 17).

further concessions made to the farmers' lobby later in 1987), electricity is freely supplied and farmers pay flat-rate charges per annum related to horsepower; however, a uniform charge (fixed at Rs 500 in 1987) applies to all motors above 10 HP.[62] This change is estimated to have cost the Government of Gujarat Rs 665 million in 1987 alone.[63]

It is worth mentioning that this successful campaign received an unexpected boost from some influential economic arguments according to which flat-rate pricing is superior to pro-rata pricing (for an exposition, see particularly Shah, 1989). These arguments, however, were developed on the basis of a concern to promote the use of groundwater resources in areas with a large unutilized potential; they have little applicability in areas where groundwater overexploitation is the real problem.

An equitable and rational system of electricity pricing would be one which combines a flat-rate charge with a pro-rata charge, and where (1) the pro-rata charge is area-specific, with higher charges being levied in areas where it is important to discourage the consumption of water (or electricity), and (2) the flat-rate charge is fixed for different users so as to achieve the greatest possible measure of equity in power pricing (e.g. by linking the flat-rate charge to horse power, or - even better - to landholding size). There is every case for demanding a change in electricity pricing policies in this direction, away from the irrational system that has emerged as a result of political pressures from influential farmers.

Discussion

Each specific measure of indirect regulation tends to raise its own problems. These

[62]. Interestingly, the official motivation for the last rule is to avoid penalising farmers in areas where the water table is low and high-powered motors are needed. The undesirable result is that water is just as cheap to extract in areas where it is scarce (often due to overexploitation in the first place) than elsewhere.

[63]. Indian Express (7 November, 1987), "Government, Farmers Sign Agreement". This pricing reform was a concession of the Congress-I government to the farmers' lobby, led by Chimanbhai Patel, then leader of the Janata Dal and convener of the farmers' Action Committee. Now that the Janata Dal has come back to power in Gujarat (with Chimanbhai Patel as Chief Minister), the prospects of a return to pro-rata pricing are more remote than ever.

may include, for instance, political resistance from the big farmers' lobby (as has happened in Gujarat with electricity pricing), undesirable "side effects" (as would apply to the taxing of water-intensive crops if these are also labour-intensive), or inequitable distribution of costs and benefits (e.g. when credit restrictions give a few rich farmers the monopoly of water extraction mechanisms). However, the most serious weakness of indirect regulation is that it also tends to be ineffective. Being roundabout and partial by their very nature, indirect regulation measures more often than not leave too many gaping loopholes to make a real dent on the problem. If electricity rates are raised, farmers can switch to diesel engines. If institutional credit ceases to be available for water extraction mechanisms, farmers - especially rich ones - can turn to alternative (if more costly) sources of credit. And support prices have little influence on open-market prices, which are far more important in determining cropping patterns.

It would, therefore, be extremely naive to think that the problem of dwindling groundwater resources can be successfully solved through indirect regulation only. The need to consider more direct forms of intervention is inescapable.

Direct regulation

Along with indirect regulation, the conservation of groundwater resources can be pursued through the introduction of direct state control on private uses of groundwater. For instance, one could attempt to ban the extraction of groundwater for irrigation purposes in a particular area when the water table falls below a pre-specified level, or to ration the available water between different users in an equitable way.

The main problem with direct control procedures (again, within the present structure of property rights) is that of enforcement. Groundwater tends to be extracted day after day by millions of farmers whose activities escape the close scrutiny of the state. Given the inefficient and corrupt nature of the Indian bureaucracy, it would be a hopeless exercise to institute a system of detailed, centralised controls on who uses how much water. In practice, direct regulation by the state has to limit itself to a small number of simple and feasible controls, such as the licensing of bores.

In Gujarat, current forms of direct regulation go back to 1970, when a Bill was introduced by the Central Ground Water Board to regulate and control the utilisation of groundwater. This Bill was sent to all the State Governments with the idea that it could pass through the relevant legal procedures in each state and turned into an Act.[64] In Gujarat, this Act was to be called "The Groundwater (Control and Regulation) Act, 1970".

Nothing happened between 1970 and 1975, when a nation-wide Emergency (which was to last until 1977) was declared. On 23 December, 1976, the State Government of Gujarat published an Ordinance promulgated by the President of India (by notification in the Government Gazette).[65] This Ordinance contained an amendment to the Bombay Irrigation Act of 1879 (which was then and is now in force in Gujarat), and was called the Bombay Irrigation (Gujarat Amendment) Act, 1976. Its motivation was stated as follows:

> In order to prevent further decline of the water table in such areas [where water table, are falling and wells drying], it is considered necessary to regulate the construction of tubewells, artesian wells and borewells exceeding forty-five metres in depth in any land assessed or held for the purpose of agriculture.

The two central provisions of this Amendment were (1) the introduction of a system of licences to control the expansion of bores and wells, and (2) the prohibition of groundwater extraction for non-essential uses. In the words of the Ordinance itself:

> "Where a holder of any agricultural land desires to construct therein any tubewell, artesian well or borewell, exceeding forty-five metres in depth for extracting ground water, he shall make an application to the Regional Canal Officer having jurisdiction for the grant of a licence."[66]

> "No holder of agricultural land in which there is a tubewell, artesian well or borewell, exceeding forty-five metres in depth shall allow any water from such well to be used for a purpose other than for the purpose of agriculture or of drinking or to be wasted

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[64]. The Parliament could not itself enact it since water is a "state subject". A "Bill" is a draft law, a pre-legal stage or a pre-enactment stage to be submitted to the authority which makes the Act.

[65]. Article 250 of the Indian Constitution empowers the Parliament to legislate with respect to any matter in the State List if a proclamation of Emergency is in operation.

[66]. Gujarat Government Gazette, Vol. XVII, December 23, 1976, p. 279.

either through leaky casing, pipe fittings, valves or pumps either above or below the surface or on account of any other reason whatsoever."[67]

The Amendment fell short of introducing much-needed measures of a more radical nature, such as an explicit clause giving priority to drinking water over irrigation or measures to regulate the use of already-constructed water extraction mechanisms. But in spite of its limitations, the Amendment was a step in the right direction. Unfortunately, the Ordinance containing this amendment was allowed to lapse before the rules necessary for its implementation could be submitted to and approved by the State Legislature.[68]

Eleven years later, a notification appeared in the Government Gazette (26 November, 1987) announcing that the Government of Gujarat had fixed 1 April, 1988, as the date on which the Bombay Irrigation (Gujarat Amendment) Act, 1976, would come into force. But on this occasion too, the State Legislature was unable to ensure the implementation this resolution. In fact, the issue was not even submitted to in the Assembly, as the ruling government decided that the drought conditions then prevailing in the state made it impossible or unwise to enforce the Amendment.

During the following year, the Government of Gujarat came under considerable pressure from the Central Government (especially the Planning Commission) to formulate and implement groundwater regulations.[69] The National Water Policy had also been formulated

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[67]. Ibid., p.280.

[68]. According to the Indian Constitution (Article 250), a law made by the Parliament at a time when an Emergency is proclaimed ceases to have effect on the expiration of a period of six months after the Emergency proclamation applies. This period elapsed before the State Legislature in Gujarat could consider and approve the rules necessary to carry out the provisions of the Amendment (these rules, in fact, were not even prepared for consideration by the State Legislature).

[69]. This is evident from a number of newspaper reports which appeared in that year. See especially "Spare Groundwater, State Told" (Times of India, 3 July, 1988), "Call for Judicious Use of Groundwater" (Indian Express, 10 July, 1988), and "Centre Asks State to Prepare Water Policy" (Indian Express, 16 October, 1988).

(in September, 1987), and while this document attracted various criticisms, it clearly stated:[70]

> The exploitation of groundwater resources should be so regulated as not to exceed the recharging possibilities and also to ensure social equity.

The Bombay Irrigation (Gujarat Amendment) Act of 1976 was revived, in a slightly modified form, in the Gujarat Ordinance No.2 of 1989 (dated 13 June). This Ordinance sought to consolidate and amend the law relating to irrigation in Gujarat; in effect, the Bombay Irrigation Act (1879) would have stood repealed. The second of the two clauses quoted above from the 1976 Amendment is incorporated without change in the 1989 Ordinance. The first clause takes the altered form of making the acquisition of a licence compulsory for the construction of "any tubewell, artesian well, borewell or dugwell (a) exceeding five metres in depth in a coastal area, or (b) exceeding forty-five metres in depth in a specified area, or (c) exceeding twenty-five metres in depth in the area other than the coastal area and the specified area".[71] Besides, there is an additional clause which proposes to regulate the use of existing wells on the same principle as that of new wells.

This new Ordinance, unfortunately, followed a fate similar to that of earlier attempts to affirm groundwater regulation in Gujarat. It was felt that some aspects of this document still needed "improvement", and the matter was therefore referred to a "Select Committee" for detailed consideration. The Ordinance elapsed before the Select Committee presented its conclusions.[72] As Girish Patel, a renowned advocate at the Ahmedabad High Court, puts it: "When the Government does not want to take action, or wants to postpone action, the issue

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[70]. For critical appraisals of the National Water Policy, see Lokayan Water Group (1989), "A Policy that Holds no Water", Ghosh (1988), "Misdirected Water Policy", and Illustrated Weekly (1987), "National Water Policy: A Drop in the Ocean".

[71]. Gujarat Government Gazette, Vol. XXX, June 13, 1989, pp.19-37. The term "specified area" is clarified elsewhere in the same document: "Where the State Government is of the opinion that in any area not being a coastal area there is an overdrawal of groundwater from confined aquifers it may by notification in the Official Gazette declare such area as specified area."

[72]. The 1989 Ordinance was promulgated by the Governor. Such Ordinances become obsolete after six weeks unless they are re-affirmed by the State Legislature (see Article 213 of the Constitution).

is referred to a Select Committee. This way, the promise is fulfilled and the result is not achieved."[73]

This brief outline of the recent history of groundwater legislation in Gujarat gives a sobering idea of the obstructive role played by the ruling classes. On at least three occasions (1977, 1988 and 1989), the State Legislature failed to take the necessary steps to ensure the implementation of legal provisions that might have laid the basis of considerable improvements. Future campaigns to reform the law will have to challenge these obstructive forces.

3.1.2. **Public sector involvement**

Aside from attempting to regulate the private sector through direct or indirect means, the government can also take an active part in the utilisation and distribution of water resources. In this context, we need to consider not only groundwater, but also surface water, since promoting the latter is one possible way of protecting the former.

In the case of groundwater, current government involvement almost exclusively takes the form of constructing and operating public tubewells. With an accountable and competent bureaucracy, public tubewells can ensure not only an efficient but also a fairly equitable distribution of groundwater. The Indian bureaucracy, however, is hardly a model of accountability and competence, and past experience with public tubewells in India has been rather sobering.[74] As far as equitable distribution is concerned, the rural elite usually succeeds in appropriating most of the benefits of public supply. In the light of these past experiences, it would be unwise to place much reliance on public tubewells for a more rational use of groundwater resources in Gujarat.

There are stronger grounds for hope as far as surface water is concerned. Indeed,

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[73]. Personal communication.

[74]. See the review of evidence by Ballabh and Shah (1989). The authors go so far as to assert that "the experience with public tubewells is uniformly and resoundingly disappointing" (p.23).

India has a long history of public involvement in the management of surface water (through tanks, watershed programmes, dams, etc.), and some authors have argued that promoting surface irrigation is the most sensible means of protecting groundwater.[75] An important (if not completely clear-cut) distinction has to be made here between (1) large irrigation works (especially dams), and (2) small-scale works (including tanks and watershed programmes).

Planning policies in India have tended to give priority to the former. It is not surprising that there should be influential pressures on the government to undertake large-scale irrigation schemes, since the enormous costs of these schemes are largely borne by relatively powerless groups (unorganised tax-payers, displaced communities, and - in the case of environmental costs - future generations) whereas their benefits are mostly reaped by powerful contractors, land owners and politicians. The social usefulness of large-scale irrigation schemes, however, is quite controversial. They have, in fact, recently been the target of a whole range of sharp and persuasive criticisms.[76]

In Gujarat, the most important scheme of large-scale irrigation is the Narmada river development project (including the Sardar Sarovar dam and the accompanying canal system). This is not the place to comment on the numerous problems raised by this irrigation scheme.[77] For our purposes it is sufficient to note that, as far as the conservation of groundwater is concerned, little can be expected from the Narmada project. Indeed, the command area of this project by-passes most of the areas where groundwater scarcity is a severe problem (including Sabarkantha itself, as well as most of Saurashtra and Kutch). This

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[75]. See especially Dhawan (1987), who argues that "wisdom lies in paying more attention to the development of surface irrigation works, so that a sizeable fraction of surface waters end up in the groundwater table" (p.1554).

[76]. See e.g. Goldstein and Meir (1984) and The Economist (1992).

[77]. These include (1) large-scale environmental damage in the submergence area, (2) brutal displacement of hundreds of thousands of people without adequate compensation, (3) adoption of a highly risky and undiversified strategy of economic development, and (4) sharp accentuation of economic and social inequalities. The promises of large economic benefits might have made these adverse effects easier to accept, but convincing evidence that these benefits will outweigh even the most narrowly-defined economic costs is hard to find in the existing "cost-benefit analyses" of this project.

is not an accident, but a direct reflection of the political pressures that have influenced the design of the project.

Small-scale schemes of surface water development (such as percolation tanks and check dams) avoid many of the drawbacks of large-scale irrigation projects, and they also have a number of distinct advantages. Particular mention should be made of the labour-intensive nature of many of these schemes.

Efforts to protect groundwater resources carry a risk that water will be preserved at the expense of employment. The main reason for this possible dilemma is that water-intensive agriculture also tends to be labour-intensive. When the extraction of groundwater is regulated, complementary measures must be taken to generate non-agricultural employment. Otherwise, the adverse consequences of water conservation will be largely borne by unemployed labourers.

In this respect, labour-intensive schemes of surface water development have the merit of simultaneously protecting groundwater and promoting employment. Past experiences with such projects (for instance, in the context of Maharashtra's Employment Guarantee Scheme) have been quite mixed, but there is some hope that the more successful experiences can be emulated. An essential task is to investigate what are the ingredients of success in this field, and how much scope there is to recreate them elsewhere.

A more general way of looking at this whole issue is to see that employment generation and environmental protection are two of the most important challenges of social planning in Gujarat.[78] It is natural to look for strategies of intervention that meet these two challenges simultaneously. Large-scale public employment programmes oriented towards environmental protection satisfy this criterion. Programmes of this kind could form the

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[78]. It is worth stressing that the provision of employment is not just a question of immediate income generation. It is also a means of increasing the bargaining power of the poor in the rural economy and society. On the opportunities that the Employment Guarantee Scheme of Maharashtra has opened for concerted action by the rural poor, see Omvedt and Rao (1988).

backbone of an Employment Guarantee Scheme for Gujarat.

3.1.3. **Community management**

An important alternative to state intervention is that of community management. Indeed, it is sometimes argued that democratic village institutions (e.g. panchayats or gram sabhas), if properly revitalised, can play a crucial role in environmental protection.[79] In the case of groundwater, this would take the form of water being allocated through community decisions.

An important feature of this approach is the possibility of reducing the amount of external coercion needed to prevent the overexploitation of groundwater. If farmers feel a genuine sense of "participation" in community decisions, they may be much more inclined to comply with them than with state-enforced regulations. In some circumstances, community processes may even succeed in instilling a sense of individual responsibility for the conservation of community resources, making it possible to rely partly on voluntary restraint to save water.[80]

One difficulty with this whole approach is that it would require a drastic change in the perception of who owns water resources. As things stand, land owners have a legal right to unrestrained use of whatever water resources they can reach through their land. The actual perception of water ownership rights also corresponds to this legal position (as the case study of section 2 clearly illustrated). Obviously, community management is possible only if groundwater resources are regarded as "common property" resources. This would require a fundamental change in perceived ownership rights.

Another serious problem with community management is that its success depends on the cooperation of those who are, at the moment, benefiting from the rapid exploitation of

[79]. For a strong defence of this view, see Agarwal and Narain (1989).

[80]. The scope for promoting voluntary conservation seems to be greater in communities which are relatively equal and homogeneous, as is often the case in tribal communities. For an interesting example, see Swamy (1991).

groundwater resources. Their cooperation might arise in two ways. First, there is an obvious collective gain from the conservation of groundwater resources, and users are likely to cooperate voluntarily if their share of these collective gains is larger than the private gains they currently derive from unrestrained use of groundwater. This, however, is a demanding condition that is not likely to be fulfilled in the case of large farmers.

Second, the compliance of potential "free-riders" can be sought through coercion and sanctions (e.g. the imposition of fines on those who violate agreed rules of water use). This approach is not likely to work, however, if community institutions are controlled or dominated by those who also stand to gain from the overexploitation of groundwater. In much of rural India, unfortunately, it is the case that rich farmers are precisely in that position. Progressive changes have been achieved in this respect in some parts of the country, notably in West Bengal, where democratic control of panchayats has made possible certain forms of community management of environmental resources. But replicating these achievements elsewhere would require a radical transformation in the balance of rural power.

The possibility of community-based regulation of the private sector has received insufficient attention in the literature on groundwater resources in India, and deserves to be more fully investigated. The potential of this approach, however, appears to be severely limited by the concentration of power in the hands of those who derive strong private gains from the allocation mechanism that underlies the current overexploitation of groundwater.

3.1.4. **Property rights**[81]

The existing structure of property rights applying to groundwater is quite astonishing. These rights are governed by the Indian Easements Act of 1882.[82] The Easements Act

[81]. The factual basis of this section draws heavily on Iyer (1975:155-68), Ratanlal and Dhirajlal (1987: 311-22), Ballabh and Shah (1989), Chandrakanth (1989), and Jacob (1989).

[82]. This was Act V of 1882. It applied only to certain provinces like Madras, Central Provinces and Coorg, and was extended by Act VIII of 1891 to Bombay, N.W. Provinces and Oudh. This Act does not apply to West Bengal or the Punjab as they existed then.

makes a crucial distinction between underground running streams and underground percolating water. Rights over the former are governed by the doctrine of "riparian rights" (perceived as natural rights linked to the ownership of the riparian land), which essentially states that "each coriparian has the right to have the water flow pass his lands undiminished in quantity and unimpaired in quality".[83]

As far as underground percolating water is concerned, the situation is almost the polar opposite: according to the Easements Act of 1882 (section 7), "a landowner has the right to appropriate water percolating in no defined channel through the strata beneath his land; and no action will lie against him for so doing, even if he thereby intercepts, abstracts or diverts water which would otherwise pass to or remain under the land of another"![84] This provision removes all barriers to the right to extract percolating water for private purposes.

The resulting status of (percolating) underground water has been described as that of a "fugitive resource", "for which private property rights exist but these rights are indefinite among the overlying land owners", creating a situation where "each user protects his rights by capturing the groundwater in the fastest possible way, as the user knows that the deferred use is subject to great uncertainty, since other users would capture the resource in the mean time".[85]

It is easy to see that the present structure of property rights in groundwater is both illogical and inappropriate. It is illogical because it gives diametrically opposite treatments to flowing and non-flowing underground water, even though this distinction hardly affects the nature of the problem. It is inappropriate because it creates strong incentives for overexploitation of a common resource by private individuals.

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[83]. Jacob (1989:1).

[84]. Ratanlal and Dhirajlal (1987: 321). It should be stressed that individual rights to groundwater resources always remain "subject to the State's sovereign right... to regulate [these resources] in the public interest" (Jacob, 1989:2).

[85]. Chandrakanth (1989:3-4).

This odd situation largely results from the indiscriminate adoption of the principles of English common law (which the Easements Act of 1882 closely followed). In England, percolation is abundant, irrigated agriculture is practically non-existent, and also land holdings tend to be quite large so that problems of "interference" between different users of groundwater are much less acute. In this context, the legal provisions outlined above (including the distinction between flowing and non-flowing water) may have made some sense. However, the situation is completely different in India, where the depletion of groundwater resources is a real danger, and where small, contiguous holdings share common aquifers. The Indian Easements Act of 1882 is a relic of the colonial period.

This statement also holds, in fact, for more basic aspects of Indian legislation that interfere with the protection of groundwater and other environmental resources. For instance, Indian legislation (including the Easements Act of 1882) has adopted from English Common Law the notion of exclusive natural right of an individual owner to private property, including the assertion that "no use of property, which would be legal if due to a proper motive, can become illegal because it is prompted by a motive which is improper or even malicious".[86] The notion that reprehensible motives do not render the interception of underground water illegal has, as a matter of fact, been explicitly upheld in court on several occasions.[87] In contrast, modern legislation in countries such as France, Germany and the United States includes provisions that permit "only reasonable use for improvement of one's property and not acts done with intent to injure the neighbours".[88] Similar principles have been recommended for India.

The need for legislative change is clear enough. What is much less clear is how alternative property rights should be defined. One option would be to limit the right of water extraction over a particular period to the amount of water that percolates through the land in

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[86]. Iyer (1975).

[87]. A decision to this effect was taken by the House of Lords in the case "Mayor of Bradford Corporation vs. Pickles (1895)", which raised a number of general questions of principle. On this, see Iyer (1975: 164).

[88]. Iyer (1975).

question over the same period. This principle does not do away with the privatisation of water, but at least it is geared to a sustainable and less inequitable use of groundwater resources. A more radical departure from existing legal provisions would be to define some kind of collective property rights over groundwater.

Of course, neither of these two types of property rights would be easy to define and enforce. In fact, it is quite likely that, initially at least, there would be large-scale violation of the law (as is already the case with riparian rights), and that existing malpractices would continue. But this does not mean that legislative changes of this kind are not worth accomplishing. Indeed, social perceptions of what are "legitimate" uses of groundwater are partly influenced by the legality of the matter, and changes in these perceptions can, in turn, have an influence on groundwater extraction practices through a variety of extra-legal processes. These may include bargaining between conflicting parties, community decisions, *lok adalats*, social sanctions, popular protests, and pressures from political activists.[89] If easy enforceability had been regarded as a pre-condition for legislation, laws such as those prohibiting child marriage or bonded labour would never have been passed - and the eradication of these social evils would have been correspondingly slowed down.

Further, the prospects of actual legal enforcement should not be completely dismissed. Even if changes in property rights do not lead to an immediate, across-the-board transformation in the practice of groundwater use, legal provisions may still consolidate local struggles against anti-social practices. Some rich farmers will be taken to court for (say) drying up their neighbours' wells, or for wasting underground water during a drought. If they lose, the case will receive publicity and strengthen similar struggles elsewhere. Even if they win, the fear of getting involved in a legal dispute will deter other farmers from violating the law. As in many other fields, legal action and social action are the two legs on which the people stands strong.

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89. On the attitudes of farmers towards the law, including the fact that large farmers standardly justify their unrestrained use of underground water by pointing out that their behaviour is perfectly "legal", see section 2.4.

3.1.5. A "mixed" form of intervention: The social ownership of bores

In our discussion of "what people said" in section 2.4, we noted that a recurring demand of small and marginal farmers was that the ownership of bores should be "socialised", even if motors continue to be privately owned. To understand this proposal, we have to remember that a bore (the metal pipe running vertically from the ground to the underlying aquifer) and a motor (the powered engine that draws the water through the pipe) are two separate objects, which need not be owned by the same person. Indeed, it is a common practice in North Gujarat (as in many other parts of India) to put a motor on a mobile cart, and to attach it to different bores (including, possibly, bores belonging to other persons) according to the circumstances. In most villages, the services of a motor or of a bore can be easily hired at a standard rate.

These arrangements make it possible to envisage a situation where the bores are publicly owned, while motors remain privately owned with their services being hired by owners to non-owners. The socialisation of bores would have some major advantages (many of which were clearly mentioned by small farmers in the responses reported in section 2.4). First, it would help to prevent overexploitation, since public control could be exercised on the number and depth of bores in a particular area. Second, it would facilitate a rational location of bores through coordinated planning. In particular, the problem of "well interference" could be greatly reduced. Third, public ownership of bores would permit a more equitable distribution of groundwater, since large farmers would no longer have the virtual monopoly of access to this resource. Fourth, this arrangement would ensure a much better "spreading" of the risks involved in drilling bores, by transferring these risks from private individuals to the community or the government.

Last but not least, the social ownership of bores could facilitate the emergence of various forms of community management. Indeed, if bores are owned by the community rather than by private individuals, their use could also be more easily regulated. For instance, if a simple technology for monitoring the amount of water extracted by different individuals becomes available, it may be possible to introduce and enforce collective rules for the allocation of groundwater.

The socialisation of bores would involve a creative combination of the different forms of intervention discussed earlier, and it would certainly represent a major step forward compared with the existing situation. It is interesting that this highly practical and effective means of intervention should be so alive in the minds of the farmers we interviewed (particularly the smaller ones), while it has been overlooked in the vast literature on the management of groundwater resources in India.

3.2. **Proposals for action**

The depletion of groundwater resources in large parts of Gujarat is an alarming and urgent problem. If present trends continue, irreversible damage will be done to these resources, with devastating consequences for future generations. Immediate action is imperative.

It should be clear from the discussion of the preceding section that there is no quick and simple solution to the problem of groundwater overexploitation. While individual authors tend to argue in favour of one particular line of action, in practice only a combination of different forms of intervention can succeed in making a significant dent on the problem. State regulation, community management, etc., should not be seen as mutually exclusive measures.

This section recapitulates a few things that can be done to protect groundwater resources in Gujarat, in the light of the preceding review of possible avenues of action. The analytical framework used in that review will be retained, and the reader is referred to the corresponding sub-sections of that section for further discussion of the relevant themes. The intention of this summary is not just to supply "policy recommendations" for the consideration of government agencies. These conclusions are addressed to the diverse audience of all those concerned with the protection of groundwater resources. Some of the proposed changes are "moderate" suggestions that will not encounter much resistance from the concerned authorities. Others can only be won through hard political battles.

Before entering this discussion, it should be emphasised that what can be done within the present institutional framework is, inevitably, limited. As we saw again in again in this paper, there are deep connections between the overexploitation of groundwater resources on the one hand, and the inequitable distribution of economic opportunities and political power on the other. Perhaps the most important of these connections relates to the fact that, as things stand, usufructuary rights to groundwater are entirely derivative on ownership rights to land. As long as land itself is privately and unequally owned, the scope for achieving a more equitable and sustainable use of groundwater is bound to be limited. The need for immediate action should not make us lose sight of the equally vital need for long-term structural changes. These alone hold a real promise of stopping the plunder of groundwater and other environmental resources in Gujarat.

State regulation of the private sector

It has been argued that regulation of the private sector, in both "direct" and "indirect" forms, is a vital ingredient of groundwater protection. Under the heading of indirect regulation, we have considered credit policies, cropping patterns and electricity pricing. Other avenues of indirect regulation should also be explored, but meanwhile we can recall some of the measures that are feasible in these three areas:

(1) Institutional credit for water extraction mechanisms from all sources should be banned in areas of severe groundwater scarcity, and reserved to small and marginal farmers elsewhere.

(2) The incentives given to various crops (e.g. through support prices) should take into account the need to discourage water-intensive crops in areas of groundwater scarcity.

(3) In particular, the installation of sugarcane factories should not be allowed in these areas. The expansion of sugarcane cultivation outside South Gujarat has to be vigorously discouraged.

(4) The irrational and inequitable system of flat-rate electricity pricing created by earlier pressures from the farmers' lobby should be abolished, in favour of a mixed system of flat rates and pro-rata charges along the lines outlined in the preceding section.

While helpful and necessary, indirect regulation is by nature a blunt instrument for disciplining the private sector. The driving force behind groundwater protection has to lie in other forms of intervention, including direct regulation. Here, it is important to remember that individual property rights relating to groundwater resources always remain "subject to the State's sovereign right... to regulate [these resources] in the public interest" (see section 3.1.3). While there can be serious problems in enforcing direct regulation measures, it has been argued that the provisions of the Bombay Irrigation (Gujarat Amendment) Act of 1976 are realistic and represent a step forward.

> (5) The Bombay Irrigation (Gujarat Amendment) Act of 1976 should be enforced in all areas of potential groundwater scarcity. The granting of licences for the construction of water extraction mechanisms should be subject to clear guidelines and open to public scrutiny.

Public sector involvement

As things stand, there is little hope that public sector involvement in the extraction and distribution of groundwater in Gujarat (e.g. through public tubewells) would bring about a substantial improvement in the management of this resource. However, there is greater scope for public involvement in the management of surface water resources. This can help the conservation of groundwater, both by raising water tables (as with percolation tanks), and by directly meeting some of the water requirements of irrigated agriculture. In this area, a major reorientation of existing priorities and policies is needed.

> (6) Public sector involvement in the management of water resources should be reoriented away from large dams and public tubewells towards the promotion of small-scale, labour-intensive works of surface water development.

Community management

The notion that groundwater resources in Gujarat can be sustainably and equitably managed through community institutions (e.g. gram sabhas), in spite of the vulnerability of these institutions to manipulation by the rural elite, was strongly questioned earlier in this section. Perhaps this assessment has erred on the side of undue pessimism. That would be good news. Given that some promising experiments in community management have actually taken place (usually through the leadership of voluntary agencies), it would be useful to reflect on the lessons that emerge from these experiments.

(7) Past experiences of community management of groundwater and other environmental resources should be methodically assessed (e.g. through published surveys and public workshops).

Property rights

The existing structure of property rights in groundwater is an illogical and inappropriate. While it may not be easy to define and enforce alternative property rights, it has been argued that even a formal change in the legality of groundwater uses could have a crucial effect on their perceived legitimacy. This, in turn, would strengthen the bargaining power of the victims of groundwater exploitation. For these reasons, a redefinition of property rights is essential.

(8) Groundwater resources should no longer be governed by the Easements Act of 1882. Instead, legislation should be passed which gives recognition to the fact that underground water is a common resource (or, at the very least, which limits legal rights of groundwater extraction to the recharge rate of the concerned aquifers).

The social ownership of bores

As was mentioned in the preceding section, social ownership of bores was an important demand of many of the small farmers who were interviewed in the course of our "case study" (see section 2.4), and this step can be seen as a creative and highly sensible combination of the various forms of intervention discussed so far. The socialisation of bores is quite a radical demand (especially if it applies to existing bores as well as to future bores), and it remains to be seen whether these small farmers will ever have enough political strength to obtain its enforcement. However, public demands should be geared to what is just and desirable, and not just to what seems "realistic" under the present configuration of political forces. It is therefore important to affirm this demand made by the small farmers.

(9) All bores, or at least all new bores, should be publicly owned.

Some neglected issues

A few words should now be said about several issues which have not received special attention in the preceding discussion, even though they are important aspects of the problem of groundwater protection and had an essential place in the earlier parts of the paper. Three issues will be considered: (1) drought, (2) drinking water, and (3) information.

As we saw in section 1, the connections between drought and groundwater scarcity in Gujarat are increasingly important. Drought relief policies should give due recognition to this recent development.

> (10) Guidelines for the protection of groundwater resources during droughts should be included in the Gujarat Relief Manual. Drought relief works should be used to create permanent structures aimed at an expanded, sustainable use of surface water.

In the case study included in section 2, we noted the sharp conflict that can emerge between the use of groundwater for irrigation and drinking purposes. While government documents constantly reiterate that "priority" should be given to the latter, these resolutions have no teeth. Affected people should be given a better chance to affirm their right to drinking water.

> (11) There should be a legal right of access to private water extraction mechanisms for drinking water purposes when drinking-water facilities in a village are unsatisfactory.

Last but not least, it should be stressed that public campaigns for the protection of groundwater resources can hardly take place in the absence of adequate information on all matters relating to groundwater. At the moment, even the most basic facts (e.g. data on water tables) are shrouded in secrecy. The release of groundwater-related information to public scrutiny is long overdue.

> (12) Information relating to groundwater resources in Gujarat should be made public. An annual report on the state of groundwater resources in Gujarat should be published by the Central Ground Water Board and made widely available.

3.3. Concluding Remark

The protection of groundwater resources in Gujarat ought to be a lively social issue. As things stand, there are tremendous pressures from influential farmers to adopt or perpetuate policies that allow the unrestrained use of these resources for short-term private gain. There is no corresponding pressure group acting for the protection of groundwater. The plunder goes on with astonishingly little resistance.

Ultimately, this is perhaps the most important cause of the disaster we are witnessing today. But this situation can be changed. In India as in many other parts of the world, environmental issues have recently become political issues in a way that never applied before. Within this emerging political movement, the groundwater question deserves an important place.

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APPENDIX 1

History of Droughts and Famines in Gujarat

	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
Early Period				
1396	Famine	Durga Devi	Western India	Lasted around 12 years. The districts south of Narmada were entirely depopulated.
1482	Famine	-	Surat	-
The Mughal Period (1526-1707)				
1559	Famine	Jagdusha	Saurashtra	Named after the merchant prince of Saurashtra, who helped the people liberally with cash and kind.
1574	Famine & plague	-	NA	Inhabitants both rich and poor were forced to abandon their homes.
1577	Famine	-	Kutch	Relief was given through direct distribution of cooked food to the starving. The poor left the countryside for the towns. The rich were also ruined.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1596	Famine	-	NA	Relief works were established and the army was enlarged to give maintenance to the poor.
1631-32	Severe Famine	Satyasyo	Throughout Gujarat	Due to the complete failure of crops, food became scarce and people parted with their children for a loaf of bread. Frequent acts of cannibalism were reported. The economic effects of the famine on the great cotton handicrafts were disastrous. Emperor Shah Jahan responded by giving doles in cash and kind, remitting taxes to the extent of Rs 70 lakhs, and establishing soup kitchens and alm houses. It is estimated that a million of the poor people died during this famine, whose grievous effects lasted until 1640.
1647	Famine	-	Saurashtra	-

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1681-1697	Recurring drought and severe famines	-	Throughout Gujarat	The first decade saw an acute scarcity of foodgrains and sharp price increases. In the latter half of the second decade, especially 1696-97, the situation seems to have worsened. The whole of North Gujarat is said to be in the throes of a disastrous drought, so that from Patan to Jodhpur neither water nor grass were to be found. Starvation and epidemics followed, taking a serious toll on human life.
<u>The Maratha Period</u> (1708-1800)				
1718-19	Severe famine	-	Ahmedabad, Surat	Large-scale starvation followed scanty rainfall. The breaking out of a cholera epidemic led to a large number of deaths. Parents sold their children for a pittance.
1723	Famine	-	N.A.	-
1731-32	Severe Famine	-	Throughout Gujarat	Thousands of people died of plague.
1746	Famine	-	Kutch	-

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1747	Severe Famine	-	Kutch, Rajkot, Amreli, Bhavnagar, Surat	Severe food, water and fodder scarcities.
1751	Famine	-	Parts of Gujarat	-
1757, 1774-75, 1782, 1784	Scarcity Conditions and a few major famines	Panchotra (1775)	Kutch	-
1764, 1780, 1785, 1787, 1790	Famines	Second Satyasyo (1787)	Bhavnagar	During the century that passed after the death of Aurangzeb (1707 AD) and the settlement of Kathiawar (1807-08), no fewer than 11 famines of greater or lesser severity occurred in the region. These were in 1718-19, 1723, 1731-32, 1747, 1751, 1764, 1774, 1780, 1785, 1790 and 1804.
1791-92	Devastating famine	Sudtalo	Whole of Gujarat (including Sabarkantha)	Thousands of people died for want of food. Many children were either sold or deserted. The Peshwa distributed free, imported foodgrains and remitted land taxes in a few districts.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1801-03	Famine	Tilotra	Surat, Kutch	'Tilotra' means three famines. In Kutch, the scarcity was caused by locusts and followed by a failure of rains.
1804	Famine	-	Bhavnagar	-
1812-13	Drought led to intense famine	Agnotra	Kutch, Saurashtra, Ahmedabad, Kheda, Baroda, Surat, Sabarkantha	The year 1812 marks a point of transition in relief policy. From this year onwards, relief works were increasingly adopted. The head of the state of Kutch as well as the Deewan of Palanpur State employed the starving population in the construction of a tank and paid them in kind. The opening of a fair price shop is also reported for the first time. This famine was caused by scanty rainfall and an invasion of locusts in North and Central Gujarat. Foodgrains being in short supply, their sale was supervised by government officers, who had given strict orders to the Banias in Bharuch forbidding them to sell more foodgrain to the people than was required to maintain life.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1815	Scarcity Conditions	-	Throughout Gujarat	Crops were destroyed by an invasion of locusts and rats, leading to food scarcity.
1824-25 1833-34 1834-35 1839-40	Scarcity conditions	-	Parts of Saurashtra, Kutch and other districts (Sabarkantha, 1825, 1834)	Scarcity was caused due to failure of rains. Relief works were opened up and foodgrains were also freely distributed.
1845-46 1856 1861 1864	Scarcity conditions	-	Many parts of Gujarat	-
1876-77	Scarcity conditions	-	Gujarat	-
The British Period (1800-1947)				
1897-98	Scarcity conditions	-	Gujarat	Crop failure due to invasion of locusts

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1899-1900	Severe famine	Chhappanio	Most parts of Gujarat (Sabarkantha)	The famine was caused by a complete failure of rains, which resulted in total loss of fodder as well as food crops. Relief measures like relief works, cash doles, tagavi loans and remission of land revenue were adopted. The rulers of the former states of Saurashtra were also active in giving grants for the digging of wells and for setting up of poor houses and fair price shops. Wives and children were sold or deserted, while young girls were sold to brothels for Rs 2. It is said that human flesh was sold in the Sojitra village of Kheda district. Mortality in the human and cattle population was very high. This was the most widespread and severe famine that India experienced during the nineteenth century.
1900-1901 1901-1902	Scarcity Severe famine	-	Ahmedabad, Kheda, Bharuch, Surat, Sabarkantha	Deficient and unseasonable rains in some parts. Complete failure of rains in others. The situation was aggravated by invasions of rats, locusts and grass-hoppers, which damaged crops.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1911-1921 (except 1913 and 1914), 1926	Famine conditions in 1918; other years were scarcity years.	-	Ahmedabad, Kheda, Panchmahals, Bharuch, Surat, Sabarkantha	The scarcities and famine during this period seem to have been mainly caused by absence, deficiency or poor distribution of rainfall. The intensity and causes of distress, and the extent of relief measures, varied greatly between different districts. Relief measures consisted mainly of relief works (in the famine-affected districts), deepening of wells, grain doles, tagavi loans and suspension of land revenue. In Panchmahals in 1920-21, grass for cattle was obtained from outside the district and supplied to the people from grain depots.
1935-1938	Scarcity conditions	-	Gujarat	The years 1935-38 were drought years caused by failure or deficiency of rainfall. Fodder scarcity was felt in some parts. Aside from the above-mentioned relief measures, metal-breaking works and cheap grain shops were opened in large numbers. (In 1927 and later in 1941, scarcity and famine like conditions were caused in some districts like Sabarkantha due to heavy rains.)

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1939-1943	Scarcity and famine conditions	-	Most of Gujarat, part of Saurashtra	Due to inadequate rainfall, scarcity conditions were experienced in most parts of Gujarat while famine occurred in Kutch and parts of Saurashtra. For the first time, oil engines and irrigation pumps were imported (by the Maharaja of Kutch) as part of relief measures. Among other measures, the government of Saurashtra gave gratuitous relief to the aged and the infirm and free ration cards as per the provision of the Bombay Famine Code.
1946	Fodder Scarcity	-	Kutch, Panchmahals	Scarcity caused by delayed rains.
<u>Post-independence Period</u>				
1947-48	Lean Year	-	Parts of Gujarat (<u>Sabarkantha</u>)	Hardship caused by delayed rains.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1948-49	Famine and Scarcity conditions	-	Kheda, Sabarkantha	Famine and scarcity were caused mainly by deficient rainfall. There was famine only in part of the Matar Taluka. Although there was deficient rainfall throughout, farmers who had equipped themselves with water pumps did not succumb to an otherwise inevitable predicament.
1951-53	Famine and scarcity conditions	-	Parts of Gujarat Sabarkantha	In 1951-52, famine conditions were experienced in parts of three talukas of Sabarkantha district. Scarcity conditions were declared in some other districts.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1957-58	Scarcity conditions	-	Kutch, Banaskantha Sabarkantha, Mehsana, Kheda, Ahmedabad, Panchmahals, Baroda, Bharuch, Jamnagar, Surendranagar, Bhavnagar, Amreli	Scarcity caused by prolonged drought. In Jamnagar district (which was one of the worst hit), aside from other relief measures, the village panchayats gave subsidies for maintaining cattle, gratuitous relief was given to the sick and the aged, and skimmed milk powder was distributed. Water was supplied by tankers in Ahmedabad, Kheda, Bharuch, Kheda, Mehsana and Amreli districts. Fodder was also supplied in most districts. In Ahmedabad, cattle camps were opened.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
<u>Period after the formation of Gujarat state in 1960</u>				
1960-70	Frequent scarcity and semi-scarcity conditions	-	Most parts of Gujarat	Special mention needs to be made of the year 1965-66, when, due to the failure of rainfall, all the districts in the state experienced scarcity or semi-scarcity conditions. In 1968-69, 16 out of 19 districts were declared scarcity-affected. During this decade, relief measures acquired greater diversity and effectiveness. Schemes of productive and protective character such as minor irrigation, soil conservation and road building were given priority. For the first time, a spinning scheme was started in order to provide employment at home to the affected persons. Tagavi loans were given for the purchase of bullocks and the construction and maintance of houses. Drinking

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
				water was supplied through tankers and bullock carts and by digging wells, sinking bores and deepening old tanks. Concentrates and grass were moved by special trains and made available at concessional rates through grass-depots specially set up by the Government. Subsidies were given to panjrapoles for the maintenance of cattle.
1971-73	Drought	-	Throughout Gujarat in varying degrees	The year 1971 was already a scarcity year. The situation worsened with the failure of rains in two thirds of the State; 66 per cent of the villages and 16 out of 19 districts were affected. For effective relief administration, a "gang diary" was introduced, with details about the persons employed on relief works. On account of its usefulness the GOI recommended this method to all the States for adoption. Relief administration was on the whole more systematic and well planned than in earlier years. For the first time, the State imported grass from Madhya Pradesh for Panchmahals.

Year	Event	Popular Name	Affected area in Gujarat	Remarks
1	2	3	4	5
1974-75	Drought	-	Parts of Gujarat	-
1979-80	Drought	-	Parts of Gujarat	-
1985-88	Drought	-	Throughout Gujarat in varying degrees	Of Gujarat's 19 districts, 17 were declared scarcity affected.

Sources: Gujarat Relief Manual, Vol-1, 1979, section on 'The Historical Survey of Calamities in Gujarat'; Statistical Atlas of Gujarat, Vol-1, Resource Profile, section on 'Famine, Scarcity and Drought'. The information relating to droughts and famines in Sabarkantha district (which receives special attention in this paper) is based on the Sabarkantha District Gazetter, 1974. The terms "drought", "sarcity" and "famine" have been used as in the Government reports. It should be mentioned that this chronology is not exhaustive, particularly for the earlier periods, for which historical records are incomplete.

APPENDIX 2A: YEARLY RAINFALL (mm) AND NUMBER OF RAINY DAYS IN GUJARAT (1951-88), BY DISTRICT

DISTRICT	NORMAL RAINFALL	AVERAGE RAINFALL 1901-1950	1951 RD	1951 R	1952 RD	1952 R	1953 RD	1953 R	1954 RD	1954 R	1955 RD	1955 R	1956 RD	1956 R	1957 RD	1957 R	1958 RD	1958 R	1959 RD	1959 R	1960 RD	1960 R
AHMEDABAD	783	626	N/A	326	N/A	764	N/A	972	N/A	840	N/A	828	N/A	1198	30	371	40	982	N/A	1453	27	394
AMRELI	515	501	N/A	405	N/A	323	N/A	909	N/A	733	N/A	428	N/A	633	N/A	696	N/A	724	N/A	N/A	31	417
BANASKANTHA	751	627	N/A	376	N/A	662	N/A	623	N/A	835	N/A	566	61	1548	23	580	31	386	N/A	1190	23	452
BARODA	917	969	N/A	565	N/A	882	N/A	989	N/A	1176	N/A	1023	51	1310	33	777	45	1242	N/A	1475	37	564
BHARUCH	877	950	N/A	374	N/A	728	N/A	755	N/A	1787	N/A	755	60	1359	40	736	67	960	N/A	1484	49	743
BHAVNAGAR	620	593	N/A	315	N/A	320	N/A	751	N/A	762	N/A	N/A	35	652	27	668	3	849	N/A	1021	21	432
DANGS	1780	1999	N/A	1233	N/A	1344	N/A	1739	N/A	2203	N/A	2422	99	2774	66	1217	93	2467	N/A	2181	72	1251
GANDHINAGAR	N/A	815																				
JAMNAGAR	466	471	N/A	410	N/A	531	N/A	N/A	N/A	947	N/A	460	36	728	18	377	9	311	N/A	869	16	287
JUNAGADH	844	623	N/A	484	N/A	561	N/A	666	N/A	1002	N/A	556	61	1411	42	1072	42	1024	N/A	1797	49	824
KHEDA	770	815	N/A	406	N/A	711	N/A	1058	N/A	1046	N/A	707	50	1411	31	488	45	845	N/A	N/A	21	N/A
KUTCH	340	322	N/A	631	N/A	261	N/A	547	N/A	333	N/A	209	24	528	12	216	23	275	N/A	1153	9	80
MEHSANA	613	609	N/A	287	N/A	737	N/A	757	N/A	785	N/A	785	53	1084	22	527	33	730	N/A	1107	30	321
PANCHMAHALS	1027	988	N/A	550	N/A	927	N/A	847	N/A	1276	N/A	923	63	1476	37	675	54	1263	N/A	1296	38	494
RAJKOT	594	590	N/A	389	N/A	539	N/A	N/A	N/A	600	N/A	527	45	1260	36	558	36	886	N/A	2050	29	570
SABARKANTHA	794	811	N/A	470	N/A	784	N/A	1044	N/A	1264	N/A	1016	56	986	32	328	43	743	N/A	1599	33	570
SURAT	1071	1521	N/A	735	N/A	625	N/A	1712	N/A	2268	N/A	711	59	1209	39	932	48	1290	N/A	1966	46	1000
SURENDRANAGAR	487	507	N/A	285	N/A	333	N/A	876	N/A	610	N/A	521	45	747	23	404	22	464	N/A	1130	20	428
VALSAD	1806	1905	N/A	1365	N/A	1521	N/A	2153	N/A	3953	N/A	1737	N/A	1970	N/A	1262	N/A	3194	N/A	3328	N/A	2077
ALL GUJARAT AVERAGE		855		534		697		1025		1246		834		1238		660		1035		1569		641

RD = number of rainy days. R = annual rainfall (mm).

1961		1962		1963		1964		1965		1966		1967		1968		1969		1970		1971		1972	
RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R
N/A	831	N/A	756	N/A	1005	37	698	26	457	28	609	42	986	17	392	29	470	49	1245	34	544	23	250
N/A	215	N/A	356	N/A	N/A	36	845	24	865	24	256	30	448	14	404	15	332	28	929	29	638	13	242
N/A	672	N/A	405	N/A	608	34	595	21	450	21	434	38	936	15	560	20	253	43	739	26	641	17	464
N/A	883	N/A	620	N/A	1045	44	842	28	595	28	698	47	1020	19	513	31	1079	51	1232	47	921	22	315
N/A	897	N/A	612	N/A	901	45	1149	31	647	N/A	N/A	39	736	20	815	33	645	58	1604	43	962	18	323
N/A	463	N/A	360	N/A	656	37	500	26	412	23	512	41	630	21	720	23	467	41	1430	33	534	15	192
N/A	1567	N/A	1235	N/A	1805	70	1892	59	1879	66	1713	81	2160	59	1771	65	2120	80	2082	81	1739	57	1239
N/A	952	N/A	283	N/A	278	29	567	17	319	12	261	32	773	14	383	14	286	35	735	18	698	12	239
N/A	1760	N/A	750	N/A	690	53	1489	25	647	28	523	46	1093	27	896	26	640	49	1124	32	859	20	344
N/A	1017	N/A	746	N/A	203	33	783	21	613	33	666	44	942	16	358	N/A	N/A	57	1532	29	686	18	281
N/A	723	N/A	188	N/A	203	18	348	14	318	8	205	24	714	5	81	N/A	N/A	N/A	N/A	12	300	2	62
N/A	620	N/A	536	N/A	686	26	496	18	364	24	402	34	664	10	361	20	289	39	658	23	419	14	183
N/A	944	N/A	1014	N/A	960	33	594	29	402	23	587	46	906	23	618	37	969	49	1086	40	828	21	507
N/A	747	N/A	405	N/A	505	30	765	21	466	20	437	27	484	20	591	19	317	36	1152	26	544	13	355
N/A	645	N/A	671	N/A	1009	33	606	25	470	24	679	42	545	14	523	26	384	44	1405	30	552	23	412
N/A	1474	N/A	723	N/A	1220	59	2084	31	931	36	1008	52	4096	31	1022	35	943	59	1628	48	918	22	565
N/A	633	N/A	345	N/A	523	24	431	19	599	31	497	N/A	440	12	258	14	147	36	1123	22	513	N/A	N/A
N/A	760	N/A	1436	N/A	3162	64	2708	58	1780	63	1988	71	1488	51	1598	60	2264	76	2405	70	1984	38	1432
	878		636		909		966		679		675		892		659		725		1301		793		436

RD = number of rainy days.   R = annual rainfall (mm).

1973		1974		1975		1976		1977		1978		1979		1980		1981		1982		1983		1984	
RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R	RD	R
46	1043	15	412	41	1213	45	1282	44	1134	30	701	31	524	31	733	33	1264	33	759	51	1090	41	763
19	297	20	394	32	434	35	528	27	720	22	436	28	738	22	855	30	805	31	843	32	1088	19	294
38	1002	12	196	48	1241	40	613	41	1274	33	793	32	454	29	512	29	476	20	356	42	646	26	704
51	1228	20	262	52	814	54	1715	47	1344	39	1074	37	847	31	1009	31	766	30	662	52	1389	40	707
51	998	23	315	44	1416	49	2467	57	1101	35	830	43	1086	43	621	43	1131	29	501	53	1381	36	799
37	829	12	147	40	579	40	1044	33	543	25	496	27	777	32	487	32	764	27	418	36	654	19	449
90	1944	67	1249	55	1407	77	3443	79	2211	82	2581	72	2594	86	2780	86	3064	59	1674	99	2915	86	2743
										32	444	35	517	34	377	34	618	22	472	40	519	34	846
28	383	10	142	38	996	28	525	26	448	23	592	36	971	24	1210	24	1369	23	884	29	855	21	665
37	894	19	286	46	759	44	901	46	843	35	705	41	1424	38	1653	38	1387	37	1131	56	2538	43	1215
41	1291	12	434	N/A	N/A	53	1924	44	1252	37	1068	20	651	42	943	42	1052	33	601	48	812	26	710
13	208	8	101	19	462	20	495	13	311	17	342	16	840	12	525	17	598	9	146	17	257	10	306
29	682	17	331	37	1702	37	4036	32	1085	31	811	28	665	26	475	32	638	21	560	41	762	28	627
49	1479	24	381	43	1097	48	1941	44	1134	39	988	35	754	39	955	44	1054	26	634	57	1040	33	818
25	325	17	297	37	802	37	750	30	722	27	553	32	1291	34	635	35	641	30	470	36	637	23	539
45	1377	21	352	42	1330	44	1185	43	1197	42	879	35	620	35	822	39	829	27	519	43	997	34	925
44	1068	29	587	50	1446	54	2398	46	876	39	1305	46	1504	46	1038	48	1240	41	1182	61	1967	49	1053
25	550	N/A	N/A	43	967	18	552	28	593	21	357	26	823	22	484	22	641	18	532	29	453	19	498
74	1908	49	1194	77	2155	72	2830	48	1199	53	1821	61	2177	53	1964	69	1917	55	1523	76	3047	62	1823
	973		417		1107		1424		1039		883		1014		952		1066		730		1213		848

RD = number of rainy days.   R = annual rainfall (mm).

1985		1986		1987		1988		1989		1990	
RD	R	RD	R	RD	R	RD	R	RD	R	RD	R
25	803	N/A	452	N/A	251	N/A	728	N/A	230	N/A	973
18	311	N/A	455	N/A	113	N/A	1317	N/A	364	N/A	342
22	322	N/A	328	N/A	61	N/A	730	N/A	776	N/A	557
22	634	N/A	304	N/A	419	N/A	1068	N/A	856	N/A	780
29	686	N/A	589	N/A	447	N/A	1147	N/A	1306	N/A	445
13	657	N/A	364	N/A	121	N/A	761	N/A	532	N/A	671
71	2497	N/A	1856	N/A	1959	N/A	3172	N/A	1978	N/A	1507
20	554	N/A	537	N/A	136	N/A	650	N/A	572	N/A	1151
20	208	N/A	189	N/A	36	N/A	482	N/A	245	N/A	341
35	449	N/A	762	N/A	194	N/A	2178	N/A	1032	N/A	798
16	385	N/A	N/A	N/A	483	N/A	1256	N/A	412	N/A	662
8	118	N/A	106	N/A	5	N/A	657	N/A	358	N/A	241
15	189	N/A	169	N/A	109	N/A	635	N/A	471	N/A	874
17	407	N/A	438	N/A	471	N/A	906	N/A	1187	N/A	1451
26	278	N/A	200	N/A	180	N/A	1017	N/A	837	N/A	474
21	521	N/A	292	N/A	168	N/A	973	N/A	700	N/A	916
31	761	N/A	828	N/A	632	N/A	2298	N/A	865	N/A	1527
12	423	N/A	308	N/A	81	N/A	443	N/A	60	N/A	565
63	1305	N/A	1442	N/A	1418	N/A	2269	N/A	1568	N/A	1507
	606		534		383		1194		755	N/A	831

Source: Indian Meteorological Department, for 1951 data. Statistical Abstract of Gujarat State (various years), for the period 1952-85. Department of Agriculture, Gandhinagar, for the period 1986-88. Central Ground Water Board, Ahmedabad, for 1989-90. The average rainfall figures for the years 1901-50 have been taken from Phadtare (1988), "Dwindling Groundwater Resources of Gujarat" (paper presented at a Seminar on Gujarat's Endangered Environment and Ecosystem.

Notes: (1) The rainfall figures for the year 1988 are up to October. (2) In the case of conflicting information from different sources, the most recent source has been used.

RD = number of rainy days. R = annual rainfall (mm).

APPENDIX 2B

ANNUAL AVERAGE RAINFALL (mm) IN BHILODA TALUKA, IDAR TALUKA AND SABARKANTHA DISTRICT (1901-1990)

YEAR	IDAR	SABARKANTHA	YEAR	BHILODA	IDAR	SABARKANTHA
1901	572	458	1946		884	767
1902	698	784	1947		1034	779
1903	845	775	1948		523	458
1904	403	364	1949		955	640
1905	657	703	1950		1419	1283
1906	1237	1046	1951		497	470
1907	1685	1098	1952		1169	784
1908	2053	1234	1953		1577	1044
1909	849	877	1954		1441	1264
1910	1014	717	1955		1334	1016
1911	381	291	1956	1322	2175	986
1912	1025	793	1957	607	676	328
1913	993	975	1958	1172	1165	743
1914	753	1003	1959	1461	1276	1599
1915	305	447	1960	797	703	570
1916	939	775	1961	1061	969	645
1917	1374	1336	1962	752	606	671
1918	5610	1313	1963	1104	1264	1009
1919	1218	826	1964	659	661	606
1920	960	797	1965	482	655	470
1921	1092	1665	1966	459	596	679
1922	896	760	1967	662	749	545
1923	3110	891	1968	749	645	523
1924	1039	884	1969	467	390	384
1925	625	477	1970	1290	1053	1405
1926	1365	1074	1971	579	716	552
1927	1412	1221	1972	566	617	412
1928	673	804	1973	1633	1342	1377
1929	887	642	1974	92	395	352
1930	754	726	1975	1445	1502	1330
1931	803	983	1976	1193	1218	1185
1932	823	739	1977	1295	1239	1197
1933	1355	1220	1978	1109	770	879
1934	1217	967	1979	523	667	620
1935	847	613	1980	983	1081	822
1936	509	443	1981	843	768	829
1937	1469	1334	1982	737	699	519
1938	731	561	1983	1010	1133	997
1939	636	485	1984	963	1024	925
1940	554	565	1985	291	453	521
1941	1584	1033	1986	401	352	292
1942	1008	818	1987	315	206	168
1943	1186	926	1988	700	837	973
1944	2095	1504	1989	671	781	700
1945	1454	918	1990	1019	961	916

Source: Indian Meteorological Department. The rainfall figure for a particular area is calculated as an unweighted average of the corresponding figures for different rain-gauge stations.

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