An Appeal for Independent Technical Review of the World Bank-Funded Narmada Project

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A. Introduction

The present design of the Narmada River Basin Development project in India is based primarily on the idea of utilizing the large quantity of river water going unused every year. The entire project consists of building 2 large dams, 30 major dams, 130 medium dams, and about 3,000 small dams to regulate the river flow. The central feature of the design is the storage of water behind the two large dams for the primary purpose of irrigation outside the river basin, with power generation as the secondary purpose. Contrary to the common belief, the present design does not provide flood control, nor is flood moderation a design consideration. The two purposes of the present design, irrigation and power, were established more than three decades ago. After over two decades of intense political bargaining and disputes among the four beneficiary states, the final features of the design were established in 1979.

In 1987, the project was given a conditional clearance by the central government of India. The state of Gujarat, which has jurisdiction over the large Sardar Sarovar dam, began its construction without waiting for construction of all other upstream dams to begin. The opponents of the project have intensified their opposition stemming mainly from their observation that this project benefits vested interests and has no technical justification. Under this increasing pressure, two justifications are repeatedly cited by the project proponents in support of the present design of the project. One is that large quantities of Narmada river water goes to "waste" every year which must be put to use where it is needed, and the other is that Gujarat state is "scarcity-prone" and deserves to receive this unused water.

Both of these technical justifications require independent review. Based on evaluation of limited technical information that is available to me, they appear to be technical cover rather than justifications. It is true that water shortages in Gujarat are serious. They have reached a crisis proportion during each drought in recent years. Similarly, environmental degradation of the Narmada river basin is also serious. It continues unabated causing floods and loss of valuable water and topsoil. However, the present design of the project does not provide lasting solutions to these two serious environmental problems.

The water scarcity in Gujarat and the degradation of the Narmada river basin are not natural calamities but are man-made environmental problems. They require, first, an investigation of the root causes, and then development and implementation of lasting solutions that remove the causes

The present design of the project lacks such a scientific basis. As a result, while the river water may be impounded in large reservoirs, the catchment area degradation and the loss of topsoil are not addressed and will continue; while water will be given to the scarcity-prone state of Gujarat, very little will be given to those areas of the state that really need the water and suffer the most during droughts. A complete redesign of the project is necessary to provide soil and water conservation in the Narmada river basin and to reverse the environmental degradation there; and to provide water to the needy areas of Gujarat after the causes of man-made droughts are investigated and addressed by implementing necessary measures under a comprehensive water policy in the state.

Such a change in course will not occur without the help of impartial experts. The proponents of the project who have the political power are feeling increasingly cornered. They seem to take refuge behind technical jargon and power play backed by national and international power structures. They seem unwilling to discuss legitimate technical issues stating that they have been discussed before. The opponents on the other hand, have been frustrated in not being able to obtain technical documents and information essential to mount a challenge on technical issues and propose alternatives. They have engaged in nonviolent confrontations that proclaim people's struggle against the vested interests that dominate the government. They call for sustainable and just development that benefit all.

The determination and energy of the proponents and the opponents of the present design of the project would be well spent in evaluating together, alternatives that they know exist. Such an evaluation can only be made with scientific and technical considerations, not political. The proponents of the project need to recognize that in the much-changed world of today, this project conceived thirty years ago is proving to be an anachronism that promises to hinder economic progress by denying resources to viable alternatives that would bring economic benefits to all sections of the society. The opponents of the project need to recognize that the two problems are serious and complex. Their alternative solutions cannot be formulated in isolation and require cooperation of the government. An independent review team of impartial experts in the many disciplines involved is urgently needed to work with the two sides to develop such alternatives.

An overview of the two issues of the Narmada river basin development and water situation in Gujarat is provided in support of this appeal.

B. Overview of the Narmada River Basin Development Project

1. Need for Technical Justification of the Project

My 1987 visit to Ahmedabad coincided with the visit of a senior World Bank official to the Sardar Sarovar dam site in Gujarat. At that time the bank was already under pressure from the opponents outside Gujarat to withdraw from the project citing increasing costs and inadequate plans to deal with the environmental impact and resettlement of displaced people. The bank official was reported to have declared in the dam-friendly state of Gujarat that the bank got into the project for technical reasons and will get out only for technical reasons. The bank official did not identify what the technical reasons were.

It was surprising for me to hear that there existed technical reasons for the project. The history of the project indicates that the present design of the Narmada River Basin Development is rooted in the vision of large dams that existed in India during the fifties. Large dams were regarded as essential to deliver water and power to the population. Dam projects were considered as good in of themselves; their announcements were always accompanied by a litany of the usual benefits but no mention of costs or penalties. They did not require justification beyond a crude estimate of benefit to cost ratio, calculated with many assumptions and extrapolations in absence of either adequate technical data or adequate experience. The experience with large dams that did exist at that time was in a significantly different setting - the U.S. There was a blind adoption of the Western model of development.

The substantial differences in demographic, economic, environmental, geographical, historical, and cultural conditions of the two countries were not given much consideration in the design and planning of the large dam projects. No attempt was made to examine alternative decentralized methods of providing water and power to the population scattered in many villages. The causes of recurrent droughts and floods were not examined to develop lasting solutions that remove those causes. The causes of poverty were not examined with a historical and cultural perspective so as to provide means to people to remove their own poverty.

India now has forty years of experience with large dams. The results of this experience with centrally planned and executed development projects requiring large capital are known. Broadly speaking, it is known that while pockets of affluence have been created, the country as a whole has suffered with increasing rural poverty, overcrowded cities, pollution of urban areas, and unchecked environmental degradation. In addition, much more is now known in the area

of sustainable development with renewable resources such as decentralized small schemes for rainwater harvesting, solar energy harnessing, reforestation, and soil and water conservation. Such schemes are eminently suitable for India with a population scattered in many villages and with plentiful resources of rain and sunshine. Under these circumstances, there is now a need to provide technical justification for the Narmada project.

2. Reexamination of Project Objectives

The present design of the Narmada river basin development is in the same mold as the projects in the fifties. The lack of technical justification for the present design is evident in the following statements from the World Bank Technical Paper Number 110, Dams and the Environment, Considerations in World Bank Projects,1989[1].

"More than 90% of the river's average annual flow of about 41,000 million m^3 occurs during the monsoon season (June through September), so that effective use of its water resources can only be achieved through storage of the flows in reservoirs."

"The creation of large storage facilities is considered a sine-qua-non for harnessing the river's flows."

These quotes aptly sum up the objective and the basis of the present design of the project. The objective of the project is the "effective use" of "water resources" of the river. The method employed to harness the river's flows is by creation of indispensable large reservoirs. The objective emerges from the observation that 90% of the river's annual flow occurs in the three months of monsoon and is wasted to the sea. Then from this observation, two assertions are offered as self evident solution from which the present design of the Narmada river basin development involving two large reservoirs has evolved. This leap from observation to a solution does not constitute technical justification of the project. It requires careful analysis. In reality, the large reservoirs are created to transport the river water for use in regions miles outside the river basin. How "effective" this use is, also needs to be reviewed.

The main problem with the above quotes lies with the observation itself. It is a partial observation. It is more accurate to observe that much of the 90% of the river's flow occurring during the three monsoon months occurs in only a few days during a few severe storms. These flows are actually floods which carry not only water away into the sea but also the more valuable silt. Both, the rapid build up of the flood and the silt laden waters, are indicative of severe erosion in the basin. Clearly, the need of the Narmada river basin is to control the flood and erosion, not

impounding of water in large reservoirs. This more complete observation leads one to a different objective of the project. That objective would be to arrest the flood where it begins, in the degraded catchment area to conserve soil and water.

It would not be a difficult task at all to conserve soil and water in the catchment area. The basin area is about 10 million hectares from which the 41,000 m^3 flows originate. This flow amounts to a quantity of only 0.41m or 1.35 foot per unit area. It can be easily stored underground and in deep surface reservoirs distributed throughout the catchment area if proper flood control and soil and water conservation measures are implemented. More than half the area of the valley is under cultivation. It is populated by 18million people. They can be mobilized to undertake massive reforestation and catchment area development work. In addition, the water would be detained long enough for more effective use by the people in the basin. The population density of the river basin is the same as areas where the river water will be diverted to by the present design of the project.

The present design objectives of impoundment of water in large reservoirs for extra-basin transfer of the river water are inconsistent with the needs of the degraded environment and impoverished people of the river basin. An independent review of the project objectives is necessary.

3. History of Environmental Degradation

The above more complete observation of silt laden flood waters of Narmada river is true also for other rivers in Gujarat where the rainfall in the catchment area is lower than the Narmada basin. I have seen the wide Sabarmati river at Ahmedabad rise from a trickle to a 30 foot depth in less than twenty-four hours so often during the fifties that vivid memories remain even today of the ferocity of the flood and its brown muddy water. A more direct illustration of the silt laden water of Narmada river is the city of Bharuch at the mouth of the river. It was once a major port of Gujarat but is now silted to a point where it is no longer a worthy seaport.

The erosion in the catchment area of Narmada river basin and elsewhere in Gujarat is not a result of a combination of natural geological, geographical, and meteorological factors as might be the case elsewhere in the world where seasonal rainstorms cause flash floods and erosion. The floods and erosion in this part of India are of relatively recent occurrence. It is well-known that there has been extensive deforestation throughout India as well as loss of ground cover and other degradation of the environment in over the last one hundred years.

The process of transformation of the land in tropical Asia in over the last one hundred years is examined in a recent book by James Rush, professor of Asian History at Arizona State University in the book "The Last Tree"[2]. He explains that the gradual incorporation of Asian resources into the world economy began in the latter half of the last century. The tropical Asian countries fulfilled the demand for bulk agricultural produce abroad such as sugar, coffee, tea, tobacco, timber, indigo, rubber, rice. Millions upon millions of hectares of virgin land came under cultivation. "As the land filled, it was changed: trees were felled, marshlands filled, streams and creeks diverted to water the crops. Vast stands of forest became vast expanses of paddy fields, plantations, tea and rubber gardens. Those who changed the land also changed the biosphere altering the subtle interactions of land, water, and air that control the pattern of rainfall and other features of the ecosystem". In short, the environmental degradation is man-made.

It is very likely that this man-made degradation has affected the flows in the river making them more seasonal. Environmental scientists claim that many rivers of even the semi-arid region of Gujarat were perennial in the not too distant past. For example, in an article[3] "Fighting the Drought - Is There an Engineering Solution?" by G.Ghosh, Ex-director of India's Technology Mission for Drinking Water in Villages and Related Water Management, points out that even "in areas where frequent droughts have been faced there are traces of semi-perennial rivers". In the context of water management in a "highly disturbed aquatic eco-system" Ghosh states that "it is frequently forgotten that soil is the most retentive structure and is the largest water reservoir itself".

Where should the Narmada river basin water be stored? In man-made large reservoirs miles away from most of the catchment area and closer to the sea only to be diverted for many more miles before its use or in the surface reservoirs, soil structure, and groundwater aquifers of the catchment area for use as close as possible to the point where it first touches the ground as rainwater? There is a need for an independent review to answer these questions.

4. Need to Redesign the Project

The World Bank's awareness of the problem of the environmental degradation of the river basin and its willingness to help deal with it are evident in the following statements from the same paper[1] mentioned above:

"Given the ongoing trend of forest destruction, the forests of the Narmada valley may not have too many years to survive unless urgent remedial action is taken which addresses the major causes of deforestation and land degradation. Under

the proposed Narmada Sagar Project, the Bank would support efforts designed to help reverse the trend of ongoing environmental degradation."

With the exception of the words "(U)nder the proposed Narmada Sagar Project", the above statements contain a basis for the redesign of the Narmada River Basin Development project. The redesign needs to begin with reexamination of objectives. The main purpose for the present design is storage of water in large reservoirs behind two large dams for primary use in irrigation outside the river basin, with power generation as the secondary purpose, and with flood moderation as an incidental benefit. The catchment area development in the present design is limited to 300,000 hectares[1] for the Narmada Sagar and 26,000 hectares[4] for the Sardar Sarovar. This development would support a watershed management program "in which innovative, low-cost and durable in-situ soil and moisture conservation would be introduced"[1]. The objective of this development however, is only to control the siltation in the two reservoirs. The area to be developed is only 3 percent of the 10million hectare river basin. Such a project can hardly be called the Narmada River Basin Development project. It is a misnomer. It is more accurately, a Narmada River Water Impoundment and Extra-Basin Transfer project.

This lack of candor in selecting such misleading name of the project seems to pervade the design process. Contrary to common belief, the project does not provide flood control, nor is flood moderation a planned objective. According to the same World Bank paper[1], no reservoir space has been allocated to flood moderation in the Sardar Sarovar and Narmada Sagar Projects, although there is always a cushion between the normal "full reservoir level" and the "maximum water level" allowed during floods. Flood moderation is thus not a design objective but only an incidental feature of the design.

A completely different Narmada river basin development would result if the order of the three objectives were to be reversed. Considering the need to conserve topsoil and water, the primary objective of the project ought to be flood control through massive development of the catchment area; secondary objective the power generation; and use of water gradually reaching reservoirs behind small and medium dams, by people and farmers outside the basin, as an incidental feature of the design. This would be consistent with the needs of the environment in the basin and its 18 million people. The river basin has a population density of about 500 persons per square miles or just less than a person per acre. This population can be trained to implement soil and water conservation measures and to care for the environment that has sustained it for many centuries except for the last one.

The reversal of objectives presented above needs to be evaluated by an independent review team.

5. Siltation of Indian Dams and the Narmada Project Dams

The effect of unexamined transplant of Western technology in the Indian setting is evident in the high siltation rates of Indian dams. World Bank Technical Paper Number 127, Watershed Development in Asia[5] provides siltation rates of eight dams in India with the following statements:

"The deposition of eroded material in reservoirs and irrigation systems is a major management problem throughout the region, yet a relatively small percentage of the total number of watersheds have such infrastructures. It is clear that sedimentation imposes a high cost in terms of shortened investment life, high maintenance requirements and reduced services....Comparisons of the design and currently estimated lives of reservoirs in India show that erosion and sedimentation are not only severe and costly, but accelerating (Table 1.6). It is now obvious that the original project estimates of expected sedimentation rates were faulty, based on too few reliable data over too short a period." Table 1.6 is reproduced below.

Table 1.6: Siltation of Selected Indian Reservoirs

Reservoir	Assumed Rate (acre-feet per annum)	Observed Rate (acre-feet per annum)	Expected Life as percent of Design Life %
Bhakara	23,000	33,475	68
Maithon	684	5,980	11
Mavurakshi	538	2,080	27
Nizam Sagar	530	8,725	6
Panchet	1,982	9,533	21
Ramgange	1,089	4,366	25
Tungabhadra	9,796	41,058	24
Ukai	7,448	21,758	34

The above table should have included figures on the assumed ratio of benefit/cost and the actual ratio to dramatize the fact that these projects have not been beneficial for India. The last reservoir in the table, Ukai, is in Gujarat, less than fifty miles south of Sardar Sarovar. The table above shows that its expected life is only a third of design life. It is the largest reservoir in Gujarat and represents 40 percent of the total reservoir capacity created since the independence in 1947. It represents a major investment and a significant loss. Who is accountable for this bad investment decision? After this track record, it is irresponsible to promote a project that is three times larger

with promises of doing better this time. Instead, the lack of technical merit inherent in large dam projects in the degraded environment of India needs to be recognized.

The opponents of the project in India have caught up to this lack of accountability on part of the state government and the Bank. About a year ago, after Medha Patkar's 22-day fast against the project, a short-lived debate occurred in a Gujarati langauage magazine Bhoomiputra[6]. Excerpts from a question on the siltation of Sardar Sarovar from an opponent of the project and the response from the present head of the project are translated below:

Question: The siltation is calculated using the rate estimated in 1972. There has been sustained deforestation in the region so it is natural to expect higher siltation rate and reduced benefit of the project....Would you furnish honest figures of the assumed siltation rates and actual siltation rates of all our irrigation projects implemented todate?

Response: The siltation calculated using the rate estimated in 1972 was also based on erosion that has occurred for years; as upstream dams are completed, the siltation would decrease. In addition, as reforestation of catchment area increases the siltation will decrease, so the actual life of the reservoir is likely to be higher than the design life.

The first part of the first sentence of the response is difficult to understand and does not address the question. The statement about upstream dam reducing siltation downstream is technically correct and I am sure that the design rate is based on that fact, so it cannot be cited as a factor that would help reduce the actual siltation rate. The first half of the second sentence of the response is also technically correct but figures for forest cover that existed in 1972 and for reforestation planned are not given. The assertion that actual life is likely to be higher than the design life does not follow from the information provided in the response. The above data on siltation rates of Indian dams is a strong indictment of dam projects in India. In light of these data, the question of siltation rate is a very important one and deserves a detailed response substantiating all the facts.

The response did not disclose siltation rates of all irrigation projects as requested by the questioner. In a personal communication to me the questioner informed me that the government has declared siltation rates of irrigation projects as classified information. Even the department of environment of the central government cannot get this information. It appears that this project will not only further impoverish India from possible bad investment, but is driving the political system towards more secretiveness

rather than openness. All World Bank aid should promote more openness in the government, less centralization and more local control. This project appears to be achieving the opposite results. The basis of calculations for the assumed siltation rate also requires an independent review.

6. Evaluation of Seismic Safety of the Sardar Sarovar Dam

The area in the vicinity of the Sardar Sarovar dam is dissected by eight faults. The dam is located directly on a major fault called Narmada fault. It is also in a close proximity of its junction with a cross fault called Navagam fault as shown in Figure 1. It should be noted that the Sardar Sarovar dam is also known as Navagam dam. The geological information pertaining to the faults is described in a letter by Dr.Ajit N.Shah published in the February 1992 issue of the Civil Engineering magazine of the American Society of Civil Engineers[7] (Attachment 1).

The Gujarat government's response to those concerned about seismic safety is noteworthy. This response is summarized below from an article by the Additional Chief Secretary, Narmada Development Department[8] (Attachment 2):

The article claims that (a) the geological fault is treated by "concreting", (b) " there is no evidence at present to presume that the river bed fault is active" (my underline), (c) the "possibility of significant movement along the fault plane met within the seat of the dam is ruled out, as the length of the fault is very short", (d) the largest earthquake reported in the region was in 1938 at a Richter scale magnitude of 6.5 and the latest earthquake reported was in 1970 (of magnitude 5.4[7]) (e) the seismic design of the dam is based on the peak ground acceleration of 0.25g for the Maximum Credible Earthquake and of 0.125g for the Design Basis Earthquake, (f) the "issue regarding suspected activity of the fault and the type of the dam to be constructed at Sardar Sarovar have been amply discussed at length with eminent experts and consultants of India and abroad".

Structures cannot be designed to withstand earthquakes if they are located directly above an active fault. So the only option a designer has to locate a structure directly on a fault is to show evidence that the movement of the fault is not expected during the life of the structure. This is a very difficult standard to meet in a seismically active region. For example, recently, during the expansion of a school in Los Angeles, California an earthquake fault was discovered running directly beneath the 14-year-old building. This minor fault, called in the news report[9] "a trace of the Newport-Inglewood fault system", was not detected by a geotechnical survey conducted before the construction of the existing building. According to the

chief structural engineer of the State, the State law prohibits construction of school buildings over earthquake faults where movement is expected during the life of the building. The engineer explained that although structures located away from the fault can be designed to resist shaking during an earthquake, they cannot be designed to resist differential motion at a fault. As a result, the authorities will close the building.

The above example of the school building in California is cited to illustrate the importance of the Gujarat government's "presumption" that the fault is "not active" and its declaration that "significant" movement along the fault is "ruled out" because the fault is "very short". All the terms in quotes above need detailed technical justifications. Does the Gujarat government have any, or are these too claims made based on incomplete data and unjustified extrapolations?

Commenting on the government's presumption of the fault not being active, Dr.Ajit N. Shah states: "(S)ome say the Narmada fault is an ancient Precambrian feature that is probably healed. But there is evidence that shows a possible reactivation of these faults in the current stress regime. These faults are associated with seismicity because they are zones of stress concentration rather than zones of weakness". In 1966, an earthquake of magnitude of 5.0 hit the Koyna Dam located about two hundred miles south of Narmada river damaging the dam and causing death and destruction. According to Dr.Ajit N.Shah, the "area was considered seismically stable before this earthquake activity". He states that after the 1970 earthquake, increasing seismic activity has been observed in western India.

All faults where data of seismic activity are lacking may be logically "presumed" inactive until the next earthquake occurs. Important structures such as large dams with useful life of two hundred years cannot be built on a "presumption" based on evidence of inactivity going back only a few decades. Geologists may even propose theories why some faults are inactive which they would promptly revise after an earthquake is recorded. Engineers responsible for design of a structure cannot rely on a geologist's evaluation that a fault is "probably healed". Professor Leonardo Seeber of Columbia University's Lamont-Doherty Geological Observatory recently wrote[10] the following with reference to the lack of seismic activity in the eastern U.S. and design of structures there:

"Engineers designing structures must rely on proven principles; in contrast, seismologists investigating geologic processes have the privilege of proposing, testing and discarding erroneous hypotheses. This difference in

approach may be in part responsible for difficulties in communication. Propositions that are only working hypotheses for seismologists, may be given undue credit by engineers. This is particularly likely in the eastern U.S. where the state of knowledge on seismogenesis is rather primitive."

Only in the last decade have the building codes in parts of the U.S. outside California and other regions of previously known seismic area been upgraded to account for potential seismic activites. They no longer rely on "presumption" of inactivity based on existing evidence. They rely on "potential" of activity based on a more comprehensive understanding of the geology, movements of faults and records of microseismic activities that have become available in recent years because of installation of highly sensitive recording instruments.

Dr.Ajit N. Shah believes that such microseismic data are now available for western Gujarat. The Gujarat government needs to reassess its presumption of seismic safety of the dam. This large dam in Gujarat deserves more careful attention than a school in California. Unless Gujarat government can demonstrate with a very high degree of certainty that the fault will remain inactive through the design life of the dam and makes a plan now to decommission the dam after its useful life is over and accounts for its cost in the benefit to cost ratio, the dam should not be built. "Presumption" of inactivity of the fault based on limited data is not an acceptable proposition in the U.S. and should not be acceptable for Gujarat. Ever since the Bhopal tragedy, people in India have become aware of lower standards of safety accepted by their overzealous managers and leaders.

An independent review team needs to look into this design issue as well.

7. The Basis for an Independent Technical Evaluation

This appeal for an independent technical evaluation is based on my assessment that this conflict between the opponents and proponents of the project is leading to a political conflict because of the lack of proper procedures and rules with which such projects are normally implemented in the U.S. Full disclosure of all technical information on public projects, public hearings, peer reviews, independent expert reviews, value engineering studies of the alternatives, public involvement in the decision-making process are the norms that are followed for such projects in the U.S. If this project is to be assisted by our tax dollars, it is important that the same procedures and rules are followed for the Narmada project. The following three policies and positions of the American Society of Civil Engineers for public projects such as the Narmada project are given in Attachment 3 as a guidance:

1. ASCE Policy Statement 139, Public Involvement in the Decision-Making Process.

2. ASCE Position Paper 280, Responsibility for Dam Safety.

3. ASCE Policy Statement 351, Project Peer Review.

In particular, this project should be reviewed for compliance with the following issues:

1. Complete presentation and discussion of viable alternatives with regard to (a) engineering impact, (b) environmental impact, (c) social impact, (d) economic impact. The viable alternatives are not intended to mean alternative dam sites or other integral features of the same design but alternatives to the project itself for achieving the same objectives including the "no-project" alternative (See ASCE Policy Statement 139).

2. Seismic hazards must be evaluated based upon the tectonic regime of influence, and must consider levels of magnitude and associated ground motions consistent with the potential hazards created by the existence of the dam (See ASCE Position Paper 280, Item 11).

3. All phases of design and construction of dams, to be located where failure could cause significant flooding in areas downstream with attendant hazard to life and property, must receive an independent review by qualified engineers and geologists (See ASCE Position Paper 280, Item 12).

4. A peer review is conducted of all aspects of the project to assure that the project objectives are met (ASCE Policy Statement 351). This is needed particularly with regard to the assumed siltation rate to establish design life of the dams, irrigation water delivery canal systems, and drinking water delivery systems.

The state and central governments in India have become increasingly undemocratic, arbitrary and even despotic in dealing with opponents on this issue. This is contrary to Indian history and heritage of tolerance and openness. Just this reason alone is sufficient for the U.S. to not support the project until an independent technical review is undertaken in an open and democratic setting.

C. Gujarat's Lifeline - Narmada Water or Rainwater?

1. Introduction

The water situation in the state of Gujarat is very grim. Although the average annual rainfall in Gujarat is estimated to be 105 million acre-foot(MAF) or about 2,000 gallons per person per day, the water scarcities occur often throughout the state when people do not get even 5 gallons of water a day. About 12,000 villages of the 18,275 villages are declared by the state as "no source" villages, people and cattle roam the country side during scarcities in search of water, farmers lose entire crops for lack of 2 inches of water during critical growth period if the rains fail, fertile land in millions of acres is lost to salinity along the coast due to ingress of seawater.

This is so because the groundwater tables have been depleted due to overexploitation resulting in loss of age-old lifeline of well water that people relied on during the scarcities, extensive deforestation has occurred reducing the forest cover to only 7 percent, extensive loss of ground cover has occurred due to over grazing by cattle, the deforestation and loss of ground cover results in flash floods and loss of topsoil during storms and reduced natural recharge of groundwater, and there is lack of adequate reservoir capacity to collect rainfall during good years for use during droughts.

Ignoring all these serious and fundamental problems, the state is pursuing the Narmada project calling it a lifeline of Gujarat. Gujarat will import 9 MAF water from the Narmada project of which 8 MAF is for irrigation in what is called Narmada canal command area. The remaining 1 MAF water is for domestic and industry use which is less than 1 percent of the rainfall. In a situation like this it is natural to ask for justification for undertaking an expensive project to import 8 MAF irrigation water in the state so that a fortunate few farmers would receive 21 inch of water for irrigation every year regardless of whether the year is a drought year or not.

As stated before, two reasons are repeatedly cited as justification for the present design of the Narmada project. One is that large quantities of Narmada river water goes to "waste" during floods every year which must be put to use where it is needed, and the other is that most of Gujarat state is "scarcity-prone" and deserves to receive this unused water. In the previous section it was shown that the Narmada project does not provide the development of the Narmada river basin to control the floods and conserve the valuable topsoil. It neither solves the water scarcity situation in Gujarat.

2. The Definition of Scarcity-Prone Area

The criterion employed to justify the water import from the distant Narmada project into the Narmada canal command area is whether the area is scarcity-prone or not. The definition of scarcity-prone area issued by the central government in 1972 is employed[11], which defines the scarcity-prone area as that area with five year recurrence period of 25 percent or more deficient rainfall. Against this yardstick it is claimed that 71 percent of the command area is scarcity-prone so the water delivery from the project to the command area is justified. This is not so. The only conclusion one can make with this yardstick is just that 71 percent area of the command area is scarcity-prone and nothing more. It does not automatically follow that the solution to deal with scarcity is to import irrigation water from the Narmada project. In one step they have observed the symptom, diagnosed the illness and prescribed the medicine. The observation of the symptom is correct. But the diagnosis of illness is yet to be made and a choice of medicine to cure the illness remains to be made and justified.

The definition of scarcity-prone area is only a measure of minimal scarcity conditions. All it says is that areas not experiencing such scarcity should not need irrigation and rainfed farms should be able to absorb such a variation of the rainifall. 25 percent deficiency or more only once in five years is not a very strict standard. By that definition many areas of the world would be called scarcity-prone. This does not mean all such areas should be given 21 inches of imported water for irrigation. For example, an area with an average rainfall of 120 inches may well be, by this definition, a scarcity-prone area because every fifth year it has rainfall of only 90 inches. Yet, common sense tells us that area with such a high rainfall cannot be considered in need of any irrigation and one cannot undertake expensive projects to provide imported water to the region. When the opponents complain that imported Narmada water is justified for only 38 percent of the command area, the discussion gets bogged down in claims and counter-claims of percentages of scarcity-prone versus non-scarcity-prone areas.Such debate does not help develop policy options. Instead, the debate should focus on determining the causes of the problem and the method of irrigation that should be prescribed for each region identified as scarcity-prone.

3. Irrigation Needs in Gujarat

It is claimed that the rainfall in the command area is also insufficient in addition to being unreliable. The term "insufficient" rainfall also requires an evaluation.
Another factor that must be evaluated is the severity of scarcity conditions. Clearly, more severe scarcity conditions can occur such as 3 year recurrence period of 33

percent deficient rainfall. In otherwords, after the scarcity-prone areas are identified and before methods of irrigation can be evaluated, engineers need to identify regions of varying needs of irrigation based on amount of rainfall, severity of scarcity conditions and other factors I need not mention here. Gujarat state has done this and produced a map of Gujarat shown in Figure 2. The map divides the state into six regions of varying irrigation needs from exceptionally high irrigation needs to low needs. It should be noted that 73 percent of the state representing the north-Gujarat, Saurashtra, and Kutchh is shown as "high need" or worse while only 27 percent is better than "high need". The debate should now focus on the methods of irrigation to deal with this varying degrees of scarcity conditions.

4. Command Area Rainfall and Scarcity

Let us examine how scarcity-prone the command area is. The Narmada canal command area can be divided into the following four regions[12].

	Rainfall Range mm	inches	Average mm	inches	Percent Area
1.	800-1,000	(32-40)	900	36	17
2.	700-800	(28-32)	750	30	21
3.	600-700	(24-28)	650	26	40
4.	400-600	(16-24)	500	20	22
	400-1,000	(16-40)	700	28	100

First, the above data indicate that the average rainfall in the command area of 28 inches is higher than the average rainfall of 660mm or 26 inches shown in Figure 2 for the rest of the state. Second, if you accept that importing Narmada water is the only solution for the command area then an obvious question arises as to what plans the government has to deal with the remaining more severe scarcity-prone areas of the state. The government cannot provide a satisfactory answer because of a dilemma. For example, if the government proposes many small projects to capture the rainwater for the other areas, opponents of the project would claim that the same should be done for the Narmada command area to alleviate scarcity conditions, and the whole case for the Narmada project simply vanishes.

In addition, it is clear that vast areas outside the command area are in greater need of water. The Irrigation Commission that provided the definition of scarcity-prone area which the Gujarat state government uses to justify importing the water to the command area for irrigation, also established priorities of water use[11]. It states that "the first charge on the available scant water resources should be the drinking water needs of human beings and of the animals

raised and maintained by these human beings"; the "second charge shall be that particular need which will generate employment opportunities to as large a section of the drought affected people as possible so that they can earn money power to buy food for themselves and fodder for their animals .."; the "third charge shall be for grass farming, tree farming, animal husbandry like sheep, pig and poultry farming, which do not require any one particular type of food or fodder but can survive and thrive on waste material, bushes and shrubs..", and "the fourth charge shall be growing hard food crops which can survive long spells of dry weather...". Clearly, the state government needs to demonstrate that all these priorities established by the same irrigation commission that they so respect for its definition of scarcity-prone region, are followed. This is not the case. Providing 21 inches of irrigation water to farmers in the command area should not be the first priority of the state government. I am not aware that the opponents outside Gujarat oppose the project because Gujarat is getting 9MAF water. They have only pointed out that it is not being used to alleviate poverty and suffering experienced in more scarcity-prone regions of Gujarat out side the command area.

The objective of the irrigation is to remove scarcity conditions that may occur by saving the crops. If the crop failure occurs due to deficient rainfall, then crops may be saved by making up the deficiency of 25 percent. The deficiency in the most needy region of the command area as seen in the table above is 7 inches based on 33 percent deficiency (which is likely in Gujarat with a recurrence period of three years). From this, one can see that a dose of 21 inch of irrigation water in the command area almost every year is not justified if the objective of irrigation is simply to alleviate scarcity conditions. The least needy region of the command area receiving 36 inch of rainfall should not be receiving any imported water at all. It is clear that the definition of scarcity-prone region ~~is~~ introduced by the promoters of the project into the debate is not meant to be a tool for scientific inquiry. It is really intended by the promoters of the project as the sole justification of the project and to end any further debate.

5. Lack of Water Policy in Gujarat

The recent droughts have been cited by the politicians to justify speeding up of the construction of the project choosing to ignore the good years. Drought of 1987 was extreme but so were the floods of 1988. Obviously, for every year that is deficient in rainfall there is a year that has surplus rainfall that makes up for the deficiency. In irrigation planning, one cannot simply cite deficient years to justify imported water and ignore the surplus years. Unreliability of rain is a known meteorological fact which

should be planned for in the design of storage capacity. Lack of proper planning of storage capacity is evident in the frequent floods and scarcity conditions that occur when people either get flooded or cannot get even five of the possible several hundred gallons of water per day.

Gujarat can learn from Israel how to deal with scarcity conditions without importing water. Israel too has unreliable rainfall. Also shown in Figure 2 is a map of Israel showing the average rainfall. One can see that Israel does well with half the rainfall. Israel's population density is about 18 percent higher than Gujarat's, its desert region is 60 percent of the total which is far larger than Gujarat's desert region of 16 percent. Israel's per capita use of water is half of the potential rainwater use in Zone C of Gujarat. Israel does not experience either flooding or scarcity because of proper planning and utilization of rainwater storage capacity. Israel's live storage capacity is calculated as 150 percent of the average annual collectible rainfall based on a 15 year cycle that includes consideration of consecutive moderate drought years and wet years. The 15 year cycle also includes years of severe deficient years and surplus years.

In comparison, Gujarat has no water policy beyond creating medium to large dam reservoirs. 92 percent of the reservoir capacity exists in the medium to large dam reservoirs. Gujarat's surface reservoir capacity is perhaps only about half of the annual collectible rainfall received within its borders. Remaining reservoir capacity will have to be small reservoirs in villages and the country side in the catchment areas. The government is not able to manage small projects so they are not being undertaken on a large scale. Also, the World Bank prefers the medium and large reservoirs and has just recently begun to look at the NGOs to provide development money for small reservoirs.

6. The Ideology of Big Dams in Gujarat

(a) A Meeting in Saurashtra

In April,1987 a group of prominent citizens and social workers of Gujarat met in Saurashtra, the north-west region of Gujarat, to discuss the problem of water scarcity there. A short report of the meeting was published in the September 1987 issue of a Gujarati language monthly, Navneet:Samarpan. The following points were made (my translation):

"Every time we discuss the issue of water scarcity a question arises whether the quantity of water is insufficient or is our planning for it inappropriate? Why is it that Israel with rainfall of less than 10 centimeter manages to produce enough food to be able to export it, while we experience scarcity with more than 50 centimeter rainfall?"

"We are not able to collect and store the rainwater we receive. For example, the Rawal village in Kalyanpur Taluka gets engulfed in flood waters in the monsoon but experiences drinking water shortage in summer. It is certain that we get adequate rainfall for everyone's need only if we can capture rainwater directly and store in ponds or behind a check-dam."

"But the deficiency is in our planning. We do not undertake programs that fundamentally deal with this issue and we incur unnecessary expenses on projects that do not solve the long-term problem to anyone's satisfaction".

It is important to note that these were prominent citizens of Gujarat who do not oppose the Narmada project. To an impartial and objective observer of Gujarat's water situation, their opening question would appear pointed and logical, their observation in the second quote accurate, and the conclusion about deficiency in planning in the last quote valid. The most interesting aspect of the report was that at no time did they complain about the rainfall being "insufficient" or "unrealiable" as is invariably done by the aggressive supporters of the Narmada project in Gujarat. On the contrary, they asserted that it is not the rainfall that is deficient but Gujarat's planning of water projects.

This group of citizens offered the following solutions:
- Revive the tradition of rainwater collection in tanks.
- Construct farm ponds and village ponds so that rainwater falling in the village stays in the village and falling on a farm stays on the farm.
- Repair existing village ponds and if none exists in a village, construct a new one of size proportional to the village population.
- Build check dams and bunds.
- Undertake dense reforestation.
- Control water use in irrigation.

The above recommendations of rainwater harvesting measures by this group of citizens stand in sharp contrast with the "big dam" position of two government officials presented below.

(b) A Debate on the U.S. National Public Radio

A report on the Narmada project was broadcast on the U.S. National Public Radio on March 20,1991. The relevant excerpt from the transcript of the broadcast is provided below:

(Note: Hollick is the reporter, Saigall is a project opponent, Mehta is the ex-chief of the project in Gujarat)

Hollick: No one denies the desperate need for water, but

Saigall says rainwater can be caught and stored behind small check dams and in village ponds just as effectively as behind a giant dam. It would not only cost less but submerge a lot less farmland. But Sanat Mehta, the driving force behind Sardar Sarovar, says that simply isn't true. Besides, there aren't enough suitable sites for small dams. The alternatives offered by the environmentalists may be ideologically pure, he says, but they won't do the job in Gujarat. Mehta: The basic fallacy in this argument is that these small dams--the watershed program, conserving every drop of water, is not an alternative to big dam--they're complimentary, they're not contradictory.

Mr.Mehta did not provide any data on the state government's experience in the last forty-five years on big dams versus watershed programs to back up his claims of lack of performance of watershed projects, proof of performance of big dam projects, and on expenditures on the two types of projects to demonstrate that the government indeed regards them as complimentary. Because, had he done so, it would have revealed that as far as Gujarat government is concerned, the watershed development programs get only a pittance with the bulk of expenditures going to the large and medium dam reservoirs as seen in the comparison of reservoir capacities presented below.

(c) A Debate in Bhoomiputra

In the short-lived debate in Bhoomiputra that was mentioned earlier, the opponents pointed out that most of the more needy regions of Gujarat, that of Kutchh and Saurashtra out side the command area will not get water from the Narmada project. The government in response admitted that fact and stated, "there is not one scheme that covers all", and went on to state, "there is under review feasibility of a scheme to divert water from rivers of south Gujarat to these regions, and if determined feasible, these regions will also be provided for".

So, once again when confronted with the inescapable reality of severe water problems of Saurashtra and Kutchh, the government's reflexive response is to suggest another scheme of transporting large quantities of water from one end of the state to the other. The rainwater harvesting schemes and dense reforestation recommended at the citizen's meeting in Saurashtra are not even considered "complimentary" to the big dam.

In addition, according to the irrigation commission recommendations on the priority of water use, the more needy regions of Kutchh, Saurashtra, and the North Gujarat have the priority for more important uses of water identified by the commission than for irrigation use in the command area. It would therefore be more appropriate to supply the Narmada

water to these regions for such uses and let the command area wait for other feasible schemes government is contemplating. Also, as seen before, the rainfall in the command area is sufficient to implement rainwater harvesting schemes which is not the case for regions of Kutchh, Saurashtra and the North Gujarat. These regions therefore have greater claim to the Narmada water.

(d)Reservoir Capacity in Gujarat

The reservoir capacity created in Gujarat since the Independence is shown in the following tabulation[13].

Name or Type of Reservoir	Reservoir Capacity Mil.Cu.Ft. (mcf)	Mil.Ac.Ft. (MAF)	Percent of Total
1a.Largest Reservoir Ukai	250,470	5.75	44%
1b.Next Ten Large Reservoirs	163,265	3.75	29%
1. 11 Large Dam Reservoirs	413,735	9.50	73%
2. 120 Medium/Small Reservoirs	109,688	2.52	19%
3. 922 Surface Reservoirs	42,881	0.98	8%
Total Reservoir Capacity	566,304	13.00	100%

Distribution of Reservoir Capacity By Region

Name of Region	Percent of State's Area	Population	Reservoir Capacity Dam	Surface
Kutchh	16%	3%	1.8%	1.5%
Saurashtra	40%	40%	11.7%	2.5%
Remain.Gujarat	44%	57%	79.0%	3.5%
Total	100%	100%	92.5%	7.5%

The above information shows that of the 13 million acre-foot reservoir capacity created, 44 percent is in one large reservoir of Ukai. It was built with state funds belonging to all eighteen districts of Gujarat but serves only two districts with the highest rainfall and the least need of water in Gujarat. We have seen before that Ukai reservoir's life will be one third of the design life due to high rate of siltation resulting in loss of investment. The eleven largest reservoirs represent together 73 percent of the capacity, with 19 percent in medium reservoirs, and only eight percent in small reservoirs located in the catchment area. An eighty-two percent reservoir capacity is created in the area of Gujarat which has a higher than average rainfall and only 14 percent capacity is in Saurashtra which suffers the most during droughts and recently even in normal years.

(e) Conclusions on Ideology and Alternatives

The above data lead to the following conclusions:

- An ideology is evident on the part of the government, of almost exclusive reliance on large and medium dam reservoirs.

- Given the grim situation of water in the state this ideology has just not done the job in Gujarat

- The watershed programs have not been implemented on a scale in the region where they are needed to conclude "they won't do the job in Gujarat".

- The government has run out of sites for large and medium dams.

- The government could not have run out of suitable sites for check dams and village ponds. The catchment area of 75,000 square miles dotted with 18,273 villages ought to provide thousands of suitable sites for small dams, check dams, village ponds, farm ponds, groundwater recharge sites, dense reforestation and so on.

- This is the only alternative to the Narmada project left and must be fully evaluated to determine what areas cannot be served by such schemes and then to provide water to such regions from a redesigned Narmada project discussed before.

- Such an approach would show that imported water in most of the present Narmada canal command area is not justified and that it is justified in some of the region lying outside the present command area.

- Just as the objectives of the project for the Narmada basin development were ordered backwards, the benefit distribution in Gujarat is also backwards. The less needy areas will be getting most of the water and the most needy areas will be getting little or none.

7. A Case History of Rainwater Harvesting

Utthan-Mahiti is a non-governmental organization (NGO) in Ahmedabad which completed eight village ponds in four years starting with a demonstration pond in 1983. The sites for the ponds were selected to collect rainwater from the catchment area.

These villages were, in theory, not considered "no source" villages because they were, in the government's books, receiving water from a pipeline. This pipeline was 100km long and the villages were at the tail end of it. The villages did not receive water because of loss of pressure

due to leaky pipeline and pilferage along the way. The government had made plans for another pipeline and had even got the World Bank interested in the project. When the NGO heard about the plans, they sought intervention and proposed their rainwater harvesting scheme. The NGO too was told by the state government that the scheme is not technically feasible. Mr.G.Ghosh in the central government, referred to earlier in this letter, prevailed over the state government and provided assistance. The ponds have served the villages with water ever since.

The government that could not maintain a 100km pipeline is now proposing 65,000km canals as part of the Narmada project. A clear case exists for intervention from above the state government level to reevaluate the present design of the Narmada project. Utthan-Mahiti recently was awarded funds by the World Bank for construction of another 14 ponds. There are 12,000 no-source villages in Gujarat. They cannot wait for funding at a rate of 5 ponds a year or less. What is needed is to stop the Narmada project for reevaluation and redirect all the funds for the next three years to create such ponds for all villages where rainwater harvesting is feasible as determined by an independent review team.

8. A Case for Diverting Narmada Funds for Reclamation Work

My interest in Gujarat's water problem was aroused by an article I read by chance, in early 1986, in the magazine "India Today" titled Tears of Salt. A copy is enclosed in Attachment 5. It described a man-made environmental disaster along the coastal Saurashtra and Kutchh where 1.2 million hecatres of fertile land turned saline due to overdraft of well water resulting in seawater ingress. It happened during the decade that followed the mid-sixties when tube wells with diesel or electric powered pump sets were installed all over Gujarat.

The land that cost Rs.25,000 per acre in 1965 became worthless. The loss at that rate adds upto Rs.72 billion in the 1965 value of the rupee, which exceeded the cost of the Sardar Sarovar project at that time. The area of fertile land lost is about 66 percent of the land that will be irrigated by the Narmada water to be imported in Gujarat.

The cost of reclamation estimated by two different government commissions was about Rs.10 billion or a fraction of Gujarat's share of the cost of the Narmada project. The state government has refused to undertake the full reclamation work becuase it does not have money. The proposed solution was simple: bunds on rivers, artificial recharging of the subsoil with rainwater, massive afforestation. The small portion of the entire proposal that was implemented was successful in reclaiming the land.

Legislation to control ground water withdrawal was considered by the Chief Minister of the state as "politically impossible".

It is difficult to understand why the Gujarat government can find funds for the Narmada project that are several times higher, and political will to implement the project that is so complex, but not find the funds and political will to address this problem. The benefit to cost ratio is about seven, several times higher than the benefit to cost ratio of the Narmada project. The fertile land that would be reclaimed is 66 percent of the land to be irrigated - and potentially lost to salinity eventually - in the Narmada command area. The independent review team needs to look into this and many other incomplete projects that deserve funds but are denied so as to finance the Narmada project.

9. A Case for Restoring The Lost Lifeline of Groundwater

India is running out of groundwater due to overexploitation. "Hydrologists note that the long-term effects are probably understood, but until the water disappears, it is hardly likely that anyone is going to do anything about the situation."[14]

In Gujarat however, all water related problems are blamed on droughts. The politicians hold a belief that the groundwater levels have fallen in many parts of the state because of droughts. For example, in the Bhoomiputra debate, the state expressed the following view for drinking water shortages[15],"..subsequently, during three or four continuous droughts, many other villages came under water scarcity. Because of short fall of rains the groundwater levels were lowered".

This apparently, is a common view held by politicians who are unable to control the over-exploitation, because Mr.G.Ghosh felt compelled to address this view in his article[16] as follows:

"Very often than not the failure of monsoon is connected with the lowering of the water table and also the cause leading to the drinking water crisis. The aquifer which develop over the thousand of years cannot be depleted merely due to the demand of drinking water. The avrice of man resulting in overexploitation of groundwater for so-called development of a region either through water intensive industries or cash crop has led to this crisis."

Another technical article[17] deals with this issue as follows:

"But then the question would arise why in recent drought years, the difficulties of drinking water has been on

increase....the difficulties are on increase since Green Revolution in sixties. The Green Revolution was ushered in mostly by large scale activities of the Gujarat State Co-operative Land Development Bank Ltd. The Bank earned great reputation throughout India by its loan programmes to farmers for tube wells, dug wells, diesel and electrical pump-sets. The result has been there is over pumping and water levels are going down in many areas. Criteria for recharge for development of groundwater were adhoc in our State and elsewhere at that time and there were not such detailed investigations as available now. More over there is too much of private development for which there is no control. This phenomenon of decline in levels of groundwater has been at the root of the drinking water problem which is becoming more and more serious in lean and drought years. Ingress of sea, polluting fresh waters in the coastal areas of Saurashtra and Kutch, wells going dry, tube wells getting defunct are some of the resulting phenomena which are obvious to see."

As a result of the overexploitation of groundwater and resulting lowering of water levels in wells, the number of no-source villages have risen from about 4,000 in 1965 to 12,000 in 1987. Thus, the same government that watched helplessly the robbing of the age-old lifeline for Gujarat, is now promoting this massive project to give only 1MAF drinking water to 8,000 villages (the number increases each time I read about the project) instead of restoring the age-old lifeline by imposing groundwater control and implementing groundwater recharge schemes. If in the context of such schemes, it is determined by the independent review team that temporarily, imported water is necessary to recharge the aquifers, pumping water from a redesigned Narmada project may be considered. But any import of water from any Narmada project must be justified against the substantial long-term gains that would result from restoring the environment to its natural state from the degraded one of the present.

10. A Case for Greening Gujarat

An article titled "Let's Green Gujarat" appeared in September 16, 1991 issue of Bhoomiputra, written by Mr.Vasudev Vora, an environmental scientist in Gujarat. In it he suggested dense reforestation on 2.9 million hectares in Gujarat stating that the resulting natural recharge and storage of groundwater would exceed the water storage capacity of Sardar Sarovar. In comparing his proposal to the Narmada project, he stated that the forests are not only indispensable to the villages of Gujarat but that they are more crucial than the Narmada project. Calling his scheme Freedom Forest, he estimated its cost at Rs.29 billion, about a quarter of the cost of Sardar Sarovar.

Reforestation of all twelve districts of Gujarat which will receive Narmada water is proposed to increase the forest cover from its present average of 7 percent to about 33 percent which is the minimum recommended in the national reforestation policy. It is pointed out that South Korea reforested the land from a low of 6 percent in 1970 to 60 percent in 14 years. From the benefit-cost considerations no other alternative can contest with Freedom Forest because fundamentally it is natural and also nature's scheme.

An erstwhile Governor of Gujarat was quoted as saying, "it has been proven that the key to the productivity of the land is in soil conservation in small watersheds by reforestation ..truly, in areas such as Gujarat and Rajasthan, the soil/water conservation schemes need to be based in small watersheds".

In a prior correspondence with Mr.Vora, the present head of the Narmada project in Gujarat wrote: "Your proposal is attractive; and just as you suggest, desereves consideration. While I did not get an impression that it is as easy and as inexpensive as you state, the proposal certainly deserves consideration no matter how expensive or difficult; since in the long run the solution to our problem lies in it...my hearty congratulations for your sound proposal!"

It is necessary for an independent review team to consider such proposals without prejudgement based on cost, time or difficulties involved.

11. Water Inventory of Gujarat and Narmada Water

Rainwater harvesting, land reclamation, groundwater recharging, soil and water conservation measures, and dense reforestation are alternatives to the Narmada project. None of these would be possible if the rainfall is as unreliable and as insufficient as the supporters of the Narmada project claim. Unfortunately, they do not define these terms fully

or provide data with which to make a judgement on the alternatives. Obviously, there is rainwater that goes to waste uncollected as shown by Utthan-Mahiti's and other NGOs' work in Gujarat. Firm estimates of rainwater going to waste in Gujarat cannot be made without conclusive studies throughout the catchment area. However, based on applicable studies made elsewhere and the preponderance of evidence of flooding after each heavy storm, it may be safely estimated to exceed the amount of water to be received from the Narmada project.

The total quantity of rainwater collected in ponds or recharge pits increases with decreasing catchment area for each pond or pit. In otherwords, smaller the catchment area for each pond or pit, greater the percent of rainfall collected. The map of Gujarat in Figure 2 shows isohytes of average annual rainfall. The table provided under the map shows a total rainfall of 105MAF. Assuming a 20 percent collection of rainfall as runoff from a small catchment area of 1 to 10 hectares, the total rainfall that may be collected is 21MAF. Previously, we saw that the total reservoir capacity created in Gujarat is 13MAF. Of this, most of the water collected in Ukai reservoir comes form outside the state, and possibly some for the river Mahi as well. Deducting say 5MAF from 13MAF as out-of-state water, only about 8MAF rainfall within the state's border is being collected.

The reservoir capacity of 8MAF for collecting rainfall of the state is a very small number compared to the estimate of 21MAF as collectible rainfall calculated above. About 14MAF rainfall is estimated to recharge groundwater but access to it is lost by many due to lowered groundwater levels. Between the uncollected rainwater and inaccessible groundwater about 27MAF water is lost from the system for people without access to tube well or piped/canaled water from the reservoirs. Access to this water must be restored to all people for water scarcity in Gujarat to alleviate. Importing 9MAF of Narmada water for fortunate few farmers in the command area will not solve Gujarat's water scarcity. Those areas of Gujarat, particularly in Kutchh, Saurashtra and North Gujarat, where there is no alternative feasible for lack of sufficient rainfall averaged over a 15 year planning cycle, importing of Narmada water would be justified.

D. Concluding Remarks

Gujarat needs to put its house in order before importing water from Narmada river. This can be easily done while the present design of the Narmada river basin development is reviewed and revised with reordered objectives. In their plea in Bhoomiputra a year ago, opponents had only asked for a non-partisan national debate on all aspects of the project in the following words:

"Then let us debate - on every condition, on all aspects of the project, let us have non-partisan, national debate! Open debate in peoples' parliament .. If you are so sure the dam is beneficial, then what is your objection to prove your case at a national level in an impartial forum? A society which cannot tolerate free exchange of ideas, ..is not a society, it is surely a jail".

The government's response was as follows[18]:

"There cannot be any objection to a debate on this issue. All the details can be examined and verified. That this issue be studied freely is my wish."

Unfortunately, the debate remained inconclusive for want of technical details on both the sides. When confronted with facts the Gujarat government has made necessary changes in the allocation of water. For example, the 1MAF drinking water will not be supplied to villages in areas of Gujarat where rainfall is adequate for the purpose, and instead the state plans to provide the same to the regions of Saurashtra and Kutchh. The remaining water of 8MAF likewise needs to go where it is needed the most for priority uses established by the Irrigation Commission. The opponents need to support Gujarat's claim of just royalties for its crude oil and gas that the central government has denied.

I am not familiar with political compulsions of each party. I do not personally know anyone involved in this issue in India. I became familiar with names of the opponents less than three years ago. Having studied in a small way the water situation in Gujarat, I felt their entire plea in Bhoomiputra was very sound and appeared to be made for the good of Gujarat, not just for their cause whatever, it may be. At that point I felt compelled to do something about this issue in the U.S. in as much as our tax dollars were involved in this project. That was the reason for writing to Mr.Bradford Morse in August, 1991. I urge you to make a strong recommendation to the World Bank to undertake an independent review of all aspects of the two major problems that exist; the water scarcity in Gujarat, and environmental degradation of Narmada river basin.

E. References

1. Annex on Narmada Projects, World Bank Technical Paper No.110, Dams and the Environment, Considerations in World Bank Projects, 1989, John A.Dixon, Lee M.Talbot, and Guy J.-M. LeMoigne.

2. The Last Tree - Reclaiming the Environment in Tropical Asia, James Rush, 107 Pages, Asia Society, New York,N.Y.

3. Proceedings of All-India Seminar on Strategies For Drought Proofing and Management, February 6-7,1987, Water Management Forum, The Institution of Engineers(India), Bhaikaka Bhavan, Law College Road, Ahmedabad 380006.

4. Third National Convention of Civil Engineers, National Seminar on Planning, Construction, Operation And Maintenance of Canal System of Sardar Sarovar (Narmada) Project, February 13-15,1988, The Institution of Engineers (India), Gujarat Centre, Bhaikaka Bhavan, Law College Road, Ahmedabad 380006. Page I1/11.

5. World Bank Technical Paper Number 127, Watershed Development in Asia, Strategies and Technologies, 1990, John B. Doolette and William B. Magrath, Editors. Pages 7,8.

6. Bhoomiputra, April 1,1991, Page 23, and May 1,1991, Page 19.

7. "Indian Dam Site is Located Over Faults", A.N.Shah, Page 35, February 1992, Civil Engineering, American Society of Civil Engineers, New York, N.Y.

8. Page I1/7, Reference 4.

9. "Quake Fault Discovered Below College Building", September 16,1991, Engineering News Record, New York.

10. "Problems in Intraplate Seismogenesis and Earthquake Hazard, Leonardo Seeber, Page 143, Proceedings from the Symposium on Seismic Hazards, Ground Motions, Soil-Liquefaction and Engineering Practice in Eastern North America, October 20-22,1987, Edited by: K.H.Jacob, Technical Report NCEER-87-0025, December,1987, National Center for Earthquake Engineering Research, State University of New York at Buffalo.

11. Page 24, Reference 3.

12. Page T1/2 Table, and Table 2 on Page T1/2, Reference 4.

13. From Gujarat Samachar Newspaper, Circa August 1988.

14. Page 51, Worldwatch Paper 62, Water: Rethinking in an Age of Scarcity.

15. Bhoomiputra, April 16,1991, Page 22.

16. Pages 158-160, Reference 3.

17. "Combating Water Scarcity", Shri Nandubhai K.Patel, Retired Chief Engineer, December 7,1986, 12th IWWA Annual Day, Bhaikaka Bhavan, Near Law Garden, Ahmedabad 380006.

18. Bhoomiputra, February 16,1991, Page 23.

FIGURE 1.

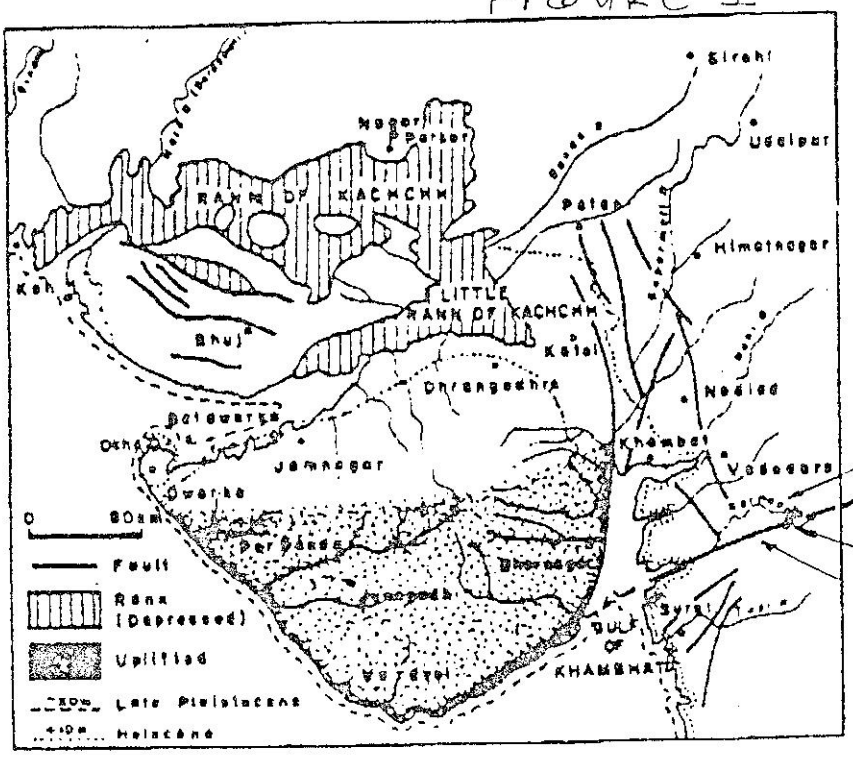


FIG. 15.1. The temple town of Dwarka is located in the area which has been subsiding and rising since the end of the Mahabharat times (~3000 years). The southern Saurashtra coast is, however, rising episodically as is manifest in the raised beaches. (After S.S. Merh, per. com. 1981).

~1600 Km

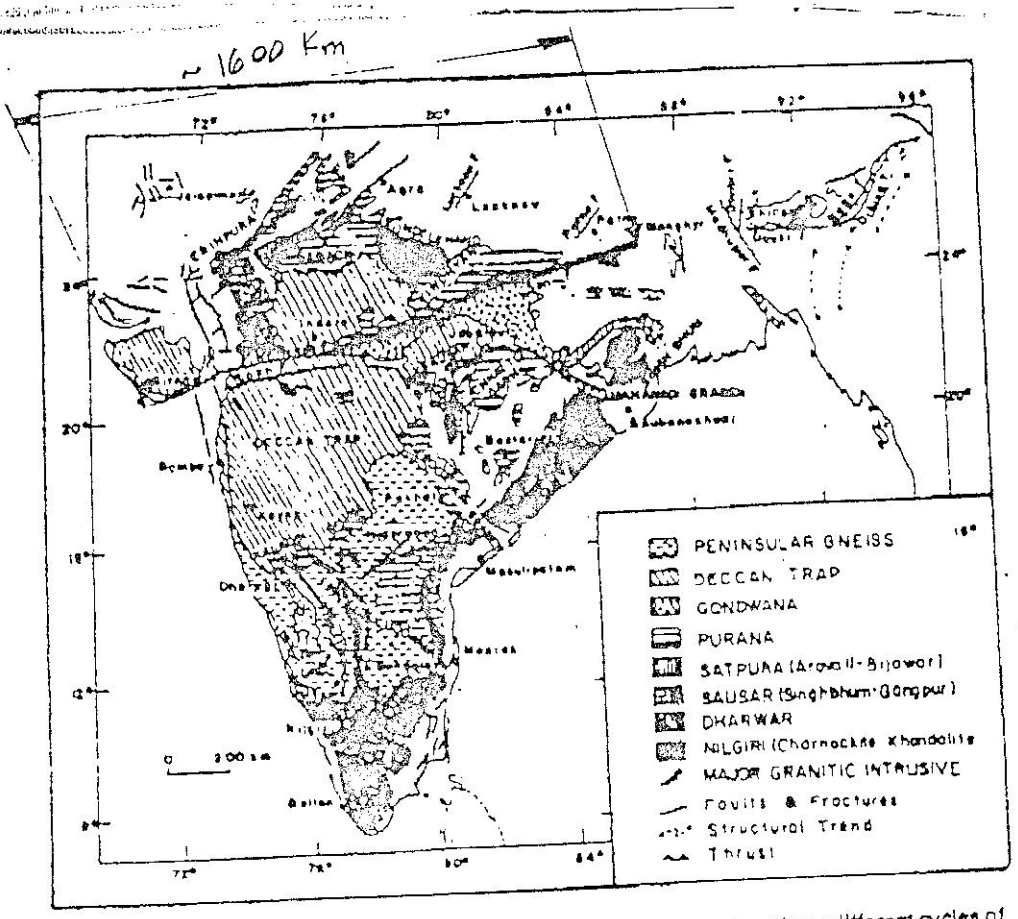
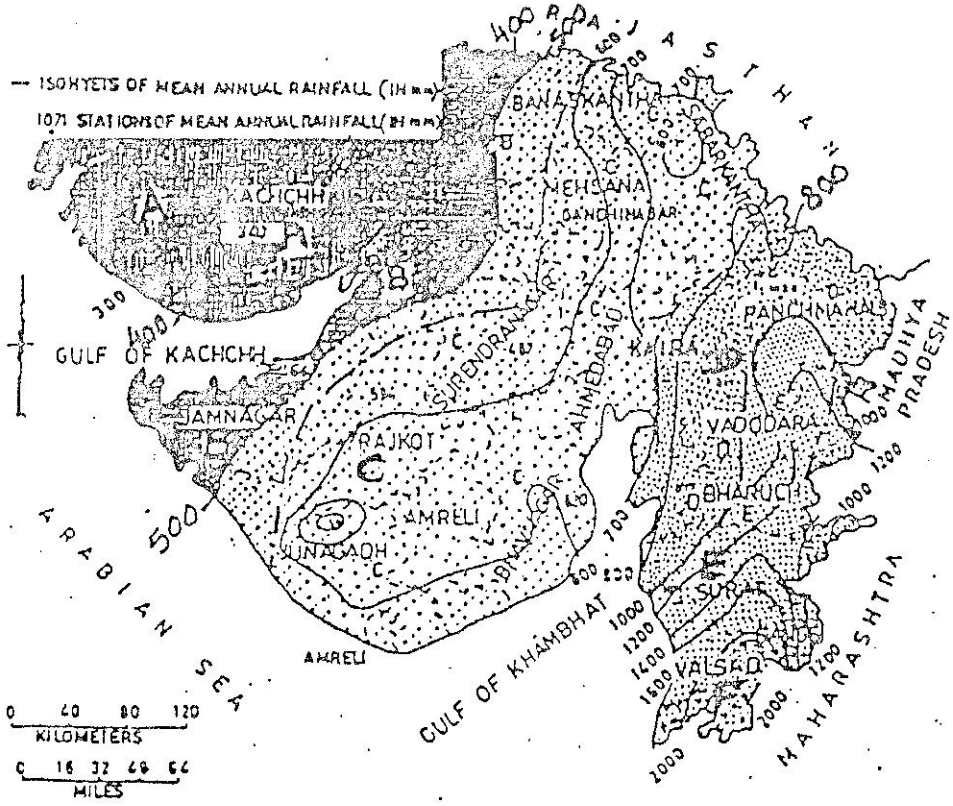


FIG. 7.5. The tectonic provinces of the Indian subcontinent which evolved from different cycles of orogeny panecontemporaneous with global orogenic cycles. (Valdiya, 1973)

GUJARAT
Isohyets and Irrigation Needs



IRRIGATION NEEDS	AREA SHOWN AS	(1) AREA OF STATE	(2) RANGE OF RAINFALL mm	(3) AREA M.Hs	(4) RAINFALL QUANTITY M.Ha-M	(5) POPULATION IN MILLIONS	(6) X (4) (5) PER CAPITA RAINFALL/DAY LITERS	GALLONS
EXCEPTIONALLY HIGH NEED to VERY HIGH NEED	A	16%	200-400	3.14	1.02	1.30	21436	5650
	B	11%	400-500	2.16	0.97	.90	29529	7812
HIGH NEED	C	46%	500-700	8.08	5.44	22.50	6624	1752
MODERATE NEED	D	18%	700-1000	3.14	2.87	8.07	9355	2134
MODERATE TO LOW NEED	E	10%	1000-1600	1.96	2.56	5.98	12343	3265
LOW NEED	F	1%	1600-2000	.2	.30	.56	17408	4469
TOTAL	—	100%	890 average	18.8	13.01	40.01	8909 STATE	2357 WIDE

1. CONVERSION: 1 Hectare = 2.47 Acres; 1 MHa-M = 8.1 MAF
2. Numbers in the table are estimated from the map or calculated as shown except the population figures which are the author's estimate.
3. For per capita potential of water, multiply column (6) by 0.3 for zones C to F, representing surface runoff and ground water recharge.

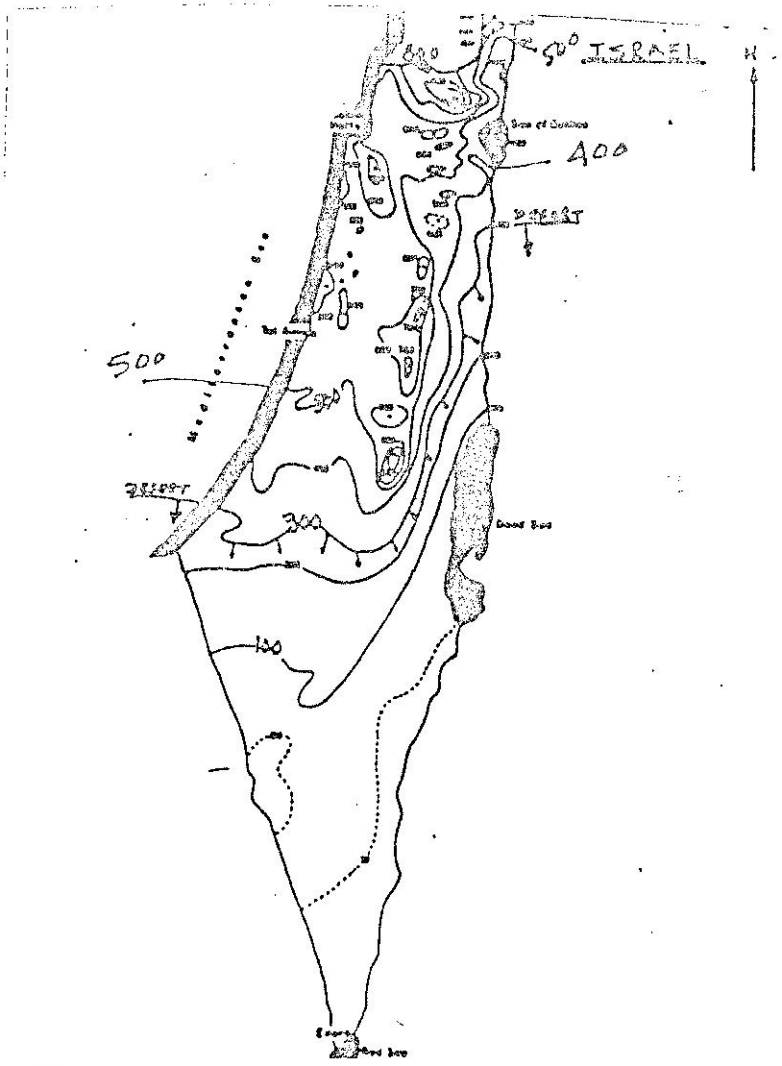


Fig. Average rainfall (1931–1960) in millimeters. (Data from Meteorological Service of Israel.)

FIGURE 2

TABLE-Estimate of Renewable Nonbrackish Resources		
Fresh Water Resources	MAC-F	MCM
Jordan River Lake Kinneret	.432	570
Groundwater 2 Large Aquifers	.639	830
Storm runoff interception	.025	.30
	1.216	1500
Renovated sewage effluents	.243	.300
Total	1.459	1800

Average rainfall (1931-1960) in millimeters

ATTACHMENT 1

READERS WRITE

of decisions that are currently being made. We are, by default, passing these decisions to others less capable. The question remains: Have we advanced to a point where a broad education, covering not only engineering but also the humanities and the other sciences, is beyond the reasonable expectation of our educational system?

RALPH M. HANSEN, M.ASCE
New Port Richey, Fla.

BRIDGE REHAB IS BAD IDEA

"Rehab to Start on Williamsburg Bridge" (News, CE October 1991) reports the $72 million first phase is to be completed by June 1994, after which the $400 million replacement of the approach and main span decks will commence. So, after spending $472 million, what will we have in 2000?

The main span will still have substandard, narrow lanes with no safety shoulders. The constriction at the towers will continue to make the passage an exciting and harrowing trip. The replacement, in kind, of two tracks of subway lines that run in the center of the bridge will lock in a bottleneck that now slows rush-hour commuters and creates rocking and impact stresses on the structure.

In addition to the above-noted points, the Metropolitan Transportation Authority has just begun seeking capital funds for a new East River tunnel to relieve congestion on Manhattan-bound subway routes. The right course of action should have been to build a new modern bridge and a subway tunnel to relieve the congestion.

The federal government and the state should have stuck to this approach, instead of caving in to an expedient, politically motivated solution that will set back needed transportation improvements for decades to come.

IRWIN FRUCHTMAN, M.ASCE
Brooklyn, N.Y.

INDIAN DAM SITE IS LOCATED OVER FAULTS

The World Bank–supported dam project Sardar Sarovar is mentioned in "The Case Against" section of "The Debate over Large Dams" (CE August 1991). The author reports that the project is opposed by social activists and the local population.

This dam, on India's Narmada River, is located directly on a major fault. I have taught geology for 22 years at a university in Baroda in the state of Gujarat, about 60 mi north of the dam site. My familiarity with the geology of the region indicates that the dam safety should be a matter of serious concern to all civil engineers regardless of their position on large dams.

Prevalent geological facts about western India are as follows:

The Narmada Valley is a rift valley. The Narmada fault further extends to the west and bounds the southern Saurashtra Peninsula, where neotectonic activities have been observed.

An earthquake in 1966, with a magnitude of 5.0, hit a Koyana reservoir, further south of Narmada Valley in western India. The area was considered seismically stable before this earthquake activity. On March 23, 1970, an earthquake with a magnitude of 5.4 hit the city of Bharuch, located on the Narmuda fault. Increasing seismic ac-

READERS WRITE

tivity has been observed since these earthquakes occurred.

The west coast of India is bounded by a north-south trending fault. The Koyana and Narmada faults trend east-west and intersect this major fault. Parallel to both of these are several north-south and east-west trending faults and fractures.

Some say the Narmada fault is an ancient Precambrian feature that is probably healed. But there is evidence that shows a possible reactivation of these faults in the current stress regime. These faults are associated with seismicity because they are zones of stress concentration rather than zones of weakness.

Taking these geological facts into consideration, the utmost safety precautions should be taken. The World Bank has appointed an independent commission to review the environmental and social aspects of this project. The concern over safety warrants an independent review conducted by a commission that includes engineers and scientists.

A.N. SHAH
New York

CORRECTION

In the December 1991 Members column, Carl R. Nelson should have been listed as the current director of public-works programs at Holmes & Narver, Orange, Calif.

MORE ANCHOR KNOWLEDGE NEEDED

"Anchors in the Desert" (CE December 1991) brings into focus the peculiar nature of the design, construction and contracting procedures of rock and soil anchor projects. The authors rightly attributed the success of the project to the practical contracting procedure adopted by the client. This procedure became a major motivating factor for the performance of the specialist contractor. Specifications do not have to be rigid to be rigorous and practical.

The anchorage industry, whether for anchorage into rock or tieback into soil, has many specialists who have succeeded (through experience on thousands of tiebacks) in developing products and unique procedures for getting the job done. Consequently, designers must avoid writing straitjacket specifications that may not allow for unforeseen situations.

The knowledgeable client should use performance specifications, thereby allowing the specialist contractor to control the many variables involved. Most American clientshave problems with this approach even though it has been adopted successfully all over Western Europe. This attitude can usually be traced to clients using consulting engineers who are inexperienced in the peculiar design of such structures, or to public agencies that have rigid specifications, stifling innovation.

Also, designers must broaden their base of knowledge. There is a need for research into the mechanics of load transfer from anchor to soil and the long-term performance of anchors in a corrosive environment. The cooperation of public funding agencies (such as the National Science Foundation), specialist contractors and university researchers is crucial.

JOE AKINMUSURU, M.ASCE
Lawrence Technological University

SARDAR SAROVAR PROJECT ON RIVER NARMADA

By Shri P.A. Raj
Addl. Chief Secretary
Narmada Development Department.

14th June, 1987

contact may be tight or open with the weakest members beign the agglomerate and red bole.

The geological investigations for the project commenced as far back as 1947, since then complete geological investigations have been made for the dam site including alternative sites considered so far and other appurtenant works.

The area in the vicinity of dam is dissected by eight faults.

(b) Treatment of Geological Fault

The treatment for the river bed fault was taken up in the year 1980. The fault zone was excavated upto elevation -16.0 m in the upstream and upto -8.0 m in downstream after carrying out obligatory pumping of water from stagnant pool in the fair weather river channel and clearance of silt deposited during 1979 monsoon. The concreting of fault one was taken up in March, 1981. The treatment of the river bed fault comprises removal of the weak material in the fault and its replacement by concrete which is reinforced near its bottom. Photo-elastic studies both two diamentional and three-diamensional determine the depth of the fault zone plug which was around 2.0 to 2.6 times the maximum width of the river bed fault. Detailed studies have been carried out by the Geological Survey of India and the State Geologists for last several years and Dam Design Review Panel. The issue regarding suspected activity of the fault and the type of dam to be constructed at Sardar Sarovar have been amply discussed at length with eminent experts and consultants of India and abroad. The concensus reached after various discussions was that there is no evidence at present to presume that the river bed fault is active. The possibility of significant movement along the fault plane met with in the seat of the dam is rule out, as the length of the fault is very short.

The work of the fault zone treatment was completed in the year 1984. Comprehensive scheme of instrumentation of the concrete plug was evolved in consultation with Central Water and Power Research Station. The treatment of the fault zone involved 2.56 lakh m^3 of precooled concrete (with placement temperature 9.0° - 12° C/50° - 55°F and 53,000 tonne of reinforcement steel and has cost about Rs. 17.5 crores.

(c) Treatment of weak layers in Foundations

Treatment for safety against sliding of the dam on argillicous sandstine layers on the right bank and redbole layer on the left bank was started in the year 1982-83. The treatment consists of excavation of longitudinal and transverse drifts in required grid in the red bole layer on the left bank and in two individual layers of argillaceous sandstone on the right bank and back-filling them with concrete/colcrete to provide grid of shear keys for resistance against sliding. Similar type of treatment has laso been provided on Itaipu dam, Brazil. The complete analysis for the treatment of foundation was done for the spillway blocks both by the conventional analysis and by Finite Element studies. The studies were carried out in-house and werevetted and okeyed by the Dam Design Review Panel. The foundation treatment for the red-bole layer has been completed since June, 1986 and the foundation treatment for the argillaceous sandstone layers is expected to be completed before June, 1987. The total cost of the treatment is expected to be about Rs. 15 crores.

4.3 Seismicity

The dam is located in a region which has experienced seismic action with largest occurence reported in 1938 having a magnitude of 6.25 on the Richter scale. The latest large one felt was at Broach in 1970. The seismic design parameters for the Dam have been evolved by the University of Roorkee, Department of Earthquake Engineering which have been subsequently vetted by the Members of the Dam Design Review Panel and other noted Experts in this field. The effective peak acceleration for the Maximum Credible Earthquake at the Dam site adopted is 0.25 g and the design Basis for Earthquake is 0.125 g for designing the dam sections, as recommended by the panel.

4.4 Layout and Configuration of the Dam Complex

The main dam will be a concrete gravity dam 1210 m long, 128 m high and will require

ATTACHMENT 3

PUBLIC INVOLVEMENT IN THE DECISION-MAKING PROCESS

Approved by the Professional Activities Committee
on July 15, 1986.
Approved by the Committee on Policy Review on July 17, 1986.
Adopted by the Board of Direction
on October 26, 1986.

Policy

It is the policy of the American Society of Civil Engineers to encourage its members to seek the involvement of individual citizens and advocacy groups in the decision-making processes at the local, state, and national levels with regard to engineered projects.

Issue

We are in a period of enhanced awareness of the long term effects that engineered projects of all types have on the lives of individuals. There is a general concern for the environment, a recognition of the sensitive balance of nature, and an understanding that our natural resources have finite limits.

Rationale

Civil engineers have a unique responsibility to develop clear statements of purpose, to illuminate the costs and benefits of proposed public actions, and to thereby assist the general public in making better informed decisions with regard to engineered projects.

Civil engineers are therefore encouraged to seek appropriate public involvement through

1. timely and thorough public information programs;
2. participation in public hearings;
3. accurate explanation of the consequences of project delay;
4. complete presentation and discussion of viable alternatives with regard to

    a) engineering impact
    b) environmental impact
    c) social impact
    d) economic impact

5. complete presentation and discussion of the "no-project" alternative.

Where proposed projects affect economically disadvantaged groups, ASCE encourages its members to provide information and as a public service to aid such groups in developing their advocacy positions.

PROJECT PEER REVIEW

Approved by the Professional Activities Committee on January 8, 1989.
Approved by the Committee on Policy Review on March 10, 1989.
Adopted by the Board of Direction on April 9, 1989.

Policy

It is the policy of the American Society of Civil Engineers to promote and support the use of project peer reviews for projects in the following categories:

- Projects where performance is critical to the public health and safety of large groups of the public using or affected by the facility.
- Projects where reliability of performance under emergency conditions is critical to national defense.
- Projects using new materials or techniques, projects particularly vulnerable because they lack redundancy in the design, or project types that have a poor performance record.
- Projects that have unique construction sequencing or a short/overlapping design-construction schedule.

Project peer reviews are initiated by the owner/client, the design organization, governmental approval agencies, or others. They are performed to address a defined scope as set forth by the initiating party. A project peer review should preferably take place throughout the design process.

Issue

Projects as described above are expected to meet extremely rigid standards of performance. Project peer review is a separate, important step in the design process for selected projects to provide an evaluation of design concepts and management to meet performance objectives. Reviews by teams or individuals within the project design team are not project peer reviews.

Rationale

Quality management of engineering projects is an important matter that has received increasing attention, partially as a result of dramatic failures and partially as a result of lesser problems in constructed projects. Among the several contributing factors, design practices represent one cause. Project peer review is an extra precaution that can, on those projects for which it is appropriate, add a measure of increased confidence that the design is adequate.

Professional leaders first proposed in 1983 that project peer reviews be used more frequently. Since that time, the project peer review concept has further evolved through a series of conferences and discussions. A survey of the professional leaders has confirmed that the concept has support for projects that are properly selected for this additional step, within guidelines for project peer review implementation that the joint ASCE/ACEC task force has been charged to develop.

RESPONSIBILITY FOR DAM SAFETY

Approved by the National Water Policy Committee on May 20, 1991.
Approved by the Committee on Policy Review on August 24, 1991.
Adopted by the Board of Direction on October 20, 1991.

Position

The American Society of Civil Engineers believes it is the responsibility of, and urges, the state governments to enact and fully enforce dam safety statutes for all non-federal dams to protect the health and welfare of their citizens. The Federal government should continue to take appropriate action to assure the safety of all federal dams and federally regulated dams.

ASCE endorses strict adherence to the following principles to maximize the safety of the public in the design, construction, operation and maintenance of dams.

1. The owner of a dam bears the basic responsibility for its safety.

2. Dam safety programs of government agencies should be reviewed regularly to maintain adequate supervision and oversight of all dams.

3. Performance of engineering for a dam must be done by qualified professionals. The exercise of experienced professional judgment is required in every stage of planning, analysis, design, construction and operation of a dam project and in evaluating and improving old dams.

4. All dam owners and all engineers responsible for the engineering of dams, must recognize that dam safety is the paramount consideration, and they should be alert for situations in which the public interest could be jeopardized and where economy must consequently be subordinated to safety.

5. Within an organization owning a dam, the individual responsibility and accountability for dam safety must be defined clearly.

6. Persons designing a dam project must be involved in inspection and oversight throughout its construction. Persons responsible for inspection of construction and contractors, must be fully trained, with direct access to knowledgeable professionals who can furnish advice.

7. Operation and maintenance personnel at dams should be selected based on sufficient relevant experience and training for their specific duties in safe dam operation, inspection, maintenance and emergency procedures.

8. The design for every new dam must be based on site investigations and geological explorations of all affected areas consistent with the importance of the dam, the potential life and property hazards, and anticipated design and construction problems.

9. Design criteria and standards for static and dynamic loadings used for dams must be consistent with the importance of the dam, and potential hazards created by the project, and must reflect generally recognized and accepted modern practices in dam engineering. Redundant and defensive systems must be utilized to enhance safety.

10. Hydrological relationships used to evaluate project effects, and to design project components, must be based on thorough analyses of local and regional hydrologic records. The theoretical probable maximum flood (PMF) potential of the basin must be considered in designing any dam where lives and property in downstream areas may be affected.

11. Seismic hazards must be evaluated based upon the tectoni regime of influence, and must consider levels of magnitude and associated ground motions consistent with the potential hazards created by the existence of the dam. While some damage to the dam may be allowable, the dynamic response of the dam must assure safe retention of the reservoir content. The maximum credible earthquake (MCE) for the site should be considered in designing any dam where lives and property in downstream areas may be affected.

12. All phases of design and construction of dams, to be located where failure could cause significant flooding in areas downstream with attendant hazard to life and property, must receive an independent review by qualified engineers and geologists.

13. During construction of a dam, the owner is responsible for an adequate program of inspection and testing to assure that the work complies with the intent of plans and specifications. When unanticipated conditions are encountered, personnel responsible for design must determine appropriate changes in plans and specifications.

14. During the initial filling of a new reservoir, there must be close control of the filling rate, where possible, and extensive scrutiny of the effects of the initial filling. Rapid drawdown procedures for embankment dams should be closely controlled by a qualified engineer to prevent possible slope failure.

15. For each dam there should be sufficient documentation and centralized record retention of site exploration, design concepts, construction procedures and problems, as-built drawings, project operations, and maintenance activities to

provide bases for evaluation of changes subsequently observed and background for study of problems that may be encountered.

16. A surveillance and periodic inspection program must be performed for each dam, the scope and frequency of which is consistent with the dam's importance, condition, and the degree of downstream hazard. The periodic inspections must be accomplished by engineers and geologists able to evaluate observed conditions in light of design assumptions. There should be baseline data, taken during and after construction, to which all future data can be compared.

17. Older dam projects must be subject to thorough design reevaluation on a systematic schedule, when observed conditions of the dam change, and when there are significant changes in the pertinent technologies involved in the design, construction, and operation of dams. Reevaluation must also be considered when operating plans are changed and when there are changes in conditions in the vicinity of the dams, particularly development of downstream areas.

18. For a dam that represents a significant or high potential hazard to downstream areas, detailed operation plans to protect public safety must be developed, particularly for operations during extreme flood conditions when primary communication systems may not function. In addition, contingency plans for emergency project operations, notifications to civil authorities and warnings of need for evacuation must be developed for use when the safety of the dam is threatened. The plan should define areas that could be inundated and should be coordinated with the local law enforcement and civil defense authorities.

19. In those cases where federally constructed dams ultimately fall under state jurisdiction with regard to safety, input from the state should be provided during design and construction of the dams.

Issue

Public attention to the safety of dams among states has varied, except for short periods immediately following failures. An extensive inventory of dams in the United States has revealed thousands of dams that are potential hazards to lives and property in downstream areas. Under an inspection program performed under the National Dam Inspection Act, P.L. 92-367, hundreds of dams were rated unsafe, either because of readily observed structural deficiencies or because of inadequate spillway capacities. This inspection program revealed a significant national problem in protecting the public from the dangers of unsafe dams, but did not generate a public demand for remediation.

Rationale

ASCE is concerned about dam safety because the construction and operation of a dam introduce real elements of risk into the lives and to the property of all who might be affected by the failure of the dam. Often those persons do not directly benefit from the impoundment. Generally there is no direct recognition of being placed in jeopardy and, because possible damages from a failure are speculative, persons jeopardized have no legal recourse against the dam's owner prior to actually suffering damages, except through limited statutory proceedings. Thus, risks to other parties created by an impoundment impose on the dam owner legal, social and moral responsibilities to construct, operate and maintain the dam in a safe manner.

In recognition of the distinct public safety responsibilities accompanying dam ownership, most states have asserted their police authority by adopting legislation to provide for regulation, in the interest of safety, of the design, construction, operation and maintenance of dams within their respective borders. However, some states have no dam safety statutes; others have weak legislative authority to enforce dam safety measures. A great number of states have not provided the manpower and funds needed for effective regulation of dams in the interest of public safety.

REFERENCE 11

ATTACHMENT 4

India Metereological Department and the State Government :

(i) Meteorological Data;

(ii) Revenue Remissions;

(iii) The frequency of famine or scarcity, and

(iv) The availability of irrigation facilities.

After considering the meteorological criteria, the distribution of rainfall, the variability in rainfall and the adequacy of rain fall the Commission has sought to identify drought areas and chronically drought affected areas as follows :

(a) Drought areas :

Areas having 20% probability of rainfall departures of more than minus 25% from the normal.

(b) Chronically drought affected areas :

Areas having 40% probability of rainfall departures of more than minus 25%.

They have further stated that such of the Taluks, which enjoy an irrigation of 30% or more of the cultivated area should be excluded from the list of drought affected areas.

7. It is in this context that the theme of management of available waters for drinking purposes of human beings and their animals and for raising crops by irrigation comes in.

Priorities for Water Use

8. In such a planned management we have to fix up priorities for the different uses of available limited quantity of waters. On deep consideration it appears the competing priorities will have to be given below in the descending order :

(i) The first charge on the available scant water resources should be the drinking water needs of human beings and of the animals raised and maintained by these human beings.

(ii) The second charge shall be that particular need which will generate employment opportunities to as large a section of the drought affected people as possible so that they can earn money power to buy food for themselves and fodder for their animals which can be imported from surplus areas. Such income generating avenues may be by way of labour intensive industries (cottage, home, small scale, medium scale or major), handicrafts, village industries consuming little water.

(iii) The third charge shall be for grass farming, tree farming, animal husbandry like sheep, pig and poultry farming, which do not require any one particular type of food or fodder but can survive and thrive on waste material, bushes and shrubs. These will give income generating opportunities to the people.

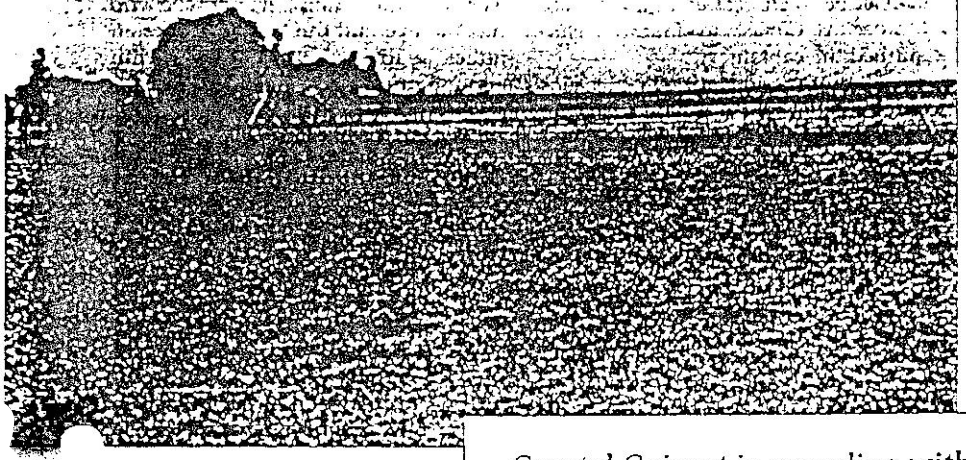
(iv) The fourth charge shall be growing hard food crops which can survive long spells of dry weather without wilting and can flourish even on ill-distributed scanty rainfall.

9. Talking about tree crops in Karnataka it may be pointed out here that casurina plantations are expanding fast in several areas which serve the needs of firewood and also provide long poles for such pur-

ATTACHMENT 5

SAURASHTRA

Tears of Salt



Coastal Gujarat is grappling with a man-made environmental disaster: 1.2 million hectares of fertile land has turned saline, affecting over 1.33 million people in 779 villages.

THE VILLAGERS in Saurashtra pride themselves on their hospitality. No visitor to this western corner of the country is allowed to return without having a cup of tea and home-made snacks. But the times are changing, and serving tea has become a problem in many of Saurashtra's villages—not because the villagers are any less hospitable but because tea cannot be made with the saline water available in the area as it spoils the milk.

Coastal Gujarat is grappling with a man-made environmental disaster: 1.2 million hectares of fertile land stretching for 1,059 km between Bhavnagar and Lakhpat has turned saline, affecting over 1.33 million people in 779 villages. The area between Una and Madhavpur is the worst affected, with salinity ingress reaching 10 km inland and affecting 120 villages in the Junagadh and Amreli districts.

The residents of the area had never dreamt that such a fate would befall them. In the 1960s, Gujarati poets had been inspired to write poems on this lush area, calling it "Lili Nager" (green creeper). The area was dotted with prosperous fruit plantations and fields of sugarcane and groundnut. But now, for miles on end, not a blade of grass grows and the reassuring beat of diesel pumps has been replaced by a deathly silence.

Prosperous farmers have been forced to leave their fields and become menial labourers in nearby areas. Laments Baval Sidi, whose four acres of land in Miyani village of Junagadh district was blighted by saline water: "My land is useless. No one wants to buy it and I have been reduced to a labourer."

Ironically, coastal Saurashtra's fertility contributed in no small measure to this distressing state of affairs. In the zeal to usher in a green revolution in this fertile tract, the state Government in the mid-1960s liberally granted loans to farmers to install irrigation pumps. Soon an astonishing 90 per cent of the fields had diesel pumps. The withdrawal of groundwater increased fivefold. Crops like sugarcane—which require large amounts of water—flourished and sugar factories sprang up in places like Talala.

But the revolution upset the delicate balance of nature. Rainfall used to replenish the water table and thereby keep sea water at bay. But the massive withdrawals of water led to a steep drop in the water table, and sea water seeped in. In 1974, Mangrol's water table was 22 feet below the surface; today it is 40 feet and the wells on the coast have become brackish. Worse, many farmers realised too late that the water had turned brackish and continued to use it for irrigating their fields, ruining the top soil.

Environmentalists like Lavkumar Khacher had sounded warnings of disaster over a decade ago, but his was a voice in the wilderness. Khacher says today with some bitterness: "When we warned people, they laughed at us and dismissed us as idealistic dreamers."

Consecutive droughts from 1972 to 1974 led to the water table falling further, and the sea water flowed in. Wells in villages like Adri, Sutrapada, Dhamlej, Antroli and Shil registered a staggering salt content of 10,000 parts per million (PPM). Water becomes undrinkable after 600 PPM and unfit for irrigation after 2,000 PPM. Sea water has a salt content of 30,000 to 40,000 PPM. Predictably, crop yields plummeted. In the area between Una and Madhavpur, the mango yield fell from 40 tonnes per acre in the early 1970s to 20 tonnes, coconut from 20,000 nuts to 8,000 per acre, bananas from 19 to 10 tonnes, sugarcane from 110 to 55 tonnes and bajra from 2,800 kg to 1,400 kg. Farmer Kana Barad of Badalpara village in Junagadh district ruefully examines the sickly-looking jowar in his fields and voices a common local sentiment: "Only God can help us now."

Land prices have fallen dramatically, when there are buyers at all. Prices in the mid-1960s used to range up to Rs 25,000 or more per acre, but now most land goes abegging. "There are no buyers," says farmer Naga Narain, whose two acres lie barren in the hot sun.

Some cultivation is still possible in many places because the farmers depend on the rains to provide one rain-fed crop a year. Many farmers have also switched to crops like cotton and groundnut as these need 80 per cent less water than sugarcane, bananas and other fruits. But even one crop a year is often not possible, because the monsoons fail, as happened this year. Some, like Laka Rana Vala, pay a heavy price when this happens. Vala had sown 370 kg of wheat, resting his hopes on the monsoon. Today, he is a broken man, and his torn clothes and gaunt cheek-bones tell the tale of a pauper even though he owns 10 acres of land.

Polarama Barad talks nostalgically of the time his parents in Adri used to grow fruits on their six-acre farm. "It was very profitable," he recalls but now, the field is used to grow only one crop of rain-fed groundnut. And it speaks volumes that among the 'happiest' farmers in the area today is Varjang Barad, who owns two

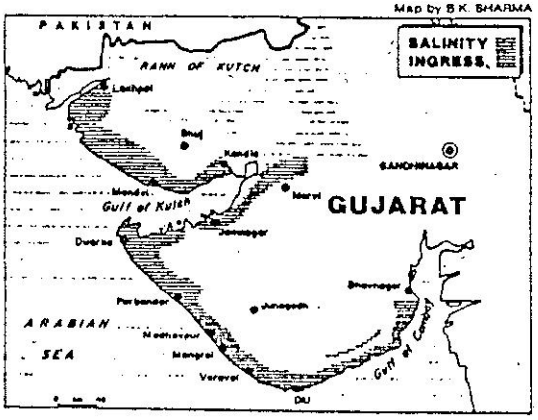
acres in the same village. His groundnut crop fetched him Rs 4,000, enabling him to make a profit of Rs 1,000. "It is ridiculous to think that I can be happy with earning such a small amount in a whole year, but 90 per cent of the farmers lost everything they sowed," he says.

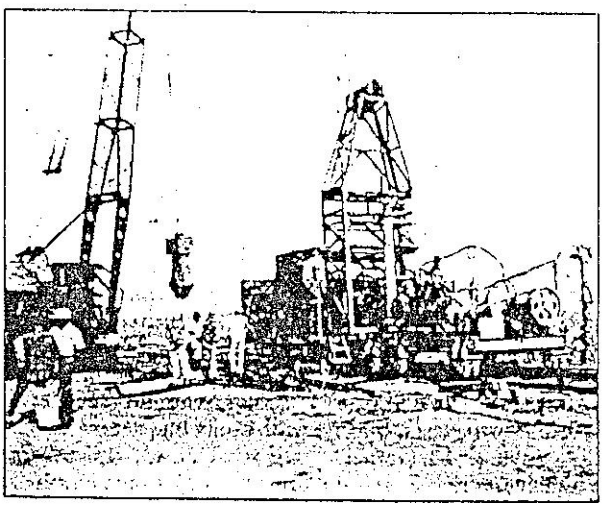
Driven by poverty, most of the Adri villagers desperately want to sell their cattle but refrain from doing so for fear that they will end up in the slaughterhouse. Says Barad: "Bullocks have been the mainstay of our lives. If they have to die, let them die in our courtyards." Many farmers have begun migrating in search of work. But others, like Kanabhai Haridas, refuse to consider that option: "We were born here and we will die here. How can we leave our land behind? All these years it gave us so much." Haridas sold his family jewellery last year for Rs 5,000 as there was nothing to eat.

Awakening to persistent complaints from villagers in Saurashtra, the state Government appointed a committee in 1974 under the then chief secretary H.K.L. Capoor to go into the complaints. The report unequivocally stated the only solution was to artificially recharge the subsoil with water. The catch: it would cost a staggering Rs 65 crore just to reclaim the 160 km stretch of land between Una and Madhavpur. So the report was shelved. But as the salinity problem got worse, another committee was appointed in 1978 under Capoor's successor, K.Shivraj. This committee recommended bunds on rivers, artificial recharging of the subsoil with water, massive afforestation and other measures—and the cost had escalated to a whopping Rs 800 crore. The Government finally started moving in a small way—a Rs 36 crore plan was drawn up, with Rs 24 crore coming from the World Bank alone.

A spate of construction is now under way in the area for erecting 150 checkdams, two tidal regulators (to prevent sea water from entering dry rivers during high tide), and bunds across rivers to facilitate water storage, while an afforestation drive is on along the coast. The most ambitious project is the Rs 6.27-crore Medha Creek project—a concrete bund to prevent the sea from flooding flat land. When completed in 1990, it will also help store 1,340 million cubic feet of fresh water, thereby recharging the water table and irrigating over 10,000 acres of land in Junagadh and Jamnagar districts.

However, all this is confined to the 160 km belt. The rest of the coastal area still cries out for attention. But a senior state government official offered little hope: "Finances do not permit us to even think of what we can start doing in the other areas," he said. Officials are also sceptical about how the Government is going to get the Rs 800 crore it needs for further conservation work, and the fact that this is the first time in the country that such a multi-disciplinary effort is under way makes the going even tougher.





Construction at Medha Creek: ambitious project

But the limited effort already made has started showing results. The Irrigation Department—which has been closely monitoring salinity levels in 1,500 wells—indicated that 15,000 of the one lakh acres affected by salinity had improved, and farmers had started cultivating them. Salinity levels in wells near bunds or tidal regulators had dropped, and wells in 35 villages had become potable again. But with the failure of the monsoon, salinity levels had once again shown an increase last month. Says J.F.Mistry, irrigation secretary: "Our projects can only be successful if there is enough rain. We cannot fight nature."

The situation is likely to get worse in the coming months as none of the checkdams now hold water, making sea water ingress inevitable. And since the rock strata all along the Saurashtra coast are of miliolite limestone—full of cavities and very porous—water easily flows in. But 10 km ahead, the formation ceases and non-porous rock checks sea water ingress. And a checkdam in Visenvel village in Junagadh district wards off sea water while stopping the river water from flowing into the sea. Turmohammed Daud, who lives near the checkdam, says his wheat crop is now flourishing. "If more such dams come up thousands of farmers will be freed from the curse of salinity," he says.

Rather late in the day, the Government has also decided not to permit any more well energisation in the coastal zone, and the land development bank and commercial banks have been restrained from advancing loans for buying motors. But this is hardly enough. Capoor and Shivraj had called for water legislation to prevent farmers from drawing excess water. "It is impossible to tell a farmer that he should use water sparsely as that would stunt his profits," laments geologist Anil Bhatnagar. "The legislation will ensure that water becomes fit for irrigation purposes, but if the farmers start withdrawing too much we will have the old problem again on our hands."

Water legislation is one solution, but as Chief Minister Amarsinh Chaudhary pointed out "it will be politically impossible." The multi-dimensional plan for all of coastal Gujarat seems equally unlikely because of the state government's shortage of funds. Said Chaudhary: "We may need about Rs 1,000 crore to control salinity for which we will have to ask the World Bank for loans. And we do not know whether such a huge loan will be possible." And there is no third solution in sight at the moment. In that situation, the thousands of farmers in Saurashtra may be fated to see only mirages of fresh water.

—RAMESH MENON in Veraval and Porbandar