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**Water resources management related to the Indo-dutch  
rural water supply and sanitation programme**

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**AN OVERVIEW OF PROBLEMS AND ACTIVITIES**

INTERNATIONAL WATER SERVICE CENTRE  
FOR RURAL WATER SUPPLY AND  
SANITATION

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## ***PREFACE***

This paper presents an overview of water resources management problems which relate to the Netherlands Supported Integrated Rural Water Supply and Sanitation Projects in India. These projects are carried out by Indian organizations in five states (Andhra Pradesh, Gujarat, Karnataka, Kerala and Uttar Pradesh). The governments of India and The Netherlands have been cooperating in the rural water sector for over 12 years. Gradually, the projects have taken on a more integrated character, in which rural water supply, community participation, involvement of women, health education and sanitation are part and parcel of the overall approach.

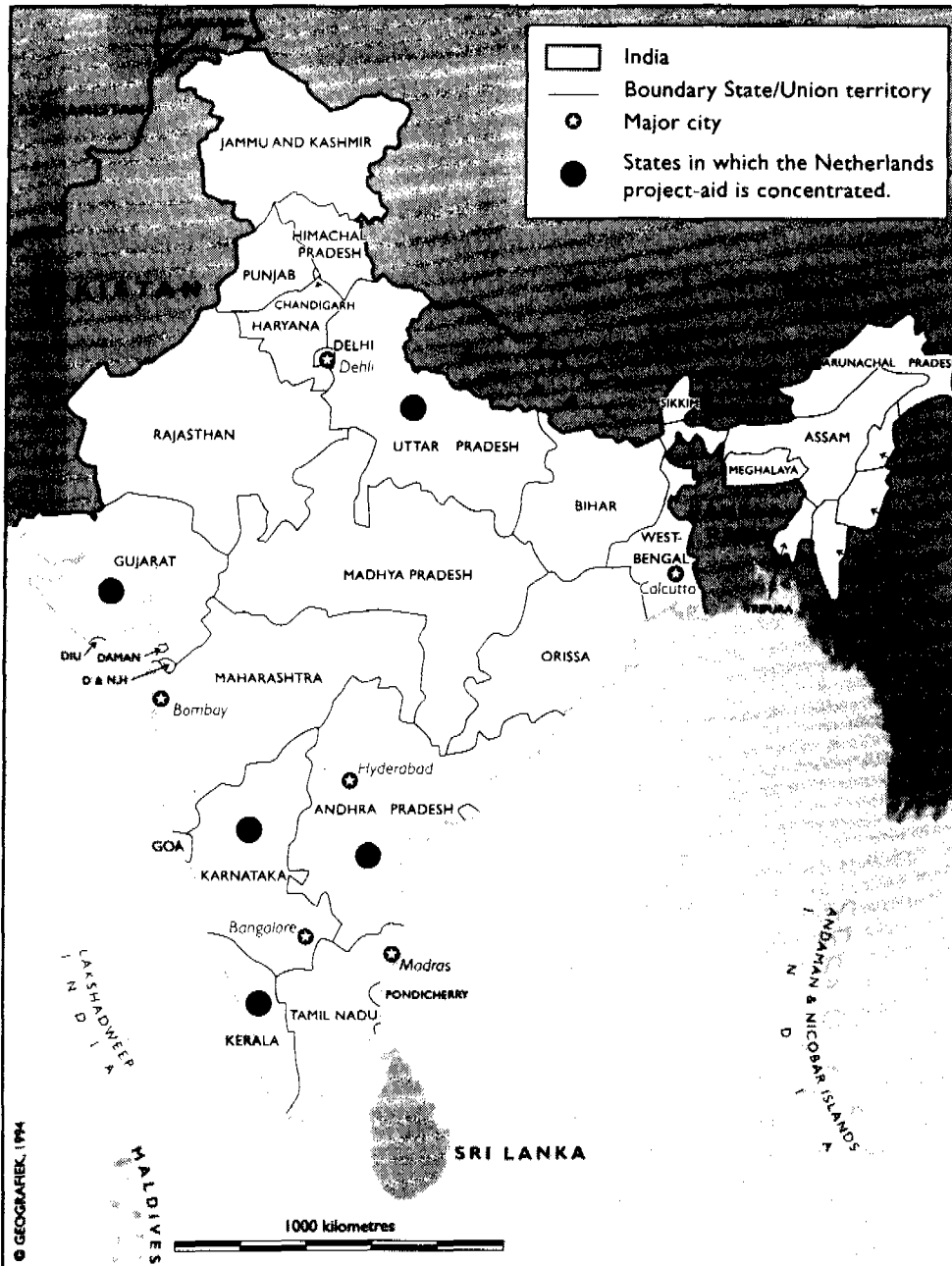
Water resources management is an issue, which to varying degrees has been addressed in the projects. First activities in the case of Gujarat, for example, date back to 1986 and there the Review and Support Mission (RSM) has kept it on the agenda continuously. In recent years, the recognition of the importance of water resources management is increasing internationally. Therefore the South Asian Country Section of the Directorate-General for International Cooperation of the Netherlands Ministry of Foreign Affairs requested Mr Jan Teun Visscher and Ms. Christine van Wijk of IRC to prepare this overview paper.

The paper has been prepared on the basis of a review of the different reports of the RSMs and other documentation. Thereafter very useful comments on to the first draft were received from the members of the RSM's and particularly: Mr Jan van Griethuysen, Mr Rob Wijdemans, Mr Rob Trietsch and Mr Sjef Gussenhoven. Comments were also received from Mr Carel Brands from the Embassy. In this second draft some guiding principles on key issues have been included which will help to improve current and particularly future projects. These principles now need to be reviewed and expanded with help of the different persons involved in the programme and the Government agencies involved in water resources management in India.



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- Based upon Survey of India Outline Map printed in 1987.
- The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate baseline.
- The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Areas (Reorganisation) Act 1971, but has yet to be verified.
- Responsibility for correctness of internal details shown on the map rests with the publisher.

Figure 1. Map of India with indications of states with NAP schemes

## 1. INTRODUCTION

"Scarcity and misuse of fresh water pose a serious threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystems on which they depend, are all at risk, unless water and land resources are managed more effectively than they have been in the past" (WMO, 1993). Competition for limited fresh water sources is growing quickly among households, industry and agriculture, while the resource itself becomes more scarce due to increasing pollution, poor land and water management and higher consumption levels. Already 26 countries are facing water scarcity, having less than 1000 m<sup>3</sup> of renewable water per capita per year, which is likely to pose severe restrictions to economic growth. Such restrictions may also occur in countries with water stress, having between 1000 and 1700 m<sup>3</sup> of water per capita per year (Waterfront). By 2025 more than 40% of the world population, including India, will be facing such conditions (Engelman et al, 1993). But even now the situation is quite critical as a large proportion of rural water systems in India are groundwater-based, and are in danger of depletion from excessive and uncontrolled extraction, primarily for agriculture. Furthermore, tapping new water sources is becoming more difficult and cost involved have tripled over the last decade.

Many documents on ecological degradation in India acknowledge that women are the most affected by the destruction of natural resources. The more so because "domestic water supply receives low priority partly as a result of the cultural and ideological background of patriarchal values concerning women and water scarcity is seen as a consequence of drought. This water scarcity, however, influences gender relations through male-out migration and changes in control over the scarce water by men of higher castes or clans. So the problem of water scarcity and rural women is very much related" (Rao, 1991).

The March 1994 Ministerial Conference in Noordwijk, the June 1992 World Summit in Rio and the January 1992 International Conference on Water and Environment (ICWE) in Dublin have endorsed the need for urgent action concerning water resources management (WRM) and give indications about strategies to follow. They call for strengthening international cooperation for sustainable development to support and complement the efforts of developing countries in WRM. The working definition of WRM as used in this document is presented in Box 1.

### **Box 1: Definition of water resources management**

'Water resources' means fresh water in the broad sense as available for use and susceptible to human interventions. 'Water' can be surface or groundwater, and is characterized by both quantity and quality.

'Management' means integrated management, covering all phases of resources planning, development, use and protection, i.e. assessment, planning, implementation, operation and maintenance and monitoring and control. It includes both 'demand management' and 'combined resources and supply management'.

'Integrated' means management of water resources as regards their development, use and protection, and considering all sectors and institutions which use and affect water resources (cross-sectoral integration).

'Integrated water management' may be interpreted as integrated 'land and water management' to the extent that land management measures affect the supply and quality of water resources.

(Adapted from Nordic Freshwater Initiative, 1992)

WRM is rapidly gaining importance. The World Bank, for example, has announced a dramatic shift in their water policy that will quadruple its spending rate for water resource development and will move away from building individual water supply projects.

Future loans will focus on environmentally sustainable, river basin-wide, comprehensive, water resources management-oriented projects. Loan decisions will be guided by three basic principles: improved management, cost recovery and privatization. Governments will have a new role under this scenario. They will become less involved in water supply and more in promoting institutional and legal measures to protect and enhance water quality and to ensure better water distribution amongst the different users. Increased efficiency in water utilization is another key principle as the bank found, for example, that some older irrigation projects now yield crops of less value than the water itself. New lending thus will shift to issues such as drip irrigation and enhanced management approaches (Lampietti, 1994).

The Indian Government has actively participated in the various international meetings and hosted the end of the Water Decade meeting in Delhi. In September 1987 the Indian Government adopted a national policy for WRM as further detailed in section 5.3. This policy calls for an integrated approach to WRM but giving priority to domestic water supply. It also indicates that water resources planning has to be undertaken for a hydrological unit, such as a drainage basin, and advocates the establishment of multi-disciplinary cells in each state to prepare for comprehensive basin-wide master plans. While national and state policies place high priorities on drinking water supply, in practice regulation of water use is dominated at state level by the Irrigation Department, which gives priority to agricultural interests. No mechanisms exist to protect wells and settle disputes on water use (Panfil, 1995).

In the Netherlands assisted projects in India a range of WRM problems exist, which are being discussed under broad headings related to water availability, quality and utilization in respectively Chapters 2, 3 and 4. In Chapter 5 the most important strategies and ideas for improvements and solutions have been formulated and Chapter 6 suggests guiding principles for the Netherlands assisted projects.

## 2. WATER AVAILABILITY

### 2.1 Rainfall and available resources

The Indian climate differs considerably over its vast area. It is characterized by a monsoon period spread over three months beginning in June in which about 80% of the annual precipitation falls. The complex system of monsoon winds and the orientation of the mountains causes low rainfall in some regions and floods in others. Twelve percent of the land receives below 400 mm of rain per year, 35 percent less than 750 mm. Out of the total cultivated area of 176 million ha, 56 million ha are subject to highly variable rainfall and 51 million ha has been identified as drought-prone. On the other hand 12 percent of the country, 40 million ha, is vulnerable to floods, which are more frequent in the eastern part of the Ganges basin and the northeastern part of the country.

Drought has been common in India for centuries as part of the uncertainty associated with tropical weather conditions. In India a 25% below normal rainfall is considered moderate drought and a 50% below, serious drought.

Rainfall figures vary considerably for the states in which Netherlands Assisted Projects (NAP) are being implemented (Table 1). In absolute terms the project areas in the north of Gujarat which is known as a dry state, receive the lowest rainfall (400 mm/yr), whereas Southern Gujarat may receive around 2000 mm/yr. Kerala receives the highest quantity (3500 mm/yr) but also coastal Karnataka receives this amount, whereas Darwhad district in Karnataka receives an average rainfall of 718 mm/yr, 60% falling during the pre-monsoon between January and May. Bijapur district receives 507 mm/yr with some 65% falling between June and September.

Table 1. Overview of rainfall and population data, 1991

Region	Population (millions)	Population density/km <sup>2</sup>	Surface area (million ha)	Average Annual Rainfall (mm/yr)*
India	860	260	329	1075
Andhra Pradesh	66	240	27.5	750 - 1000
Gujarat	41	209	19.6	400 - 1500
Karnataka	45	234	19.2	450 - 1250
Kerala	29	744	3.9	2500 - 3500
Uttar Pradesh	138	469	29.4	800 - 1750

\* Range concerns variation throughout the state

In 1947, per capita availability of renewable water in India was 5,150 m<sup>3</sup>, which in 1991 fell to 2,200 m<sup>3</sup> because of population growth. Using the UN medium population projection and assuming that no major climatic changes will occur, India will become a country facing water stress before 2020 with a per capita availability of water below 1700 m<sup>3</sup> (Engelman et al, 1993). In terms of available renewable water no data exist on the five states, but even Kerala with its abundant rainfall does not have plentiful water because of the much higher population density of 744 persons per km<sup>2</sup>.



## 2.2 Actual and projected water demand

Agriculture accounts for some 85 percent of the present water demand in India, but demand from domestic and industrial sectors is growing because of urbanization and industrialization. Table 2 shows an estimate of the actual and projected water demand. This demand is based on an average for domestic water supply of 80 lpcd for 1990, 88 lpcd for 2000 and 105 lpcd for 2025.

Table 2. Projected water requirements for India, in billions m<sup>3</sup>

Sector	1990	2000	2025
Domestic	25	33	52
Irrigation	460	630	770
Energy	19	27	71
Industry	15	30	120
Others	33	30	37
Total	552	750	1050
Surface water share	362	500	700
Groundwater share	190	250	350

source: Central Water Commission, 1990

The current water supply systems are being designed at per capita supply figures ranging from 40 to 55 lpcd for public standposts and 100 to 140 lpcd for private connections. The 1986 guidelines for implementation of accelerated rural water supply programmes refuse house connections and indicate design criteria of 40 lpcd and as an exception 70 lpcd to include cattle watering in dry areas. In the Netherlands assisted projects in Gujarat, for example, water is scarce, and the NAP schemes are designed for standpost supply with 55 lpcd including provision for cattle (10 lpcd) and water losses (5 lpcd). Most NAP schemes in UP are handpump-based and fall easily within the guidelines, but under the new arrangement for the SP IA, SP IV and SP VII schemes which combine piped supply with metered house connections with handpumps, the per capita supply for these house connections are likely to go considerably over the design guidelines. In AP the standard design is 60 lpcd and 70 lpcd when cattle are also to be provided. Since March 1993 the Government of AP has agreed to also include house connections in new schemes with supply projections of 90 lpcd (AP 27). In Karnataka NAP scheme designs are based on a consolidated supply rate (including small non-domestic demands and water loss) of respectively 46, 55 and 70 lpcd for villages below 1,000, between 1,000 and 10,000 and above 10,000 population.

Although the present NAP schemes are within the levels used for the demand projections, it may be expected that with increasing development levels domestic water supply will require a larger share of available water resources. This is already noticeable in the pressure from consumers to obtain house connections. If systems were to operate on a 24-hour supply basis this pressure may even increase. Nevertheless, in comparison with agriculture domestic water demand will remain low.

### 3. PROBLEMS RELATING TO WATER AVAILABILITY

#### 3.1 Lowering of groundwater table

Mining of groundwater is reported to varying degrees in all states and can lead to considerable *groundwater depletion* even under conditions of normal rainfall (Table 3). The situation is most serious in Gujarat. In this state, surface water availability is particularly limited throughout the north, putting a high strain on groundwater, which is used for over 76 percent of the irrigated area in the state and is also the basic source of supply for many municipal and industrial uses. Groundwater maps prepared by the Central Groundwater Board (CGWB) for the period 1979-1987 show drops of over 2m throughout Gujarat excluding canal command areas. In large areas the decline was over 4m and in others even over 8m. In addition to long-term drops in the water table, seasonal depletion - wells running dry for substantial portions of the year - is emerging as a major problem in many hard rock areas of Gujarat. Since well levels are monitored only twice a year, available data do not capture seasonal dynamics (Moench, 1992).

Continuous monitoring of the water sources for the NAP schemes in Gujarat, which has been introduced on recommendation of the RSM, show similar trends. In the Shihori well field, the source for the Santalpur scheme, the water table in the tube wells has been dropping at a rate of two metres per year (Figure 2). In October 1990 the RSM report indicated an average fall of three metres since 1986 and an expected lifetime of the well field of another 10 years, by lowering the pumping equipment from 30 to 60 metres, which implies higher pumping costs. Yet in 1994, the water table did not fall, for the first time in many years, thanks to the heavy monsoon (750 mm of rain vs an average of 540 mm). However, this is likely to have only a temporary effect (GU 31).

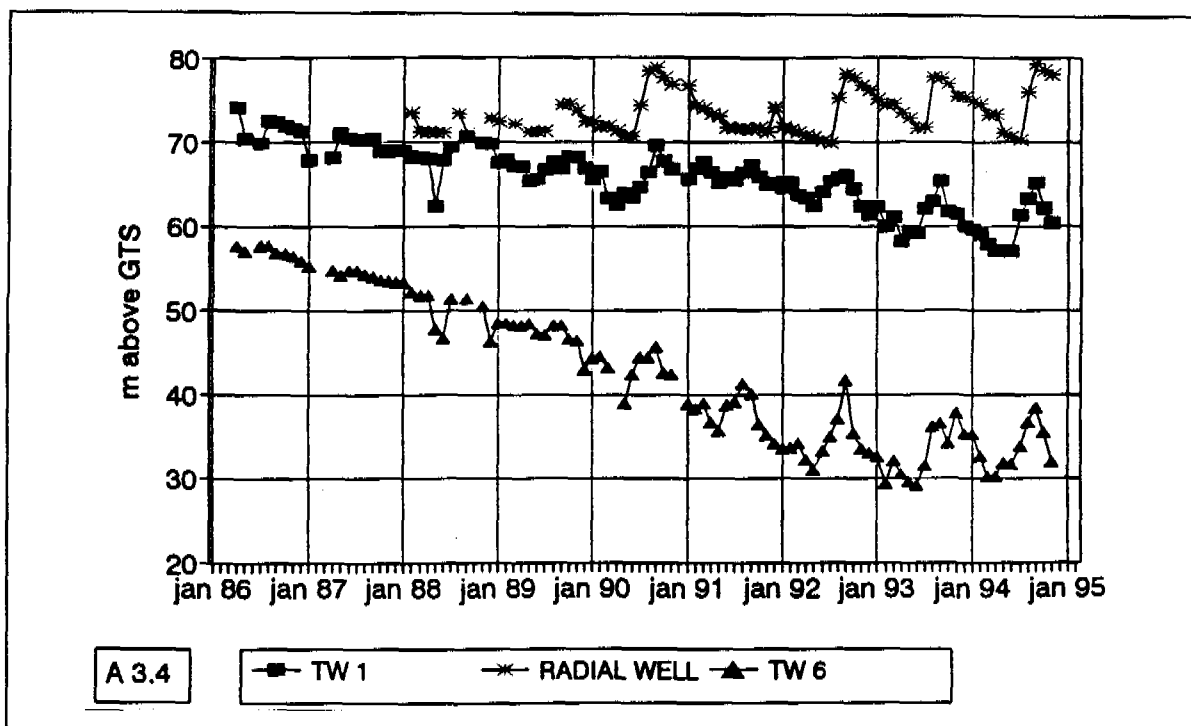


Figure 2. Static water levels in the Sihori Well field in Gujarat (GU 31)

In Sami-Harij the first layer of the Kamlivada well field is almost exhausted, and extraction of water from the second and third for irrigation is on the increase. Although not enough data are available to firmly establish the rate of decline it is estimated that the minimum lifetime of the well field is about eight years (Dadlani, 1993, GU 28 and 30).

In Andhra Pradesh groundwater levels are also declining, which according to the RSM is a question of over-abstraction, but representatives from the Groundwater Board as yet attribute it to the four droughts which have occurred in the last ten years against one drought every five years between 1901 and 1989 (Arn et al, 1992). More precise data will have to be obtained, for example, from APSRAC and the State Ground Water Board, to draw firm conclusions. A field visit to six villages in the AP III project area in 1994 showed that several traditional wells have dried up and also discharge of handpumps on tubewells was falling, whereas nearby pumping for irrigation had considerably increased.

The Drought Monitoring Cell of the Government of Karnataka reported in 1993 that in 17 out of 175 taluks groundwater utilization rate has reached a critical stage. These taluks are in the Bangalore Rural, Kolar, Tumkur and Belgaum districts; it is advised not to go in for any new groundwater abstraction. In these areas scarcity of water may occur throughout the year or only seasonally.

Table 3. Water quantity-related problems in five states

Region	Groundwater	Surface water
Gujarat	declining several metres per year	reduced availability for water supply schemes
Andhra Pradesh	declining, but mining not confirmed	Problems due to long closing times of irrigation channels
Karnataka	depletion of groundwater confirmed in several areas	water availability from tanks continues to decrease.
Kerala	data are not available to confirm the situation	most rivers run dry for six months
Uttar Pradesh	Water tables are falling due to irrigation	no data available to establish the situation

As yet the projects in UP seem to have fewer problems when compared to the other NAP schemes, particularly because they tap the very extensive aquifers of the Ganga basin. Nevertheless, falling water tables in traditional wells and groundwater pollution argue for increased attention to geo-hydrological aspects. This is particularly the case for the handpump schemes (SPIII and SPVI), where water tables fall as a result of strongly expanding abstraction for irrigation (Woersem, 1992).

***Reduction in availability of surface water***

Surface water sources in Gujarat are under stress and the conflict between different users is becoming ever more evident. Problems already occur in Lathi-Liliya whenever the Kalubhar dam does not fill up sufficiently due to drought. For three consecutive years this irrigation

reservoir nearly dried up yet in July 1994 the dam was replenished to full capacity. It was also observed that irrigation from the reservoir had started (GU 30 and 31). In Andhra Pradesh surface water quantity problems also occur but more in relative terms. The water supply in the AP I and II schemes is drawn from irrigation channels which are dry for part of the year for maintenance purposes, and insufficient storage is available in the villages to bridge these periods.

Surface water taken mostly from tanks and ponds is used mainly for drinking and cooking both in Dharwad and Bijapur districts in Karnataka, while groundwater is used more for washing, bathing and cleaning. Water availability from these tanks is gradually diminishing (KAR 1993).

The 44 rivers in Kerala are facing the prospect of a dusty death. The Bharathapuzha river, for example, is today a vast dry bed from which thousands of truckloads of sand are removed daily, which entails the risk of an increase in the hydraulic gradient (downward slope of the river). This reduces the capacity of the river to recharge groundwater, while already farmers do not get sufficient water after drilling borewells of 60 or more metres (Anthony, J. 1995).

#### ***Increased and uncontrolled competition between users***

Competition over water resources between users is increasing. There have been clashes between rural residents and cities such as Jodhpur, over municipal groundwater pumping in rural areas and associated water table declines. Similar problems are emerging in parts of Karnataka (Moench, 1992). During drought in Gujarat green irrigated plots were found next to barren land occupied by families who did not even had a source for drinking water on their land. These families thus became more dependent on their better-off neighbours.

Municipal authorities in the Sami-Harij scheme took out 1.2 MLD instead of the agreed 0.8 MLD and were not paying for it (GU 30). Following protests by the RSM this is now controlled more closely. Another factor is the continuous expansion of some schemes under political pressure. For example the Santalpur scheme was expanded from 141 to 151 despite repeated protests by the RSM. The same is happening in Lathi-Liliya, where 5 will be added to the planned 36 villages.

Although there is widespread acceptance in Gujarat that irrigation water has to be traded for drinking water in periods of drought, the acceptance may have its limits (Dadlani, 1993).

### **3.2 Main causes for water quantity-related problems**

#### ***Uncontrolled abstraction for irrigation***

The present problems with water availability are to some extent related to *population growth*, but over-exploitation is prevalent and increasing (Chitale, 1992). Nation-wide the number of diesel and electrical pump sets jumped from 87,000 in 1950 to 12,581,000 in 1990 (Moench, 1992). In Karnataka falling water tables are attributed to indiscriminate well drilling and *uncontrolled abstraction for irrigation*, and in some isolated cases to inadequate well siting. Thus water has to be brought in at much higher cost from remote sources. Yet the situation cannot be fully generalized and local differences do exist. For example, small scale irrigation seems to be much more at the root of the problem in Dharwad villages, while in Bijapur villages the climatic conditions together with increase in population and demand are more dominant (KAR 1993).

The driving force behind groundwater scarcity in Gujarat is not the decline of groundwater recharge through rainfall, as no downward trend in annual rainfall could be identified over the period 1951-1988, but rather rapidly growing levels of abstraction for irrigation (Bhatia, 1992). In 1950 there were roughly 900 electrified wells compared to 426,000 in 1990. The 1992 hydrogeological investigations for the NAP schemes initiated by the RSM concluded that "the whole area is facing rapidly declining groundwater levels due to mining of deeper groundwater for irrigation purposes". The RSM for Gujarat has repeatedly indicated the over-abstraction and recommended that the government should take action directed to decreasing water consumption in agriculture to safeguard the supply of drinking water on a sustainable basis (GU 31). The trend, however, is still in the other direction. In Shihori the number of tubewells for irrigation in a radius of 5 km has increased from 86 in June 1993 to 117 in November 1994 (GU 31). The water table decline in Kamlivada well field seems to be the result of a combination of the construction of an irrigation reservoir upstream and the rapidly increasing number of tubewells for irrigation. The number of private wells near Kamlivada increased from 27 in 1989 to 175 in 1994 (GU 31). Irrigation is also on the increase in the other three states and, even in Uttar Pradesh 'competition' from irrigation is having its influence.

Irrigation also has its impact on surface water supplies, causing, for example, river water depletion in Karnataka. In Gujarat the RSM has drawn the attention of the GWSSB to the fact that "in the past once too much water was released from the Kalubhar reservoir for irrigation, leaving insufficient storage for water supply". This despite the fact that in 1991 the irrigation department agreed by letter not to release water from the dam without prior consultation of the GWSSB (GU 25 and 31). The same irrigation department confirms that although no permission is given to farmers, they are irrigating inside the dry land portion of the dam. This increase in water use is thus affecting the availability for water supply.

#### ***Subsidized energy for water pumping;***

The increase in irrigation is stimulated significantly by the use of *subsidized electricity for water pumping*. This subsidy is politically popular and is detrimental for efficient water and energy use. Pump energy efficiencies measured in the field range from 17 - 27 percent as opposed to 50 percent regularly achieved in other parts of the world (Patel, 1991, cited in Moench, 1992). Farmers in Gujarat, for example, pay a flat annual rate for electricity based on the capacity of the pump, irrespective of the number of pumping hours. They therefore often invest in pipelines to sell as much surplus water as possible to their neighbours, so as to recuperate capital investments and electricity charges. They charge a flat rate (Rs 40-80/hr) during the dry season and half the rate during the wet season (Moench, 1992).

In Karnataka, electricity supply for irrigation pump sets is free of charge, regardless of capacity and yield, which has even led to financial problems for the Karnataka Electricity Board. Successive governments have stated the intention to introduce charges for electricity consumption in irrigation, but this has not yet materialized (van Griethuysen, 1995).

*Provision of credit for agriculture* has very much stimulated the installation of pumps for irrigation. Over 90% of credit of the Land Development Bank in Gujarat has been allocated to investment in modern abstraction devices. On the other hand current limitations on credit availability disproportionately affect the poor. Since the wealthy people can continue with well development, credit limitations are unlikely to control overdevelopment (Moench, 1992).

### ***Changes in land use practices and deforestation;***

Areas receiving high rainfall, like Kerala, are also experiencing acute water scarcity (Bandyopadhyay, 1987). Thus it is evident that many other processes may lead to water scarcity. Deforestation and destabilization of hydrological conditions in the catchment areas can lead to rivers and streams drying up during post-monsoon periods. In such cases *surface water drought* can occur in spite of normal precipitation. This may also happen because of dam construction and over-pumping of water from rivers. Another reason may be the deterioration of the catchment areas, as traditional harvesting structures are being neglected as described in Box 2.

#### **Box 2. Deterioration of traditional water recharge**

The Daccan Plateau in Karnataka is dotted with large open and generally earth lined ponds or lakes. (850-1550 A.D.) They have been built as multi-purpose constructions to reduce instant runoff, impound water for domestic and agricultural use and increase percolation to enhance soil moisture and groundwater resources. Often, the systems occupy convenient sites in series along valleys and are linked together to form continuous chains such that very little water falling on the catchment was lost. The systems were maintained by the beneficiary communities with rulers attending to major repairs only. In many places, the beneficiaries used to organize into a panchayat; rules and regulations were framed for judicious use of water.

Under British rule, income generation became more important than community welfare and attention turned to large scale irrigation. Due to national commitment to big dam construction, the dominance of large scale irrigation continued in the post-independence period. The minor irrigation from tanks became increasingly neglected as was the system of tanks itself. Other factors like population growth, changes in cropping pattern, deforestation, also contributed to decay of the system. As a result many tanks silted up to the extent that they could not anymore serve most of the purposes for which they were built. In the early seventies, with many tank beds empty and open wells drying up due to reduced percolation and lowering of the groundwater table, the rural population in the project districts began first to experience water scarcity during drought conditions. For relief, the state government started a massive campaign of installing borewells with handpumps for domestic supply in the mid-70s. Private land owners soon adopted the new technology for irrigation purposes. A rapid proliferation of borewells with powerful submersible pumps took place. This conducted to a further deterioration of the tank system. In many areas, the new borewell cum handpump technology did not bring lasting relief in securing water supply to the rural communities because of falling water tables. Many communities had no other option than to return to their traditional sources, or seek alternative solutions such as irrigation water and tankering water (KAR 1993).

The move towards cash crops with high water consumption is another major problem. In Gujarat, for example, raising of sugar cane on 2.6 percent of the cultivated land utilizes, 60 percent of the irrigation water (Onze Wereld, 1992). In Maharashtra groundwater exploitation for sugar production caused village wells to dry up and aquifers to turn saline, increasing the number of villages without a permanent drinking water source from 800 to 28,000 between 1985 and 1987 (Bastemeyer and Lee, 1992). The massive planting of eucalyptus, a tree with a high water consumption also causes groundwater depletion and soil aridity (Shiva, 1985).

In Kerala the prospect of a dusty death for 44 rivers is clearly related to factors which include deforestation. The threat to the rivers began in the early '40s due to massive encroachment and settling as part of the 'grow more food' campaign. Furthermore, various government-sponsored projects such as acacia, eucalyptus and teak plantations have hastened the destruction of tropical rainforests. In normal circumstances some 60 per cent of the rainwater is converted to

groundwater due to infiltration. However, denuded hills and decimated forests only promote floods and soil erosion (Anthony, J. 1995).

#### ***Lack of legislation and law enforcement***

Another important cause is *lack of legislation and law enforcement* which is particularly complicated because of private ownership of water rights and extraction means. This makes collection of water rates practically impossible in view of obvious problems of monitoring and corruption.

In Karnataka every landowner considers himself to have an absolute right to the water under his land and feels entitled to abstract as much as he likes. By legislation, however, all water resources are property of the state. Various laws deal with water utilization for purposes of irrigation and urban water supply, but not for rural water supply or groundwater. Thus with regard to protection and regulation, only the irrigation act may be of some use in that it says that no well should be constructed within such distance of another abstraction point as specified by the state without written permission. A by-law stipulates that new wells are not to be sunk within a distance of 800 feet from an existing well. This norm is one of the licensing conditions for obtaining loans for well construction and electricity supply but government agencies rarely bother to ensure that the norm is followed.

The problem of enforcing regulations or raising electricity prices can be severe. Take for example, the region in UP where Tikait, a farmer leader, holds sway. As a recent article in *The Economist* reports: no state government has dared cut off the farmer's electricity supply for fear of losing votes, or tangling with Mr. Tikait's gunmen (Moench, 1992).

#### ***Low community awareness and prevalence of short-term personal interests***

It takes many communities a long time before they really become aware of water resource problems, and by then it is often too late or very costly to take remedial actions. Symptoms of depletion that will impact yields and reliability are often hard to identify until a key threshold has been passed. This is a major drawback of adopting a curative approach designed to identify and then mitigate environmental effects through remedial actions (Bastemeyer and Lee, 1992). A further complication is that communities are not homogeneous and whereas the richer persons in the community may already be more aware of environmental problems through newspapers, they often have vested interests and may be less prepared to change. Also women, who often suffer first from problems of wells drying up may not have sufficient power to stand up to the rich farmers drawing excess water for irrigation.

The authorities are not taking action, partly because they are not well-aware of the problem, but also because they often wait until NGOs or the public opinion become really forceful and call for urgent action.

#### ***Lack of reliable data***

There is a clear information gap on the actual situation of water resources and data are not only difficult to obtain but sometimes they are also contradictory. Statistics of the Government of Gujarat showed that forested land more than doubled between 1960 and 1980, from 5.1 percent to 10.4 percent of the total land area, whereas satellite data from the National Remote Sensing Agency (NRSA) show, on the contrary, that Gujarat's forest cover shrunk by almost 50 percent between 1972 and 1982 to 2.8 percent of the total land area (Bhatia, 1992).

Many geo-hydrological data are not published, but kept as officially confidential. In particular remote sensing data and aerial photographs, but also topographic maps of coastal areas are classified as confidential and difficult to obtain for non-government agencies. Some people such as Bhatia, who have access to such data, breach their confidentiality because they very much believe that development of a more open information system is an essential prerequisite for improved management, but perhaps more importantly effective public action.

The RSM in Gujarat has successfully promoted continuous monitoring of the water levels and water quality in the wells of the NAP schemes and in the Kalubhar water reservoir. But whether this is really embedded in the GWSSB and leads to remedial action, remains a point of attention because as stated in GU 31: "The quality of the water reservoir is analyzed quarterly. For unknown reasons this monitoring practice was stopped in the past, but has been taken up again".



## **4. WATER QUALITY PROBLEMS**

### **4.1 Groundwater quality problems**

#### ***High fluoride content***

Groundwater quality problems exist in all states (Table 4). Fluoride is a major natural contaminant in many groundwater sources and particularly in Gujarat, Andhra Pradesh and Karnataka. In Gujarat 11 percent of villages have drinking water sources that are contaminated with fluoride beyond the acceptable limit of 1.5 ppm. Concentrations as high as 6 ppm have been found in several districts. In Santalpur water fluoride content has risen considerably between 1987 and 1992 but is now oscillating around 1.5 mg/l and has slightly decreased after the good monsoon in 1994. In the Sami-Harij scheme quality of the Kamlivada well field has recently surpassed the permissible limit for fluoride and now contains 2.6 mg of fluoride per litre (GU 31). Fluoride levels exceeding 1.5 ppm are reported from 12 districts in Karnataka and affect in total 302 of its 26,826 villages (Gulam, 1985). This includes villages in the project taluks Mundargi and Gadag of Dharwad district and also some villages in Bijapur (KAR 1993).

The proposed new APIII scheme in Nalgonda district in Andhra Pradesh is covering an area noted for groundwater with high fluoride levels. These levels are generally 2 to 3 ppm, and occasionally as high as 8 to 12 ppm (Dadlani, 1993). The fluoride content in many wells in the area seems to increase, probably as result of increased pumping for irrigation. This needs further study because groundwater may remain a source for domestic water supply. In several villages in the proposed scheme area small piped schemes exist. In parallel with these schemes existing handpumps are kept operational and are being used by community members (Arn et al, 1992).

#### ***Salinity***

Salinity is another quality problem which is on the increase in some areas. Salt water intrusion into coastal aquifers is a problem which is particularly significant in the highly permeable Miolithic limestone formations along the coast of Saurashtra in Gujarat. Coast areas in Kerala and Andhra Pradesh also have highly saline groundwater. In Karnataka high salinity is found in a 'brackish' belt in N. Dharwad as well as along many rivers, streams and nalahs (small streams) in both project districts (KAR 1993). In total this affects 3061 out of Karnatakas 26,826 villages (Gulam, 1985). In Uttar Pradesh salinity problems occur only in isolated groundwater pockets in the western part of the state.

#### ***High nitrate levels***

Nitrate levels exceed the WHO norm of 50mg/l in many groundwater sources throughout the state of Gujarat. The average value in Sabarkantha district is 200-300 mg/l. Kheda district nitrate rates ranged between 125-200 mg/l. Panchmahal, Mehsana, and Banaskantha are also characterized by high nitrate levels (Moench and Matzger, 1992), yet in the project areas nitrate problems are not prevalent. In Andhra Pradesh, nitrate contamination of groundwater is not reported in the project areas, but occurs locally in other areas (Bastemeyer, and Lee, 1992). In Karnataka high nitrate levels have been found only occasionally in the project area, and only in very isolated pockets in Uttar Pradesh.

Table 4. Groundwater quality problems in five States

Region	Fluoride	Salination	Nitrates
Gujarat	has increased in project area	in coastal areas	in several areas but not in project
Andra Pradesh	has increased in some project areas	in some areas	in specific locations
Karnataka	in few areas	in some areas	only in few areas
Kerala	not mentioned	in coastal areas	no information
Uttar Pradesh	no problem	in a few pockets	in a few pockets

#### 4.2 Surface water pollution

Surface water pollution is considerable in India and comprises both chemical and micro-biological pollution. About 70 percent of the surface water bodies are reported to be polluted and require considerable treatment if to be used for water supply. The Sabarmati river in Gujarat is an example of a river heavily polluted by dye, pigment, textile and chemical plants (Moench and Matzger, 1992). Salination of surface water is also taking place in coastal areas as for example reported in Alappuzha District in Kerala. Turbidity levels in many rivers are high and seem to be increasing in many places but this tendency seems less relevant for the current NAP scheme areas.

#### 4.3 Causes for groundwater quality problems

Fluoride levels in groundwater have a natural cause, but their increase in several areas has been attributed to the lowering of groundwater levels. Salinisation is also very much the result of over pumping of groundwater which has caused sea water intrusion into many coastal aquifers. In Karnataka salinity is related to geological conditions (black cotton soil with bad leaching characteristics).

Increase in nitrate concentration seems to relate more to higher loads of fertilizers in agriculture, and locally it may also result from infiltration from septic tanks (Bastemeyer, and Lee, 1992). Chemical contamination in surface water may infiltrate in the river bed and so pollute the groundwater, as reported in Karnataka, where in the immediate surroundings of factories, nearby water supplies are affected on various occasions.

#### 4.4 Causes for surface water pollution

An important cause for surface water pollution results from the increase in population in urban centers and industrialization. Untreated waste water and solid waste is simply discharged into the water courses. Only 21 towns and cities out of 3,245 have partial or full sewerage and sewage treatment facilities. Domestic waste accounts for nearly 80 percent of the pollution load

(Hukka, 1992). Surface water in Kuttanad in Kerala for example is polluted because of lack of sanitation facilities and becomes saline because of low river flows allowing seawater intrusion. Industrial pollution also takes its toll. The Tungabhadra river in Karnataka is a good example. In recent years, several major fishkills occurred during the period of lean flow (February - April) downstream of the pulp and polyfibres factories at Harihar, where the river borders the Dharwad District.

Agriculture makes an important contribution to pollution because of its heavy dependence on fertilizers and other chemical products. There is a marked increase in the concentration of phosphates and nitrates in the inland waters in India as a result of the runoff of fertilizers from agricultural lands (Cestti, 1989).

Erosion in the catchment areas is also increasing and is contributing to the high loads of suspended solids in many rivers. These problems primarily seem to stem from deforestation and inappropriate land use practices, but degradation of traditional water management strategies also contributes to increased run-off.

Over-abstraction of river water may also contribute to pollution as it reduces the base flow. This results in less water being available for dilution of waste water discharged in the river. Also dam construction may have an impact particularly if they are not constructed for river regulation but for other purposes. The Central Pollution Control Board reported that construction of the Dharoi dam and Vasna Barrage aggravated the situation by reducing rather than enhancing the lean weather flows in the river. Pollution problems are thus likely to increase if more surface water is diverted to meet municipal and other needs (Moench and Matzger, 1992).

#### **4.5 Recontamination**

At scheme level and household level there is a marked problem of possible recontamination of the water supply, because of leaking distribution networks and periods of low pressure as a result of intermittent supply. This is the result of a range of contributing factors, from poor quality construction sometimes enhanced by corruption to low tariffs and inadequate management of schemes. A further complicating factor is the possible recontamination of water during transport from public taps and handpumps, which requires considerable hygiene-related activities at community level.

## **5. UTILIZATION PROBLEMS**

### **5.1 Low efficiency in water supply**

A problem less mentioned in the different literature is the low efficiency of the water supply systems. A lot of water is still being wasted or seeps away from the pipelines. Reduction of water losses in the network and especially in the transport main is indicated as a priority by the RSM in Gujarat (GU 31). This issue is also referred to by the other RSMs and needs due attention, as it has much to do with the quality of the water supply systems and issues such as illegal connections and inadequate maintenance, partly because of prevailing low water tariffs, lack of motivated staff and insufficient monitoring.

A field visit in Andhra Pradesh revealed considerable wastage from open taps or even pipes without taps, with community members standing by and not interfering at all. Similar experiences can be found in other areas including a dry state such as Haryana, where significant water wastage can be observed from piped schemes in communities such as Jaisalmer. This shows a low awareness among the community about the need to use water efficiently. Part of the reason may be that they still feel that the water supply system is a government affair. Furthermore the discontinuous functioning of water schemes does not encourage efficient water use, as it is felt best to leave the tap open just in case water arrives. The belief that water supply is a social service rather than an economic commodity is deeply embedded in many developing countries. Since water tariffs bear little relation to the real cost, users do not make efforts to use water efficiently. Moreover, water supply institutions have experienced great difficulty in reducing water losses in their systems and often lack the necessary autonomy and instruments to manage their systems and set adequate tariffs. Furthermore government subsidies have effectively discouraged the application of tariffs that reflect the real cost of providing services (Cestti, 1989).

### **5.2 Low efficiency in irrigation**

Worldwide, the efficiency of irrigation systems is estimated to average only 37% (Cestti, 1989). This implies that 63% of the water is wasted through evaporation and leakages. The vast majority of irrigation schemes in India comprise unlined open channels which have a very low efficiency. Lined channels, closed pipes and drip irrigation are only limited in number. Scheme management is another problem contributing to water wastage, which is enhanced by subsidized electricity prices. Farmers using diesel-powered irrigation manage their systems more carefully as diesel prices can very much reduce crop profits. They face unit pumping costs which are ten times higher than those having electric pumps and therefore are encouraged to better maintain their irrigation system. Yet they do grow the same types of crops with high water demand because pumping costs are just one factor in decision making. In the USA commodity prices have been found to play a greater role in water use decisions than energy costs associated with falling water tables (Slogget and Dickason 1986 cited in Moench, 1992).

In January 1995, a water resources specialist joined the RSM in Gujarat for a land and water use study, to identify possible measures to reduce the pressure on fresh water sources. Especially in Santalpur, farm irrigation systems were found to have a low efficiency, as farmers use open earth channels. In Kamlivada, losses are fewer as irrigation takes place through buried pipes which have been introduced because of the water scarcity situation. Farmers are members of a cooperative, but little extension work takes place to improve farming efficiency (GU 31).

## **6. COPING STRATEGIES**

### **6.1 Making more water available**

#### ***Bringing in water from outside the area***

An important strategy of most state governments has been to import water into their state or the area with a water shortage. This often implies costly solutions to bridge considerable distances with pipelines or canals. Such a solution is now being planned with the Narwada dam in Gujarat. Other big dams have been constructed to capture large quantities of water, often with considerable negative consequences for both people upstream because of flooding as well as downstream by reducing river flows.

On a micro-scale water is piped to villages after the water table has been drawn down by excessive irrigation. This approach, which often draws considerable funds from budgets for water supply, does not tackle the root of the problem, however, and cost-benefit comparisons for this type of intervention as opposed to reallocation of water are not made.

In emergency situations tankers have been used as the only feasible alternative to supply water to communities if sources dry up during drought. Yet this involves high costs and it is not clear whether in several cases careful management of water resources could not have prevented the need to bring in water.

#### ***Pumping from deeper aquifers and increasing pump yields***

Solutions which are being used include deepening of existing wells or building new wells tapping from deeper aquifers, for example in Gujarat. This is done for domestic water supply, but more importantly for irrigation. It is likely that these are only temporary solutions since the aquifers are considered to be confined and water levels in the aquifers in this region are rather deep (GU 32). Hence in different regions opting for deeper aquifers does not imply a very sustainable solution, and definitely increases pumping costs.

In Karnataka more systematic hydrogeological reconnaissance and geophysical surveys to explore high yielding fracture zones in hard rock areas may offer possibilities for enhancing water availability. Production of existing wells may also be increased by hydro fracturing, for which equipment has been purchased. These solutions are not meant to overcome falling water tables, but to increase yields from existing wells and improve the siting of new wells.

#### ***Enhancing water recharge and rainwater catchment***

An approach which is gaining interest is to arrest precipitation more efficiently. Sometimes this is done through improving existing water storage systems or developing artificial recharge schemes. A check dam is under construction in the Baas river to increase recharge in the Shihori well field, at 6 percent of the cost of the total Santalpur scheme. For the Kamlivada well field recharge seems not a good possibility. Other options are being reviewed, among which deeper wells, bringing in water from further away, and removal of fluoride. Traditional water harvesting methods are also being revived, as is the case in Alwar district in Rajasthan (see Box 3). Interesting is also the Jhabua WRM programme in Madhya Pradesh which constructed over 450 tanks and 600 stop dams between 1985 and 1990. Irrigation cooperatives have been formed and many areas now grow multiple crops and demonstrate better recharge. This case shows that political support can be mobilized for labour-intensive WRM plans, provided task forces are

formed to cut through the horizontally divided bureaucracy. The felt environmental crisis made it possible to pool resources to turn around the degradation process. Yet the case also makes clear that the involvement of the community needs to go beyond labour inputs (Annex 1).

### **Box 3. Reviving traditional water harvesting structures**

Reviving traditional water harvesting structures called johads, (check dams) in Alwar district in Rajasthan sets a positive example of increasing recharge. Traditionally johads were an important means for the population to store rainwater for irrigation. However, with modernization and the erosion of community participation the system faded out. As a result the rural economy was hit hard and people began selling fuelwood destructing nearby forests to make a living, and others migrated to towns in Punjab and Haryana. Tarun Bharat Sangh, an NGO working for integrated development aiming at making villages self-reliant through self organization, stepped in and gained respect from the communities through construction of demonstration johads with help of some families. The rest of the villagers realized the importance of the johads, when rainwater was arrested and dry water wells were recharged. Since 1986 200 johads have been constructed in 100 villages after the establishment of gram sabhas to organize the community, select the sites, oversee the water management and settle disputes. To better settle disputes, 11 gram sabhas joined with local members of the legislative assembly and Parliament to set up a panel. Furthermore the gram sabhas, together with TBS arranged that farmers could get more water provided they paid the additional cost. TBS also supplies gram sabhas with saplings for planting on denuded hills, pasture land and field boundaries. In Bhawanta, women have a separate assembly to deal with women violators of gram sabha rules. This practice has been initiated only in more backward villages, where the purda system is deep-rooted.

In 1987 TBS ran into trouble with the irrigation department, which declared the johads illegal under the Rajasthan Irrigation Water Supply Act, 1954. This was solved when villagers argued their rights to manage their water resources. Then the strategy changed and the johads were branded technically unsafe, until a downpour in 1988 washed away a government-built dam at Jaitpura, but not the johads.

Whereas the building of the johads is successful, more attention seems to be needed for the formation of strong gram sabhas and women's involvement. Most girls, for instance, still drop out of school after the fifth standard (Kumar S. 1993).

SEWA gained experience by constructing a rainwater harvesting reservoir in Gokhankar village in Gujarat. This activity was undertaken in one of SEWA's eight sub-programmes on income generation for women. The capital costs of the reservoir were Rs. 100,000. The quality of the construction could not yet be fully judged, as not all data were available at the time of the RSM visit, but water quantity and quality (salination) will be closely monitored by SEWA, for which they obtained a salinity meter. The RSM has recommended that SEWA assists the village in making a cost recovery and water management plan, to ensure the long-term sustainability of the system. Two similar reservoirs are being planned, which should be implemented only after the evaluation proves the first experience is satisfactory.

A project for similar rainwater harvesting ponds, with an added filter system and handpump for the distraction of drinking water, has been carried out in the region by Utthan, a local NGO. They constructed six such ponds in six villages. Thereafter the World Bank financed 14 more ponds in 14 villages in 1990. Of these 11 were completed in 1995. Analysis of water quality samples from 16 ponds showed high quantities of salt and chloride.

### ***Enhancing water source protection***

Purchase of land around wells is suggested by the RSM in Andhra Pradesh to protect them against abstraction for other purposes than drinking water. Such "water sanctuaries" can have additional benefits. They can be used for social forestry, for recreation or for some form of income generation from which operation and maintenance costs of the water supply system can be paid. Alternatively the water rights of the land owners could be rented or bought (Arn et al, 1992). Spring sanctuaries, in combination with local reforestation, is an integrated part of Sub-Project VII in Uttar Pradesh. Also for Karnataka it is proposed to promote micro watershed development activities in view of sustaining the hydrological cycle locally (KAR 1993). In 1993, the GWSSB in Gujarat proposed to introduce a protected zone of 2 km around the well fields to the Department Secretary (Water Supply) of the Health and Family Welfare Department. Within this zone no new irrigation wells and no increase in pumping capacity will be allowed.

Adherence is to be guaranteed by the District Collector, the Executive Engineers of the GWSSB and GEB, and the District Cooperative Bank and other Rural Development Banks. No action has been undertaken since and the District Authorities in Sami Hari doubt if the safe zone can be implemented.

### ***Increasing the use of traditional sources***

A study by the Socio Economic Unit in 5 areas of the Mala scheme in Kerala revealed that the availability of traditional sources has a major impact on water use. Furthermore there is a marked difference between the dry and wet season (see Table 5). Currently local water sources in the hilly region of Kerala are being upgraded with help of the users instead of bringing in piped supply.

Table 5 Use of Standpost water supply in Mala, Kerala

	No other source	Other sources in wet season	Other sources year round
dry season use in lpcd	30 - 44	25 - 29	6 - 8
wet season use in lpcd	18 - 20	14 - 20	2 - 5

In the Lathi-Liliya scheme greater attention is drawn to traditional sources to serve as a back-up supply. It is argued that various possibilities should be evaluated on their technical, financial, organizational and maintenance aspects before a choice is made (Dadlani, 1993). These suggestions came from the RSMs and other external missions, and are being taken into account, but only the future will show whether they really are supported by the water agencies. A positive sign is that the GWSSB has done an inventory of existing water resources and will formulate a proposal for upgrading. This will be done in cooperation with the village panchayats and NGOs experienced in traditional source upgrading.

In the new schemes in Andhra Pradesh it is suggested to study the possibilities of local water sources in greater detail than before, using the information in the various departments at various levels (Arn et al, 1992). Nevertheless one should be reminded that the PRED, at least in the past, was not very much in favour of the use of handpumps and local water supply systems.

In Uttar Pradesh, emphasis in the new projects is leaning towards better protection of community water resources, and the UP VII project includes community involvement in watershed development.

## **6.2 Enhancing efficiency and reallocation**

### ***Enhancing water use efficiency***

Water saving and conservation is often a more cost-effective response than costly investments for increasing water supply. Current use of municipal and irrigation water may be reduced by metering, increasing tariffs, leak detection and repair, water saving devices, increasing irrigation efficiency, publicity campaigns and education, and reuse of waste water (Cestti, 1989). A four-year case study (1982-1985) in Uttar Pradesh was carried out in eight communities with continuous water supply and house-connections. The average consumption in six metered villages was some 50 lpcd whereas in the two unmetered communities the consumption was 130 lpcd (Chourasia, 1987). Activities are included in NAP schemes to enhance the efficiency of water use and reduce unaccounted-for water. In Uttar Pradesh user education is becoming part of projects to reduce wastage and in Kerala monitoring of taps by local caretakers has led to earlier repairs and less wastage. In view of the scarcity situation in Gujarat, attention to efficient use has been rather natural. The GWSSB undertakes campaigns to detect and repair leakages, dismantle private connections and improve operation and maintenance.

A very important area to improve efficiency is irrigation. GU-31 recommends in-depth studies and action research in cooperation with Dativara Agricultural University on current water consumption and use for irrigation, possibilities to reduce water losses and change cropping patterns; potentials to improve farm management and crop economics, and a programme to increase the farmers' awareness of the scarcity of water.

### ***Pricing***

Users who do not pay the actual cost of the water supply, are apt to waste the resource (Cestti, 1989). An important strategy will be to create incentives for individuals and groups to use (ground-)water in an efficient and sustainable way. Deterrents may also be an approach, but limiting institutional funding may have little direct effect on rates of groundwater extraction while is likely to have large, for example, equity consequences. Increased tariffs may actually exclude the poor from access to groundwater resources, while more wealthy segments of society are able to continue extraction (Moench, 1992). In Gujarat pricing has already been used as an instrument for regulating agriculture and municipal water supply, but it can be further improved (RSM Gujarat).

Although perhaps difficult to enforce, electricity pricing could be utilized to influence groundwater use. Possibilities suggested by Moench (1992) include:

- selling electricity only to user groups, cooperatives, or private 'electricity retailers' on a unit basis and having them collect fees from the end users;
- imposing a very high flat rate fee to any pumps without electricity metres or where metres show evidence of tampering;
- providing subsidies with higher water use efficiency technology.

Shifting to consumption-based electricity price structures may encourage water use efficiency. Given the lack of clear differences in cropping patterns between farmers dependent on diesel and those using electricity, energy price changes alone appear unlikely to have much effect on



cropping decisions and thus overall sustainability of water use patterns. This does not, however, negate the importance of rectifying electricity tariffs. Another approach would be to increase the economic impact of inefficient practices beyond what is possible through energy prices alone. Taxes based on agricultural water consumption could, for example, be used in water-short areas (Moench, 1992).

### ***Raising community awareness***

Gradually the issue of greater environmental awareness is coming into play. The Centre for Environmental Education, (CEE) for example, is making an important effort to increase this awareness, with support from the Ministry of Environment and Forests. In 1992 CEE submitted a proposal to the Netherlands Government to develop educational and training programmes to create an awareness among consumers of the Lathi-Liliya regional water supply scheme which is now being implemented.

From experiences elsewhere it is known that participation of male and female representatives of village sections in inventorying and problem assessment has a strong mobilizing and awareness-raising effect. Methodologies exist and are used in India for such participatory inventorization and planning, such as the PRA (participatory rural appraisal) techniques used in the NAP in Karnataka and by the AK Foundation in Gujarat, and the participatory natural resources mapping done by two NGOs in Kerala (Mitra, 1993).

## **6.3 Improving water quality**

### ***Introduction of water source protection and water treatment***

As already indicated in section 5.1, emphasis on water source protection has increased significantly in all NAP scheme areas. The prime reason has been related to safeguarding water availability, but several of the measures such as reforestation also have a positive influence on water quality.

Defluoridation has been stimulated by the Rajiv Ghandi National Drinking Water Mission, and some 17 schemes are in various stages of development in different parts of India (Arn et al. 1992). Furthermore some experiments with defluoridation of handpump supplies have been carried out in Andhra Pradesh. The success of the latter seems questionable, however, and performance data on the schemes are not available. In Andhra Pradesh and Gujarat the option of defluoridation or desalination of village sources is being reviewed as a possibility to better use available resources. Suggestions include the use of solar energy for desalination. The RSM of Andhra Pradesh, however, is already of the opinion that defluoridation is not a feasible option for remote villages. In Gujarat fluoride problems are reduced by blending water from wells with high fluoride levels with water from radial wells with much lower fluoride levels.

### ***Stimulation of wastewater treatment and reuse***

Although Netherlands support is provided to the Ganga action plan and particularly for wastewater treatment through the introduction of upflow anaerobic sludge blanket treatment, still the vast majority of wastewater is disposed of without treatment. In the rural schemes wastewater production is limited, but even with these limited quantities there may be scope to promote the re-use of waste- and spill water (Dadlani, 1993).

## **6.4 Development and enforcement of policy and legislation**

### ***National policy***

The government of India established a policy for WRM in 1987. This policy states that water resources development projects should as far as possible be planned and developed as multi-purpose projects. Provision for drinking water should be a prime consideration. The projects should, wherever possible, provide for irrigation, flood mitigation, hydro-electric power generation, navigation, pisciculture, and recreation. There should be an integrated and multidisciplinary approach to the planning, formulation, approval, and implementation of projects, including catchment treatment and management, environmental and ecological aspects, the rehabilitation of affected people, and command area development. The integrated and coordinated development of surface and groundwater and their conjunctive use should be envisaged right from the project planning stage and should form an essential part of the project. There should be a close integration of water and land use policies (Chitale, 1994).

The National Water Policy has since asserted that water resources planning be undertaken for a hydrological unit, such as a drainage basin or sub-basin. It has also advocated establishing multidisciplinary units in each state to prepare for comprehensive basin-wide master plans.

The new policy does not modify groundwater rights which are attached to the ownership of the land. This very much complicates the protection and management of water resources. Any improvements made to enhance recharge may be defeated by neighbours drawing out more water without contributing to the improvement measures. Reforming the structure of groundwater rights is therefore a critical step. This could be done in at least two ways: through direct privatization of water rights or through laws (such as prohibition of waste discharge or excessive pumping) that empower local groups to protect water resources. User group management of groundwater resources at micro level is already occurring in some areas, such as Mehsana district in Gujarat, where falling water tables have made construction of wells by individuals unaffordable (Moench, 1992).

User group management would probably require the evolution of semi-governmental water user associations, similar perhaps to water management districts in the US. Their primary theoretical advantage over governmental institutions would be direct control by user representatives over management and policy decisions (Moench, 1992). This would also require sufficient community awareness and organization and empowerment of the more vulnerable community groups. At the agency level understanding is required of the benefits which are likely to outweigh the longer duration of the initial participatory process. In Kerala an interesting project using participatory village resource mapping with support from NGOs was just stopped by the State Board as in their view planned results took too long to materialize which, according to the NGO, was because they were just gaining experience with the methodology.

### ***State policies, legislation and organization***

In 1971 and 1992, the Government of India circulated a draft model bill on regulation and control of groundwater development among the states. Based thereon the Government of Karnataka considered a Groundwater (Regulation and Control) Bill in 1987. This bill, however, has still not been introduced in the legislature and is not enacted as a law (KAR 1993).

The Government of Kerala, Department of Irrigation, established a State Water Policy in 1992. This policy opts for integrated development of land and water resources on the basis of river basins or watersheds. A master plan for water resources development will be made as well as plans for integrated river basin development and watershed management along scientific lines and with due regard for environmental and Socio-economic impacts. These plans will have to be approved by the newly established Water Resources Control Board (WRCB). Drinking water schemes will get top priority in water resource allocation. At present there is no uniform law for irrigation for the whole state, therefore legislation will be made concerning the construction of irrigation works and conservation and distribution of water for the purpose of irrigation (Government of Kerala, 1992). The technical aspects included in the WRM policy are indicated in Box 4.

**Box 4: Technical issues included in Kerala's WRM**

The long-term strategies include:

- maximization of rainwater harvesting and storage;
- avoidance of deforestation and encouragement of forestation with species to indigenous river catchment areas;
- integration of drinking water supply schemes with hydropower and irrigation reservoirs and freshwater lakes, whilst taking steps to maintain water quality;
- use of non-conventional water resources such as tanks and springs for domestic water supply and small-scale irrigation, including conversion of marsh lands and waterlogged areas into lakes;
- selective and judicious groundwater development through borewells without causing salinity and drying up of neighbouring wells;
- water scarcity areas will be identified and permanent solutions will be developed.

For the short term strategies include:

- encouragement of deepening, desilting and maintenance of house compound wells. Closing of these wells will not be permitted;
- promotion of drip irrigation and other water-saving irrigation which wherever feasible will be integrated with house compound wells;
- conservation of fresh water through desilting and deepening of tanks, ponds and community wells and construction of contour trenches;
- public training for maintenance of wells and handpumps;
- arresting leakages in existing distribution pipes.

Water quality monitoring and upgrading of existing water bodies is envisaged. Furthermore revitalization of the inland waterways, fisheries and recreation facilities will be explored. Expansion of hydropower is also foreseen, as well as enhancement of training of professionals in WRM by the Centre for Water Resources Development and Management (CWRDM).

This centre will also play an important part in development of science and technology, for which the following priority areas have been identified:

- drought and flash flood management;
- salinity prevention in coastal wells and rivers;
- estuary and backwater management;
- water harvesting techniques at levels of river basin, small watersheds, house compounds and roof tops;
- land use-erosion-sedimentation-infiltration-evaporation relationships;
- modern irrigation technology like drip and sprinkler techniques;
- water management in irrigation;
- hydropower generation through mini and micro hydropower projects.

Furthermore a number of institutional arrangements are being envisaged to implement the policy:

- a Water Resources Control Board will be formed to oversee and coordinate all activities related to the policy;
- a centralized hydrological data bank and data processing centre will be established under the Irrigation Department. This unit will receive guidance and advice from a consultative body consisting of Irrigation Department, CWRDM and KSEB;
- a separate cell in the Irrigation Department will be formed to look after and coordinate all programmes related to non-conventional water resources such as tanks, ponds and springs;
- ongoing training on WRM in CWRDM will be strengthened;
- an appropriate structure will be established to develop state inland water ways.

In Gujarat, current forms of direct regulation go back to 1970, when a bill was introduced by the Central Ground Water Board to regulate and control the utilization of groundwater. Nothing happened until the 1976, when the state government published the Bombay Irrigation Act after the nation wide drought in 1975. This act, however, was not approved by state legislature. A new effort in 1989 met with a similar fate. Future steps to reform the law will have to challenge the obstructive forces which have stopped progress so far.

In general little interest has been found with the authorities in Gujarat to improve water management in the State. Existing legislation could be enacted or enforced, new legislation could be drafted and instruments to stimulate efficient water use and conservation could be introduced. There are no such intentions. Apparently it is expected that the future Narmada project will solve the water problems of the state (Dadlani, 1993). Nevertheless, some attempts have been made to protect groundwater resources. For example, in Mehsana district, Gujarat, spacing regulations have been promulgated by NABARD for new wells whose owners desire institutional financing. Electricity connections are also supposed to be denied to wells violating spacing norms. Local farmers reported, however, that private financing was readily available and electricity connections could easily be obtained with a fee to the line man (Moench, 1992). In July 1994, a State Level Steering Committee for NAP water supply projects was set up chaired by the Secretary Water Supply and with the Irrigation Department included in its membership. The Committee is to meet quarterly but so far it has never met.

## **6.5 Improving planning and implementation**

### ***Sector plans***

The new policy of the Indian government on WRM clearly calls for the integrated development of land and water sources. Kerala seems most progressive with its intentions for making a plan for water resources development. But in practice comprehensive masterplans or a sector plan for rural water supply and sanitation do not exist in any of the states. Aiming at the development of such plans, however, seems inadequate in view of the recent policy paper of the World Bank, which calls for the development of Water Resources Management Strategies to complement water resource master plans. Thus a more comprehensive approach seems required. Such an approach could be very useful in setting the boundaries for the development of more village-based planning.

### ***Village water plans***

Village master plans are proposed in Andhra Pradesh as the main planning and implementation instrument for all project activities at village level. Also in Kerala and Karnataka emphasis is placed on developing plans at village level, taking into account available water resources.

In Kerala an experiment has been carried out through mapping of local natural resources by villagers. In December 1990, the Kerala Government brought all the panchayats in the state under the scheme. The basic idea being: economic growth is unsustainable unless exploitation of natural resources is within the limit of the carrying capacity of life support systems. Achieving development that is sustainable and environmentally friendly requires decentralized, micro-level approaches. This requires scientific data based on local resource endowments (Moench and Matzger, 1992).

### ***Getting innovative activities accepted***

Innovation appears very difficult as NGOs, for example, face problems with acceptance of project strategies. In the Bhal area of Gujarat Mahiti, an NGO developed lined tanks for water supply, as available groundwater is saline. The GWSSB evaluated the results and found them rather disappointing because the tank water did not meet potability standards. Local people, however, found them invaluable as a source for livestock watering, household use and in times of scarcity drinking water supply. As in the case of Mahiti, NGOs often encounter resistance and scepticism from water sector professionals about the results and value of local experiments. As a result, several NGOs decided to initiate networking activities with academic/research institutions (Moench, 1993).

### ***Improving data collection***

A lack of detailed data on problems at national, regional, and local level appears to be an important reason why few developing countries have formulated overall policies concerning environmental protection and the management of water resources. It is critical that the benefits of environmental protection, which often outweigh the costs of remedial actions when viewed in the medium and long term, be quantified and communicated to decision makers as a basis for a managed and sustainable approach to development.

In Uttar Pradesh, groundwater problems have led to the set-up of a geo-hydrological cell in Jal Nigam. This cell was supposed to coordinate its activities with the State Ground Water Board but this did not materialize, nor were services provided by this Board. The Government of Kerala proposes to make the necessary administrative arrangements to establish/maintain a network of hydrometeorological stations to establish the database required for proper coordination and evaluation. In Uttar Pradesh, Jal Nigam has now decided to carry out groundwater monitoring at least twice a year, in the pre- and post-monsoon periods May and September.

## **7. SUGGESTIONS FOR GUIDING PRINCIPLES**

WRM needs to be placed much higher on the agenda in the Netherlands supported projects in India. All of them have to a greater or lesser extent WRM problems which are very much related to over abstraction for irrigation, inadequate land and water management, insufficient legislation and law enforcement, low awareness about the seriousness of the problem, lack of data on water resources and poor performance of water supply and irrigation schemes. Several actions are being taken in the current projects particularly in the dryer areas, but the effect is generally limited. Thus to ensure that investments are protected and schemes can be better sustained WRM efforts need to be stepped up immediately. The WRM policy developed by the Government of India provides a good starting point for improvements. Nevertheless its operationalization is a slow process which involves a large number of partners many of which have vested interests. Hence new strategies are needed to come to grips with WRM. Against this background the following guiding principles are suggested for WRM related activities in the Netherlands assisted projects:

### ***Establishing a dialogue with the irrigation sector***

The overriding problem seems to be the over-abstraction for irrigation. This requires good analysis and dialogues to explore possibilities to take remedial action.

### ***Awareness raising at governmental and policy level***

Clarification and discussion of WRM problems with government agencies and policy makers is necessary to get sufficient political leverage to operationalize WRM strategies. At national and state level this requires a policy debate and in-depth discussions with the key ministries and agencies involved. Therefore actions are needed such as discussion meetings and news paper articles, to raise awareness on the WRM issue and its consequences, support to NGOs active in this field will be helpful. Activities may also include a joint review of actions undertaken sofar, for example in the Netherlands supported projects and the effect they have had. It may also be helpful to strengthen information sharing on ways other governments in the South but also in the North and particularly in the Netherlands are coping with WRM.

### ***Detailed assessment of water resources related risks in current projects***

In some schemes assessments are already made of the risk that water resources are being depleted. This needs far more attention as it will very much shorten the life of key components of the schemes. A participatory analysis of this problem and the associated loss of investment will provide supporting evidence to discuss with other stakeholders and work as an eye-opener on the problems.

### ***Clarifying WRM problems and linkages at local level***

Participatory approaches for problem identification and mapping of water resources and environmental conditions, as now introduced in a few projects, provides a unique opportunity to help the communities and implementing staff to understand WRM problems and identify possible solutions. Introducing these approach in all projects will very much enhance their sustainability.

### ***Enhancing the bargaining power of the drinking water sector***

Making the sector more self sustained by giving market mechanisms a more pronounced place is important because a healthy drinking water sector which provides good service can better compete with other stake holders, such as irrigation farmers and industry. The bargaining power

and the dialogue can also be enhanced by providing good case analysis of competing interests. Cases could include a cost-benefit analysis of the construction of new schemes or transport of water over long distances, because irrigation farmers draw down the water table.

***Adopting a comprehensive district development approach***

WRM can be very much enhanced if different projects including, for example, drinking water supply irrigation and forestry in the same district will receive support from the Netherlands government as this may stimulate the discussions between stakeholders and lead to a more balanced WRM.

***Stimulating the development of WRM Cells or sector cross cutting task forces***

Integrated water management needs a multidisciplinary and multi sectoral approach. The need to set up multidisciplinary units in the States and inter-State organizations for the planned development and management of river basins is already agreed at policy level, but needs to be put in effective operation.

***Development of key criteria for drinking water projects***

Agreement needs to be reached between the partners involved in the sector about key criteria and indicators for design, construction and management of water supply systems. This needs to include WRM related criteria to help ensure the long term sustainability of the system. Such criteria provide targets for implementation as well as for quality of construction and will facilitate evaluation of the results.

***Focus on existing water resources and water rights in new schemes***

In the development of new schemes adequate attention needs to be paid both to the existing water supply systems and traditional water resources and the longer term risks new water sources will face. This should include a review of the expected development of the water resources and particularly of irrigation in the area affecting the water source and the water rights prevailing in the area..

***Increased attention for WRM and water use efficiency in existing schemes***

In several projects water catchment protection is gradually coming into play and the idea of water sanctuaries with a radius of 2 to 5 km is being established to limit the influence of irrigation pumping. This is an important development which deserves to be stimulated in all relevant cases. Also some recharge experiments are being suggested, which may be a way to protect earlier investments, provided the water table is not falling because of excess irrigation, because then the root cause should be solved. On the other side scheme performance can be considerably improved if construction quality is enhanced and leak detection and repair is introduced. This can reduce water and revenue loss considerably and lengthens the effective life-time of the schemes.

***Strengthening of monitoring of water resources***

Only if reliable data are available to the different stake holders will trends of for example falling water tables become clear to a wider group. In some schemes monitoring of some WRM related key parameters is already encouraged. This needs to be expanded to the other schemes and WRM monitoring should also become a structural element in the development of plans for new schemes.

***Capacity building for integrated sector development***

A crucial factor in WRM will be the capacity of government and NGO staff to understand WRM problems and support the implementation of solutions. Capacity building is thus important and in the new training programmes which will be supported WRM is to be included.

***Enhancing irrigation efficiency***

This issue has been taken up in one of the programmes and has potential, but it implies working with very different partners and particularly with the irrigation departments. This however may be a good way to break through sector boundaries and gain access to the irrigation sector.



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### *Lessons from the Jhabua WRM programme in Madhya Pradesh*

Under this programme over 450 tanks and 600 stop dams have been constructed between 1985 and 1990. Landowners have come forward to form irrigation cooperatives resulting in many areas becoming multi-cropped and irrigated areas being doubled to become 10% of total cropped areas. Hydrogeological studies have helped to identify proper siting of the structures which have a positive impact on artificial recharge in the hard rock terrains of this district. Lessons which can be drawn are:

- \* *Political support can be mobilized;* Political support for state intervention was mobilized through establishing labour-intensive WRM plans as part of the drought relief operation with support from the Technology Mission.
- \* *Bureaucratic organization can be a major constraint;* A horizontally divided bureaucracy can be a major obstacle for the cross cutting WRM activities. This can be overcome by breaking down hierarchy and establishing task groups and a sense of collective effort.
- \* *People's participation has to go beyond labour inputs;* Despite the involvement of the community in construction, water harvesting structures in Jhabua are still seen as government property. Thus leaving even minor repairs to them. This is not due to community apathy, but people are unsure of their right to "tamper" with a structure created by government.
- \* *Pooling efforts to mobilize action;* An environmental crisis can be a strong incentive or opportunity to mobilize for collective action. Effective communication strategies call for pooling of efforts by government, NGOs, communities as well as media professionals.
- \* *Combining poverty reduction and eco-restoration;* The Jhabua case shows that areas with large scale degradation can be turned around and put on a road to recovery to sustain their inhabitants. This requires an integrated plan for WRM supported by financial resources for large-scale employment generation. Water harvesting is a labour-intensive activity and offers an ideal investment opportunity for programmes aiming at poverty reduction and rehabilitation of the environment.

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