TRADITIONAL KNOWLEDGE CONCERNING WATERQUALITY AND WATER-MANAGEMENT IN RURAL AREAS OF INDIA

SASKIA REBERS,

February 1990

Department 'Waterpurification', Agricultural
University Wageningen, The Netherlands

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for the department 'Waterpurification' of the
Agricultural University Wageningen in The Netherlands,
under supervision of Ir. J. van Buuren.

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CONTENTS

PREFACE

It's not only for this study that I went to India. First aim was to learn from the country, from the people and from their culture. Additionally I did a small job for the National Institute for Public Health and Environmental Protection in the Netherlands. This institute has organized a course on 'aquatic ecotoxicology' which is part of an Indo-Dutch program to reduce waterpollution in India. My task was to evaluate this course and therefore I had to visit people from several institutes. This gave me a very good opportunity to come in contact with many different organizations and people working in different fields related to rural development or to waterpollution.

Many people contributed to make my stay in India a significant and a comfortable one. I am very gratefull to these people but there are too many to mention them all. Those who were prepared to talk with me about this study are mentioned in chapter 2.

Especially I want to mention Mr. Bansal, Mrs. Gadkari, Shri Raut and people from Urmul Trust for their help in making contacts with other people from institutes, villages or slums.

I am very grateful to Mr. Reddy and his wife Saroja, to Mr. Trivedi and his wife, to Swarup, Padmini and Didi Ananda Mitra and to people from Glorialand farm and from Ananda Nagar for their hospitality and their mental support.

Last but not least I want to thank Joost van Buuren, Henk Renting, William Oliemans and Gerrit Dekker for their critical remarks and for correcting this report.

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Saskia Rebers

SUMMARY

Problems with the quality and availability of water in India are still increasing. In rural areas these problems are often closely related to the hydrology and are caused partly by changes in land- and water-management.

Many projects have been set up by Indian organizations, sometimes in cooperation with western organizations, to improve the quality or availability of water in rural areas. Also western technologies have been used, but a gap in culture often limited a proper application of these technologies. Nowadays the importance of the culture of the concerned population-group and their participation in a project is recognized. Nevertheless, in many projects little effort is done to make use of the traditional knowledge of the population-group or culture concerned.

The two-fold OBJECTIVE of this study is:

- to get more insight in traditional knowledge concerning water-management and waterquality in rural areas and
- to look for possibilities of application of traditional knowledge in activities focussed on improvement of waterquality and -availability.

To get more insight in traditional concepts, practices and methods for collection, storage and use of water, two ecological farms and two development projects have been visited. Possibilities to apply traditional knowledge have been discussed with people from these places and with people from non-governmental development organizations (NGO's) and from governmental institutes.

Traditional knowledge does exist and is still alive in rural areas. Traditional systems and methods found during this study include (chapter 3):

- systems for rainwater harvesting and for groundwater exploitation,
- systems for waterstorage, recharge of groundwater and prevention of floods,
- systems for irrigation and drinkingwater supply and
- methods for soil- and waterconservation.

Besides these technical systems also traditional social systems existed:

- social systems for maintenance and repair of technical facilities and
- social systems for decision making about land- and water-management.

These social systems were not only essential for maintenance and development of technical facilities, but also for the motivation of all villagers to cooperate. Especially the involvement of women was important as they would be the first to notice occurrence of diseases, lowering of watertable, etc. They will transfer their knowledge to the next generation. This knowledge includes amongst others:

- customs to prevent contamination of drinkingwater and
- methods to treat water for drinking or bathing.

Many traditional practices in land- and wateruse are disappearing or have disappeared. The main reason for this seems to be a change in government policy concerning land- and water-management.

The British introduced new technologies for large-scale irrigation, drinking-water supply, agriculture and industries. After independence the government stimulated these developments for which a centralized control was necessary. The traditional systems needed a decentralized control because of the small scale and therefore lost support from the government.

The government interfered in watersupply and in the use and division of the land. This weakened the village institutions which controlled and maintained the traditional systems. The people in rural area became more dependent on government for watersupply; for the use of common lands, and more dependent on money for products from cities and industries. A shift occured from **mutual dependency** and **self-sufficiency** within a village, towards **dependency on government and money**. As a result the social control faded away and with this the village institutions collapsed.

Large scale technologies and their necessary government control cannot take into account the diversity of the soil, climate and cultures in rural areas. The neglection of this diversity and the scale-enlargement in agriculture and watersupply contributed to deterioration of environment.

Especially poor people in rural areas were affected most by the resulting disappearance of their land. Nevertheless these people are often not interested in restoring traditional systems as they want to see direct benefit from their activities. As they feel direct need for money, water and food, they are not interested in long-term solutions.

Both governmental institutes as well as NGO's are concerned with improvement of living-conditions in rural areas. In general, NGO's search for solutions in a decentralized approach, whereas the governments stick to a mass- approach.

Many of the government officials with whom has been spoken do not think traditional knowledge might contribute to a solution. They mention the following disadvantages of traditional systems:

- No good waterquality can be guaranteed.
- Government control is not possible.
- Villagers are not interested.

NGO's working on village-level (grass-root organizations) often try to make the villagers aware of their own situation and of their own possibilities to improve their situation. The villagers are stimulated to organize themselves and to continue the activities that are started by the NGO's.

Other NGO's, often coordinating grass-root organizations, have a more comprehensive approach: creating awareness among various layers of the population about the situation in rural areas and their possible contribution to this. Several of these organizations consider it essential to link up with traditional knowledge. Reasons for this are:

1 Traditional methods are time tested and are in balance with the environment.
2 Systems based on traditional knowledge can be understood better.
3 Villagers can maintain and control these systems themselves.
4 Traditions appeal more to villagers than new technologies.
5 Emphasizing their traditional knowledge will make villagers aware of their own relation with their environment and their own possibilities to contribute to better living-conditions. This also stimulates formation of new village communities.

In different ways NGO's and some governmental institutes make use of traditions, traditional systems or traditional knowledge:

- Traditions are used to attract attention and to transfer messages.
- Traditional organization is studied for a better approach.
- Local resources and local skills are used.
- Traditional systems are restored, methods are re-introduced.
- Traditional concepts are applied in new technologies.
- Villagers are stimulated to use their own knowledge.

It is clear that it is not at all necessary to go back to traditional systems. Traditional knowledge is even applied unconsciously in modern technics, for example in the modern approach for watershed management. Nevertheless, conscious use of traditional knowledge might be important for a better connection with the needs and skills of the people in rural areas.

From this study also appears that neglectance of traditional knowledge is one of the reasons for the actual problems in the rural areas of India. Traditional knowledge could contribute both to better watersupply in rural areas as to rural development in general as well.

Organizations or individuals that are involved in application of traditional knowledge deserve more recognition and support from the government. More research should be done into the value of traditional systems and customs for soil- and water-conservation and for waterpurification. Also possibilities to apply or improve traditional concepts in a modern approach should be investigated.

1 INTRODUCTION

The issue of waterquality not only appears to cross boundaries between countries but also between cultures. People from different cultures and with different worldview deal with the same water. One reason for lack of water of good quality is the fact that scientists, politicians, producers and consumers do not see the consequences of their activities outside their world-view.

'Waterquality' is a western concept that refers to the extent to which water meets the requirements made upon it. On the one hand these requirements depend on functions for which different groups of population want to use water. On the other hand waterquality is also influenced by these functions and by the way people deal with water. Evidently, this **'dealing with water'** differs from culture to culture. A non-western culture might have conceptions of the use or 'cleanliness' of water which western people do not understand or of which they do not see the use.

Because of my Dutch background, my view on the issue of waterquality is limited to the Dutch situation. I decided to visit a non-western culture to enlarge my understanding of the relation between waterquality and culture. India was especially interesting to me because of its old and rich culture. On the other hand, since the introduction of western technologies, this country is affected more and more by severe waterpollution, lack of drinking-water, floods and droughts.

Short overview of problems in India concerning waterquality

The most acute problem in India is the lack of good drinkin-gwater. Surface-water is polluted by industries or contaminated by pathogens. Self-purifying processes are no longer sufficient. Further more, as a result of overexploitation the groundwater-level is lowering rapidly in many areas (Sarkar, 1988; S.K.S.Reddy, 1989). Estimates of this are :

- 25-30 metres in a decade, for the whole country (Schwarz, 1988),
- 40 cm a year in Jodhpur and Bikaner (Rajastan) (Monte,1988; Rai,1987),
- almost one metre a year in Chandigarh and
- 8 metres in 9 year in a village near Bangalore (L.N. Reddy, p.i.).

The number of villages with drinking-water problems is increasing. There are villages without any drinking-water, where women have to walk several miles a day to collect the water. Because of the increasing depth from which the water is drawn, the water contains more iron, fluor or salts (NEERI, film about the Water Technology Mission). Fluor can cause fluorosis, a disease of the bones very common in India. In villages near Jaipur many children died from problems with digestion, caused by the brackish water (Indian Express, 1989).

In many cities in India it occurs more often too that tap-water supply is restricted to a few hours a day, especially before the monsoon period begins (Own experience in New Delhi, Calcutta, Bombay, Lucknow, Allahabad and Bikaner).

Two-third of India suffers from droughts. Even Tamil Nadu and Kerala which receive a lot of rainfall, have experienced droughts since 1980 and 1983 respectively. Another example is Rajastan which normally has 27 years with good rains in a century but in last 50 years only had 4 years with good rains (A.Kumar, p.i.).

At the same time, large areas suffer from floods every year. The occurence of these floods is enhanced by a decrease in water-storage capacity of soils and water-bodies. Soil-erosion in the hills is caused by bad land and water management (e.g. big scale deforestation). This results in the siltation of water-bodies. 45 percent of the water received through rainfall is lost through surface run-off (Patel, 1988). According to Rai (1987) 50-60% of the surface water is lost by run-off.

Large dams have caused waterlogging and salinity, by which large areas of agricultural land have been turned into wasteland. Different rough estimates exist in this: 10 million or 6 million hectares by waterlogging, and 25 million or 7 milion hectares by salinity. In total one-third of the agricultural land (90 million hectares) would have been wasted during last years through waterlogging, salinity and erosion (Schwarz, 1988).

This short overview shows that problems with **waterquality, water availability and hydrology** can't be seen seperate as their roots all lie in **water- and land-management**. Western interference brought about changes in land- and water-management and with this in hydrology. An example is the import of western technologies and export of cash-crops.

During the Green Revolution changes in the cropping pattern occured and big mono-cultures were introduced. This had great impact on both technical and social land-management: pest-control, distribution of land, etc. Organic manure was replaced by chemical fertilizers which reduced the water-retention capacity of the soil. Furthermore the newly introduced hybrid-species needed more water. To meet the growing need for irrigation-water big dams were built. Also these dams had far-reaching consequences for the use of land and water and for the hydrology.

Measures for better waterquality

It is clear that problems with the quality and availability of water are increasing (CSE, 1985). This in spite of the attention that has been paid to these problems by the Indian government, western countries, universities and research-institutes. Projects have been set up in cooperation with western countries to purify the water or to improve its availability. Many of these projects have not been able to improve the situation of the worst affected people as no connection was sought with the population group or culture concerned (CSE, 1985). Examples are the handpumps or watertreatment-systems that are not accepted in the villages where they are built, or cannot be maintained by the local population.

Another example is the Ganga Action Plan which has been started in 1984 by the government to clean the Ganga. This plan has been criticized for accepting too precipitatedly the Dutch UASB-technology for anaerobic watertreatment (Menon, 1988). No sufficient study had been done about the available technologies in India, the applicability of the Dutch technology and about the possible acceptance and maintenance in the Indian situation.

In development projects most attention has been paid to the **symptoms** of bad water-management, pollution and shortage of water, and to **technics** to fight these. Failures occured and showed that watermanagement is related also to the local culture and to the interference of other cultures. Plokker & Spierenburg (1988) mention in this context the occurence of 'cultural disturbances'. These disturbances often occur when development workers can not understand a situation in their workingfield because of differences in norms and values. A **gap in culture** often limited proper application of a western technology in a non-western culture.

Nowadays the importance of the culture is recognized since a project is no more seen as only a technical intervention but also something involving socio-economical changes and changes in organization (Plokker & Spierenburg, 1988).

In the Dutch development-aid nowadays sociologists and cultural anthropologists are involved to bridge the gap in culture mentioned above. A lot is talked about the bottom-up approach that, in contrast with the top-down approach, starts with the needs and the wishes of the concerned population. Many projects include community-participation, trainings, health-education, etc.

Motive for this study

Nevertheless it is my impression that Dutch organizations are still focussed on only bringing their knowledge towards India. Little effort is done to make use of the traditional knowledge of the population-group or culture concerned. I suppose that India has a very rich source of knowledge, originating from its own culture.

Traditional knowledge means here : the knowledge that has grown within a group of the population, built up by experience and transferred from generation to generation. This knowledge might come to expression in methods, customs or conceptions.

Different groups of the population might have developed different conceptions, customs, methods or even systems which improved or preserved the quality or availability of the water. In drinking-water or water-purification projects little or no attention is paid to this traditional knowledge as if it does not exist or cannot be of any value.

According to Dr.N.Sengupta (p.i.) the knowledge of water management, handed over from generation to generation, is extensive. No detailed inventory has ever been made for traditional systems of water-storage and irrigation. Detailed information would not rest in ancient manuscripts but with the practitioner, the peasant (Sengupta, 1985).

In rural area water-use and -management will be more closely related to daily life then in cities. Therefore traditional customs and conceptions concerning waterquality and -availability, and traditional methods concerning water-management, might exist more in rural area. Nevertheless, a lot of traditional knowledge might have disappeared through poverty and through western influences (Custers, 1984).

These insights lead to the next two-fold OBJECTIVE of my journey to India:

- To get more insight in traditional knowledge concerning water-management and waterquality in rural area.
- To look for possibilities of applications of traditional knowledge in activities focussed on improvement of waterquality and water-availability.

This study is limited to drinking water and water for domestic use and irrigation-purposes. These uses are dealt with together as in water-management in rural areas they are not always seperated (Sengupta, p.i.). For example: The dryer an area is, the more importance is attached to drinking-water. But in years with good rainfall the water, which is collected or stored in the same way, will be used for irrigation-purposes.

In this study, water-management includes besides waterstorage and-distribution also the use in the householding. Additionally water-supply, water sources, hydrology and land-use are taken into consideration as these factors also influence the availability and quality of water.

The way in which the information has been collected is described in chapter 2. Traditional knowledge about waterquality and water-management can be found in the way water is used and water-supply systems are managed. In chapter 3 traditional methods and traditional knowledge concerning water-management and water-use are described. Chapter 4 gives a short overview of changes that made these traditions disappear. In this chapter also examples are mentioned of actual applications of traditional methods. Chapter 5 gives an overview of opinions that exist about the importance of traditional knowledge. The attitude of villagers towards the use of traditional methods is illustrated in two examples. An evaluation of this study is given in chapter 6.

Some of the visited institutes, organizations and projects are described in appendix A.

2 PROCEDURE

The procedure I followed started with some adresses from farms, organizations and institutes and was further mainly determined by the known snowball-effect. In this chapter the visited organizations are mentioned and a short description of their aim is given. some organization are described more extensively in appendix A.

At some places I was advised to visit certain projects or people or to read certain articles. These projects, people or articles are mentioned between brackets behind the places where they were recommended.

To get an idea of water-use and -management in rural areas and of traditional methods and conceptions still existing there, the following places have been visited:

. Sorahunase

A village near Bangalore (Karnataka) with an ecological farm, belonging to L.N. Reddy. His aim is to develop an independent, self-sufficient system, based on optimal use of local natural resources. Here I have helped during two weeks on the land and in the household. [Reddy, 1988; publications from the South Asia Reconstruction Association]

. Glorialand farm

This ecological farm belongs to the Shri Aurobindo Ashram in Pondicherry and is managed by M.Pal. During one week I have helped on the farm.

. Ananda Nagar (see appendix A)

An agricultural, industrial and educational development project in Purulia District (West-Bengal). Aim is to develop a 'model-city' with ecological and economical independent use of the natural resources land, water, air and sun-energy. I have visited several activities from this project. During a few days I helped at a village women's project where special attention is paid to the needs of women in all aspects of life. [Ananda Mitra, 1988; Sarkar, 1988; Jai Ante, spokesman of P.R.Sarkar]

. Urmul Trust (see appendix A)

A rural health research and development project in Bikaner-District (Rajastan). This organization wants to create awareness among the villagers about their own possibilities to improve their situation. They have programs for employment, health education, improvement of water-supply and reforestation. During a few days I visited several villages where Urmul Trust is working.

With the managers of the farms and the people working at the projects, talks were held to learn about their ideas and conceptions concerning waterquality and water-management. At Urmul Trust some questions have been posed to the villagers with the aid of translators.

The questions which I posed the people involved or which I asked myself, looking around, were:

- Which water do the people use for drinking, bathing, cleaning or irrigation?
- Where is the water coming from, how is it stored and how is it used? ?
- How traditional are these methods?
- What other traditional methods for collection, storage and use of water are known?
- What are the effects of these methods on waterquality and -availability?
- Which aspects of land-management influence the hydrology and are indirectly important for waterquality and -availability?
- How is the quality and availability of the water threatened?
- What conceptions do the people have about the use and purity of water?
- Could these conceptions and methods contribute to development of good systems of water- and land-management which improve the availability and quality of water?

In India many organizations of farmers, critical scientists, students, etc. exist. They organize discussions, meetings or write articles to create awareness about the worsening situation in the rural areas. Furthermore they organize projects and other activities to improve the living conditions there. As they try to work independently from the government, they are called 'Non Governmental Organizations', or NGO's. From some NGO's some members are requested about their approach to help people in rural areas and about their opinion concerning the importance of traditional knowledge and methods.

The following organizations have been visited (see also appendix A):

In New Delhi:

. Centre for Science and Environment, **CSE.**

This is an all-India organization focussing on science and environment. Aim of the organization is to create awareness among the whole population of India about environmental problems and to inform them about it. [Greenfiles, newspaper clippins about the environment, arranged on subject; CSE, 1985; D.Suri, reporter from The Tribune who has written about the village Sukhomajri]

. Delhi Science Forum, **DSF**.

This organization wants to stimulate discussion and exchange of experiences among scientists and engineers from different fields. The aim of DSF is to make science and technology of use for the whole population. An important point of discussion in this context is the relation between science and society.

. Action for Food Production, **AFPRO**.

Aim of this organization is development of weaker groups in rural areas by means of food production projects. AFPRO supports and advises voluntary agencies which set up such projects, and coordinates the implementation of the projects. [Voluntary Health Association India; Urmul Trust]

. Gandhi Peace Foundation, **GPF**.

The GPF studies the teachings and practices from Mahatma Gandhi and determines their importance for actual social and environmental problems. At the moment GPF is focussing on non-violent action and on the question how non-violence can contribute to a new approach for development.

Within the GPF, the Environment Cell is set up. This group assists voluntary agencies or movements that work with villagers for rural development and environmental protection. [Kumar/ Environment Cell, 1983; Ananthu et.al. 1988]

. Lokayan.

By means of dialogues Lokayan tries to improve contacts between activists, non-party political movements and individuals concerned with improvement of living conditions rural areas. [Lokayan Bulletin: Rao,1984; Column 'Survival' in Illustrated Weekly: Bandyopadhay, 1987; Bakshi, 1988],

In other cities:

. Prarambha, Bangalore.

Prarambha supports individuals and small movements that take up initiatives from villagers to improve their life-circumstances. Through villagers movements and newspapers she tries to compromise unjust situations. [Shari, 1984],

. Indian Institute of Youth Welfare, **IIYW**, Nagpur.

This organization goes to slums and villages for education and employment projects.

. Youth forum of Environmental Studies and Conservation, YFESC, Allahabad. This is a group of PHD-botany students from the University of Allahabad. They want to focus their study on environmental problems.
[Sanctuary: Bahuguna, 1987; Bharucha, 1987; Paranjpye, 1987; Bagla & Kothari 1987; Yojana: Ranganathan & Sastry, 1988; Khanna & Gupta, 1989; Science Reporter: Kaladharan, 1988; Basa, 1989; Nagarajan, 1987; Singh c.s, 1987; Articles from newspapers about Kumbh Mela: Datta, 1989; Dhavan, 1989]

The following members of these organizations were interviewed:

CSE: G. Kawarana and S. Narain,
DSF: Dr. Haque and D. Ragunandan,
AFPRO: R. Bathia and A. Kanal,
GPF: Shri Ananthu
Lokayan: S. Kothari and A. Kumar,
Prarambha: Dr.G.N.N. Prasad,
IIYW: Dr. Golpelwal,
YFESC: A. Srivastavi and A. Tiwari

These people were asked about the objectives of their organization. Depending on the type of organization, some of next questions have been posed:

- How is the quality and availability of water threatened in the area on which you are focussed?
- What activities do you have, related to these problems?
- What conceptions and ideas do and did people in rural area have about the use and purity of the water?
- What traditional methods for collection, storage and use of water are known?
- Which of these methods do still exist? Where?
- Could these conceptions and methods contribute to development of a better system of water-supply, water-management and agriculture? If so, how?
- Could they contribute to better application of western knowledge or technology in the approach of the problems mentioned? How?
- Do you know examples of application of traditional knowledge or methods in modern systems of water-management?
- What is your opinion about the use, re-use, application or stimulation of traditional knowledge?
- What is the attitude of the villagers in this?
- What role could different organizations, governmental or not, local or not, institutes and villagers play in this?

With social workers of the IIYW I had the possibility to visit slums in Nagpur and to ask the habitants about their water sources and water-use.

Also some governmental institutes have been visited to inform about their activities in rural areas, concerning waterquality and water-management:

. Central Pollution Control Board, **CPCB**, New Delhi,
. Uttar Pradesh State Pollution Control Board, **UPSPCB**, Lucknow,
. Orissa State Pollution Control Board, **OSPCB**, Bubaneswar,
. National Environmental Engineerings Research Institute, **NEERI**, Nagpur [a not published article from U. Menon, deposited for inspection with the director of NEERI; a film about the Water Technology Mission;
Water Science Technology: Kale & Bal, 1987; Kale, 1981;
Journal of Indian Waterworks Association: Gadkari, 1986 and 1987; Belsare, 1976; Bhole & Shrivastava, 1983; Kanga, 1983; Kardile, 1972, 1973, 1974 and 1977; Modi & Bhat, 1974; Shukla, 1984],
. Public Health Department, **PHD**, Bhubaneswar,

Other organizations or institutes which I was recommended to visit, are:

. Danida, Bhubaneswar, a Danish organization involved in Indo-Danish cooperation projects, working with the PHD in Bhubaneswar,
. National Botanical Research Institute, **NBRI**, Lucknow, Department of waterpollution,
. Central Soil and Water Conservation Research & Trainings Institute, **CSWCI** [Bansal & Misra, 1982; a visit to the village Sukomajri],
The Tribune, Chandigarh [Suri, 1987 and 1989],
. Madras Institute of Development Studies, **MIDS**, Madras [Economical Political Weekly: Sengupta, 1985],
. Indian Institute of Management, **IIM**, Bangalore,
. Institute for Ayurvedic Research, **IAR**,
. University of Allahabad, **UA**, Botany department,

The people visited have been posed the same questions as those from the NGO's:

CPCB : Dr.R.C. Trivedi, scientist (biology); Dr.M.A. Haque;
UPSPCB : Dr. G.N. Mishra, scientist; Dr.Y.C. Jaitly; Dr.M. Sikandar;
OSPCB : Shri B.K. Patra, environmental engineer; Dr.L.N. Pattanaik, scientist-C; Shri S.V. Rama Rao, members secretary;
PHD : Shri N. Mishra; Shri A.K. Pattanaik, chief engineer; Shri S.M. Pattanaik, chief engineer;
NEERI : Dr.A.S. Gadkari, scientist, head of the social division; Dr.C.K. Kale; Prof.P. Khanna, director;
Danida : Dr. Sukla, hydrogeologist;

CSWCI : Dr R.C. Bansal, engineer

The Tribune: Mrs D. Suri, she reports about events which affect the people in rural areas;

MIDS : Dr. N Sengupta, originally a statisticus. He has studied all irrigation systems existing in India and he further the participation of farmers in these systems;

IIM : Mr M.D. Hussain, research associate. He has studied a govern ment project for construction of new irrigation-tanks in drought-prone areas in Karnataka;

IAR : Dr Vasudevannair;

UA : Dr. D.D. Nautayal, head of the botany department.

A workshop on management of renewable resources, organized by the Madras Institute of Development Studies and the Indian Council of Social Scientific Research has been held in Bangalore. I attended one day of this 3-days during workingshop as observer and studied the papers which were to be dicussed at the workshop. I have spoken with the following participants:

Dr.A.P. Barah, economist, working at the university of Hyderabad on watershare in drought-prone areas in Andhra Pradesh.

Dr.S.T.Somashekhara Reddy, working at the Indian Institute of Management on tank irrigation.

Further more newspapers and articles have been studied.

3 TRADITIONAL WATER-USE AND -MANAGEMENT

Traditional knowledge about waterquality and water-management can be found in the traditional methods for water-management and in the way the water is used. Traditional systems for water-supply are described in section 3.1. Also the social management of these systems appears to be important (section 3.2). Traditions and conceptions concerning the use of water are mentioned in section 3.3. These traditions also include the use of plants for the treatment of drinking-water. As water-management is closely related to land-management, some examples of traditional land-use are given in section 3.4.

3.1 TRADITIONAL SYSTEMS FOR WATER-SUPPLY

In most parts of India the water from **shallow dugwells and ponds** has been used for centuries for drinking and domestic use. If more water was available, it was used for irrigation. If **lakes or rivers** were present, water was taken from there.

But the use and importance of these water-sources varied from region to region, depending on the soil and climate. The same applied for the existance of other systems to collect and to store water, and the way these systems were used.

The development of various systems started most probably with the discovery of iron, 1000 years BC. These systems were products of generations of experience and required a lot of expertise to be maintained. The systems were difficult to perceive in the landscape as they were made of natural material. Their performance was better than that of modern systems. All available water was used, the soil was kept productive and the land was protected against floods and droughts. (Sengupta, 1985)

Hilly areas

In hilly areas **tanks** were built to collect rainwater and surface run-off (Sengupta, 1985; L.N.Reddy, p.i.). These tanks were not dug but embankments in small valleys were made, which stopped the water coming from the hills. By the rising waterlevel a reservoir was formed. This type of tank was called **'erie'**, in Bihar it was called **'ahar'**, in South India sometimes **'kanmai'** (Sengupta, 1985). In Karnataka the smaller ones were called **'kuntes'** and if it was a natural depression without dam:**'katte'** (S.T.S. Reddy, 1988). In Karnataka still many eries exist. In 1989 some were still filled with water before the monsoon started.

In the higher, steeper parts of the hills the tanks were small and independent from each other. Going down towards the valleys the tanks were bigger. They were connected with each other by canals, called **'pynes'** in Bihar, and **'kalvais'** in Tamil Nadu and in Andhra Pradesh. Higher tanks provided lower tanks with water. The channals existed, according to Krishnan (1989), already several centuries B.C. The whole system was used for irrigation, but also recharge of groundwater played an important role.

Big **systems of interconnected tanks** for irrigation and for groundwater-recharge existed in South-India (Krishnan, 1989). In Karnataka 27000 villages had 43000 tanks (S.T.S. Reddy, 1988). In Anantapur district, a chronically drought-prone area in Andhra Pradesh, 2500 interconnected tanks covered 934 villages (Akhileshwari, 1989).

In the dam of the tank, sluices were made to let out the water for irrigation. The level of the sluices was determined by the level and the slope of the land and by the amount of water needed (Krishnan, 1989). Tanks without outlets were used for drinking-water and recharge of groundwater (Prasad, p.i.)

The tanks had to be desilted regularly. The silt was used as fertilizer for the soil. In North-Karnataka **pits** were made in the black soil to hold the silt, eroded by surface run-off. In the catchment area of the tank trees were planted to hold the soil. (S.T.S. Reddy, 1988).

In natural streams various arrangements like **dams** were built to divert the water. In the Himalaya these are called **'kuhls'** or **'katuls'**, in the Western Ghats:**'phabs'**, in the lower areas: **'anicuts'**.. These controlling works in the beds of the streams did not rise the waterlevel because the water was immediately diverted into canals or tanks for irrigation or groundwater recharge (Sengupta, 1985).

The steeper the slopes, the more dams. Going down from the hills, the reservoirs were bigger and the controlling works in the streams were bigger and less numerous. Canals for inundation and diversion were longer. An example of a very big dam built in the second century in the river Cauvery (Tamil Nadu) is the Grand Anicut (Sengupta, 1985; Krishnan, 1989).

In the Himalaya snow was collected from the roofs of the houses (Rai,1987).

In the lower sloping areas also **ponds** and **lakes** were dug to store rainwater. For example the Hussain Sagar Lake in Hyderabad has been made 500 years ago for domestic use and irrigation (Das, 1988).

The plains

In the flood plains of the Ganga and in the Bengal delta there were no controlworks in the rivers. The purpose of the **rivers and canals** was not irrigation, but flood control and drainage. The amount of the diverted water depended on the relative heights of the riverbeds and the channel-opening. In areas with regular and mild floods, the floods were utilized to regenerate the soil-fertility. In Bengal the farmers broke embankments along the rivers regularly to inundate their land. When later the British prohibited this, drainage became a severe problem. (Sengupta,1985).

It is possible that some of the major rivers of Bengal were originally artificial drainage canals as they have some geographical features, typical for man-made systems. The Yamuna Canal in Uttar Pradesh was dug by Firuz Shah Tughlah, 1400 A.C. (Sengupta,1985).

Where no floods occured, water for irrigation was provided by **shallow dug-wells**. The areas with dugwell-irrigation were often the most prosperous and densily populated areas, e.g. the Ganga valley. Recharge of the groundwater was quick because of the very permeable soil. Most wells were **kacha wells**, which means that the walls were permeable, made from stones, mud or clay. They were cheap to make and easy in maintenance and management. **Pakka wells**, which were stronger, were sited further away from the rivers (Sengupta, 1985).

Drought-prone areas

In areas with very little or irregular rainfall and without rivers, many systems existed to collect and to store rainwater.

In Gujarat and in Rajastan **'khaduns'** were used. According to A.Kumar (p.i.) these were natural depressions closed with a small dam (up to 2 m high). In dry years a Khadun was often moistened enough to grow crops in it. After a normal raining season the land around the khadun was cultivated. After a good raining season the water was used for irrigation, but only if there was no lack of drinking-water (Sengupta, p.i.).

Natural depressions without dam, like ponds, were called **'talav'**. The deeper ones were called **'nadi'** and were only used for drinking (Kumar, p.i.).

For drinking, rainwater was also collected and stored in perennial covered systems, **'kunds'** (Rai, 1987; Sengupta, p.i.; Bathia, p.i.). These kunds were sited in the centre of a hardened depression or water-catchment area. This area was desilted regularly. Water came into the kund through holes in the walls of the kund (figure 3.1). The covering prevented silt coming inside the kund (through sandstorms), contamination by pathogens and evaporation.

In Rajastan still many of these kunds exist in or near villages, most of them neglected. These are not very old as the catchment areas are cementised. Every joint family (The family of the father and his married sons) had one kund. These kunds provided drinking-water during 5 to 6 months average. Sometimes they were not used and the water was stored for periods of severe drought. If they were maintained well, the water could be kept good for 3 to 4 years (Urmul Trust, p.i.).

Within the houses small kunds were made, **'tanka'**, to collect rainwater from the roofs (Rai, 1987; Urmul, p.i.; Kumar, p.i.). The large kunds in the middle of the desert were called **'agor'** (Monte, 1988).

Different types of **wells** existed, although the use of wells was limited. The availability of the water was determined by recharge of the groundwater.

- A **'paar'** is a shallow well, dug in a depression with a rocky layer near the surface (figure 3.2). The water was used only for drinking (Kumar, p.i.).
- A **'kuiyan'** is a somewhat deeper well with more regular water-supply and often covered (Rai, 1987; Kumar, p.i.).
- A **'chua'** is a well which is dug in a dry riverbed.
- A **'baoli'** or stepwell is bigger. Water was often taken out by animals but no water was spilled. In Jodhpur (Rajastan) 42 baoli's existed of which one was built in 1618 (Monte, 1988). In Gujarat many stepwells existed but not more than one per village. This limited the wateruse and in this way it prevented depletion of aquifers (Sengupta, p.i.).

LABOR CONSTRAINT

Ponds were dug or **tanks** were built near villages or cities to collect rainwater. They were mostly used in the raining-season when a lot of work in the fields was done and these water-reservoirs were most nearby. The water was used for all purposes (Urmul Trust, p.i.). Bikaner (Rajastan) had 35 tanks, the biggest one with a catchment area of 149 km^2 (Rai, 1987). Jodhpur had 43 tanks, the oldest one built in 1500 (Monte, 1988).

Often trees were planted around tanks and ponds. In the dry, sandy areas wells were dug on the banks of ponds (Modi & Bhat, 1974).

Also palaces and forts, built centuries ago, had stepwells or tanks for watersupply, e.g. Ferozshah Kotla in New Delhi and Great Imambara in Lucknow.

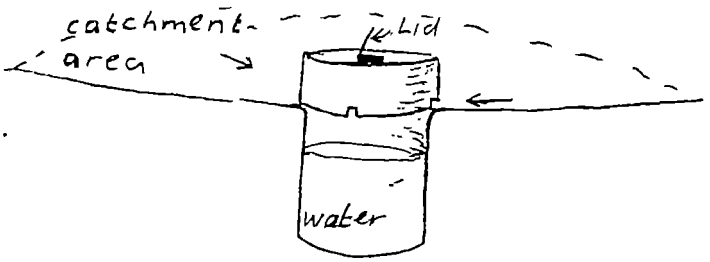

Figure 3.1: A traditional system in Rajastan to collect rainwater, a kund.

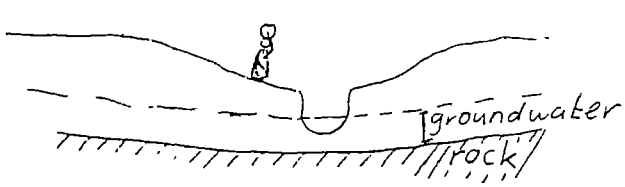

Figure 3.2: A traditional shallow dugwell in Rajastan, a paar.

3.2 SOCIAL MANAGEMENT

Water-supply not only involves technical systems but also social systems. Over thousands of years social and ecological mechanisms were developed for water-management, which protected against droughts (Bandyopadhay, 1987). As Sir Bampylyde Fuller wrote:'.. the Hindu's had two institutions: caste and village. Both served one purpose: Development of small self-contained societies which can resist outside aggression and natural calamities..'. (Krishnan, 1989).

According to Prasad (p.i.) the rural people had traditional knowledge of **filosofy, nature** and **organization**. It would go beyond the scope of this report to go specificaly into the fields of filosofy and nature, although section 3.3 refers to knowledge of nature. In this section the traditional knowledge of organization will be explained.

The experience of the rural people in organization manifested itself in the various **village committees** or **institutions**. These institutions took care for schools, temples, tanks, water-distribution, disputes, grazing-land and other things which concerned the villagers (Krishnan, 1989; Prasad, p.i.). These groups worked independently from the government (Reddy & Subbalakshmi, 1989).

The institutions were administered by the **Panchayat**, consisting mostly of landowners (S.T.S. Reddy, 1988). The panchayat made use of unwritten rules and conventions, arisen in the village. This **common rule** concerned amongst others:

- delivery and distribution of water,
- maintenance of tanks, ponds, kunds,etc,
- available quantities of water,
- cropping patterns (S.T.S. Reddy, 1988;Bansal, p.i.)

All villagers were involved in water-management. As they all made use of the water, they participated in repair and maintenance (Sengupta, p.i.). Water-supply was a social responsability (Monte, 1988; Barah, p.i., Bansal, p.i.).

An informal organized village action for maintenance of a tank was called **'goam'** in Bihar and **'kudumarath'** in South India (Sengupta, 1985; Krishnan, 1989). In 1982 near Patna thousands of villagers assembled in a goam to divert the river Punpun for irrigation (Sengupta, 1985).

Equal division of irrigation water was difficult because of different distances from the diverting canals, different periods of irrigation, different crops, etc. Deliberation and good contacts between farmers were necessary for equal division.

A rotation system existed, **'muray'**, in which farmers took turns in irrigating their land (Krishnan, 1989; Sengupta, 1985). In some villages in Karnataka farmers used to sing a special song during the time they opened a sluice in a dam for irrigation. The irrigation took as much time as the song and the whole village could hear it. (Hussain, p.i.). Another old management system that still exists in some places in Karnataka is **'dhamasi'**: In case of water shortage, farmers at the beginning of a distributary placed land at the disposal of farmers at the end. (Hussain, p.i.).

Sengupta (1985) described a still existing system in Bihar from which the villagers themselves were unaware: In spite of the different castes, all farmers had a plot at the beginning of the distributary, some plots in the middle and some at the end. As all the farmers grew paddy and sowed at the same time, also irrigation was needed at the same time. This made a fair distribution of water much easier.

The community not only maintained the systems for watersupply. **The technical provisions also maintained social life** (Reddy & Subbalakshmi, 1989; Sengupta, 1985; Prasad, p.i.; Urmul Trust, p.i.):

- The well as meeting place for women is of vital importance for the social aspects of water-management. Women fetch the water and determine the use of water in the household and with this also the hygiene (Gadkari, 1986). They are the first who will notice changes in availability or quality of water. The meeting is important to exchange experiences with diseases or to utter discontent about the water-supply. Women also transfer their customs and knowledge concerning wateruse to the next generation.
- The community systems sustained a system of control and decision making in land and water management.

For decisions on higher level villages are nowadays put together in a 'block', and more blocks in a 'district'. Earlier also districts existed, but they were formed in a different way. Delhi Science Forum studied how, in the case of artisans, towns in rural area, big and small villages were organized (Ragunandan, p.i.):

Work for which expensive instruments were needed, was done several by artisans in the town. Simpler works were done in the surrounding villages. The easiest works (regular reparations) could be done in the scattered smaller villages.

The villages surrounding one town formed a district, which differed from the districts by which states are divided later, see figure 3.3.

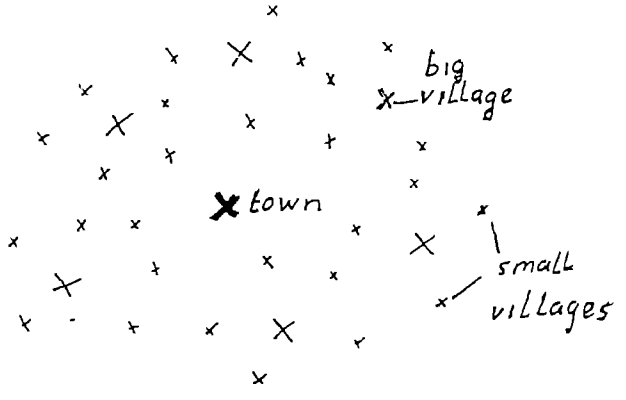

Figure 3.3: The traditional organization of a district

3.3 WATERQUALITY: TRADITIONS AND CONCEPTIONS

The water source

Groundwater is bacteriologically safe. Unless the soil around a well is polluted, the water does not need any purification. For this reason groundwater is nowadays thought to be the best water-source in India (G.N.Mishra, S.M.Pattanaik, P.K.Pattanaik, p.i.).

Before kolonization some **awareness of the purifying capacities of the soil** did exist. The water people took from chua's (see section 3.1) was filtered in the riverbed. Where it was possible they dug shallow wells, even on the borders of ponds and tanks. But they also knew that **this water-source is not inexhaustible**. Their systems of small and big tanks show the importance of **recharge of aquifers** to make longer use of the wells possible.

Places with water in the underground could be found by the vegetation present. Some **plants** indicate the presence of abundance of water or salts (Kaladharan, 1988). Another known traditional method to find water is the stick method or **divining rod** (Golpelwal p.i.). Also a water-source should be present if an ant-hill was built near a dead tree.

Nevertheless not everywhere the groundwater was used for drinking. In some villages people still don't drink the water from tubewells. They are not used to it or it has a bad taste. The mineral-rich rocky layers from which the water is pumped up, cause a high iron or salt content. Also in coastal areas the water may be saline.

In Rajastan **rainwater** was considered to be the purest (Rai, 1987). Still the villagers prefer rainwater, although now water is provided by tubewells.

Furthermore also **surfacewater** was and is still used for drinking.

Maintenance and use of the water-supply systems

Waterquality is not only determined by the water-source but also by the maintenance and use of the water-supply systems.

Often separate wells, ponds or tanks were used for drinking-water, for animals and for washing. No animals and people with footwear were allowed to come near sources for drinking-water or in the catchment area of kunds. The surroundings were kept clean. (Rai, 1987; S.M. Pattanaik, p.i.). In rural areas the people wash their feet after walking on the land or through cowdung.

The villagers were very strict in observing the rules against pollution of water-sources as they considered water to be holy. According to their religion, water purifies the soul.

Temples were built near ponds or tanks (Rai, 1987). Also near temples tanks were dug in which people washed themselves before entering the temple (S.M. Pattanaik; N.Mishra, p.i.; Bathia, p.i.). It was not allowed to use the water for other purposes. In Bhubaneshwar sick people are not allowed still to bathe in tanks near temples.

Still religious festivals are held near the water. Many rivers and especially the Ganga were and are still holy. This also implicates that pollution of a river would be severely punished (Datta 1989; Dhavan, 1989).

See TP 22 for some data on these aspects

Contamination

People may not have been aware of the existence of pathogens. Nevertheless they knew its relation with diseases. For example they prefered to wash themselves in streaming water or they boiled water for drinking if enough fuelwood was available (Bathia, p.i). Their knowledge manifested itself also in the way they stored and used the water in the household.

Water was stored in covered, earthen or copper pots. In copper pots bacteria are killed by a slight amount of copper-ions in the water. Earthen pots cool the water through evaporation. A low temperature checks the growth of bacteria.

Earthen pots are still used in the visited villages near Bikaner,in Rajastan, near Ranchi in West-Bengal and near Allahabad in Uttar Pradesh. In some slums near Nagpur people start using these pots after 'Holi', an important religious festival in February (Golpelwal, p.i.). In February the temperature starts increasing and with this the danger for bacteriological diseases increases.

Economic and hygienic use

In the household economic use is made of water (Rai, 1987; Bahuguna,1988; L.N. Reddy, p.i.). In Rajastan the water used for washing is afterwards used to clean the floors and to cool the houses. The thick walls and the small windows also keep the houses cool.

In Sorahunase the water used for washing, streams to the latrine. Wastewater from the latrine and from the stables is used for irrigation. The water used for washing hands after eating is collected on the dirty dishes to remove the foodleavings. This economic use doesn't have to be unhygienic:

- Still people working on the land wash their feet before entering the house.
- The housewife washes herself before she enters the kitchen in the morning.-
People wash their hands before and after eating. Only the right hand is used for eating, the left hand is used for the latrine.
- Water for different ends is stored in different pots or buckets.

The clearness of water

During storage the suspended particles settle down so that the water becomes clear. Beside the taste also the cleanliness of water was thought to be important (S.M. Pattanaik, p.i.). Other methods to remove turbidity are:

- **Cloth-filtration** (Urmul Trust, p.i.; S.M. Pattanaik, p.i.; Ragunandan, p.i.). In slums around Nagpur people still bind a cloth around taps from pumps during monsoon (Golpelwal, p.i.). In monsoon most diseases occur because contaminated wastewater from latrines easier reaches drinkingwater sources.
- **Pot-filtration** (see figure 3.4): 3 or 4 earthen pots were put on top of each other. In the first one pebbles were put, in the second one sand and in the third one charcoal. These pots had a small hole in the bottom through which the water dripped in the next pot. In the fourth pot the filtered water was collected. (Gadkari, p.i.; Ragunandan, p.i.). With this method also slightly contaminated water could be purified (S.M. Pattanaik, p.i.).
  Pot-filtration is still used in villages in Andhra Pradesh (Barah, p.i.) and in West Bengal (Purulia District), for example for sick people. In Gorakhpur it is still used during monsoon (Bathia, p.i.).
- The wiry roots of vettiver (Vetiveria zizanoides) were laid in a clay jar with a few tiny holes. The filtered water was not only clear, it also had a pleasant smell. (DST, 1979).

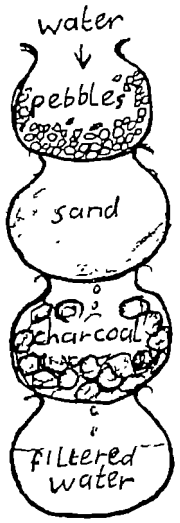

Figure 3.4: Traditional Pot-filtration method.

Bhole & Shrivastava (1983) mention the following plants from which powdered seeds are used as **coagulant or coagulant-aids**: Strychnos potatorum; Masur (Lens esculata), Jawar (Sorgum vulgare), Potato (Solanum tuberosum), Singhara (Trapa natans) and Drum-stick (Moringa olivera). Also alum is a coagulant. It was added to open wells and is still used in some villages (Ragunandan, p.i.; Bhole, p.i.).

Treatments with parts of plants are (if no latinic name of the plant is known, the hindi name is underlined):

- Seeds from the nirmali plant (S.potatorum) or clearing-nuts, were sliced and rubbed around the sides of earthen pots or they were crushed to make a paste. This paste was added to water and after stirring alum was added. (DST, 1979).
- The seeds of Drumstick (M. olivera) were crushed and a suspension was made. This suspension was slowly stirred with the turbid water. (DST, 1979; Bathia, p.i.).

- Seeds of lady-finger (Abelmochus esculentis) were crushed and put into the turbid water (Gadkari, p.i.).
- A piece of the Hingala tree was added to the water (Sukla, p.i.).

Purifying capacities of plants:

In India it is still very common to treat drinking-water with parts of special plants to purify it or to improve the health. A lot of traditional knowledge exists about the **medicinal value of plants**, fixed in the **Ayurvedic Medicinal System**. Some of the plants are used against waterborne diseases.

The following information comes from Dr. Vasudevannair from the Ayurvedic Research Institute in Trivandrum, if no other source is mentioned:

- A mixture of the heartwood of acacia (Acasia catechu) and sandelwood (Santalum album) the root of V.zizanoïdes, the bark of cinnamon (Cinnamomum zeylanicum) and the seeds of cardamon (Clettasia cardamomum), is boiled in the water. Beside purification this preparation is good for general health. This method is used more in the South than in the North.
- Fruits of Terminalia chebula are crushed, boiled in water and kept overnight. This preparation is healing in general and is used in the plains up to 800 metres, where this tree is growing. The tree possibly absorbs allergy creating materials from water and air.
- A paste is made from nirmali-seeds (S. potatorum) and the roots of black vettiver (V. zizanoïdes), which is smeared on the inside of earthen pots or stored in the water. After filtering the water is used against dysenteri.
- Hindoes chewed on the leaves of Ocemum sanctum before drinking. This very sacred plant was used in all villages. It worked amongst others as a desinfectant and mosquito repellant. The plant was planted on the borders of ponds against erosion and to reduce the salt content in the water. The last is especially important in coastal areas. The plant is also believed to purify the water.
- The leaves of neem tree (Azadirachta indica) are boiled in water before drinking (Nautayal, p.i.). Also the skin is boiled in water (Sukla, p.i.). The tree desinfects the air (Nautayal, p.i.). The seeds and the leaves of neem contain materials that repel insects, disturb their growth or kill bacterias (Basa, 1989).
- Dried fruits or a piece of the bark of amla tree is put in the water before drinking. Pieces of amla were also added to water, together with lime, when a rat was found in it (L.N. Reddy, p.i.). The fruits, goozeberries, are rich in vitamin C and improve the general health. Amla is a very holy tree, planted around ponds and worshipped by women.

- Seeds of red sorella are put in the water before drinking.
- Pieces from the tree Mathuka latifolia are kept in water to purify it.

The following plants are believed to have some purifying capacities, but no preparations have been found:

- Nut grass (Cyperus robundus) helps against worms.
- The roots of brinjel or eggplant (Solanum melongena) are used against diarhoea.
- Waterlilies (Nymphea spiciosum, N.stellata and Lotus) are used against childrens diseases like diarrhoea. Nymphea is thought to detoxificate the water. In some villages people only drank water from a well when a lotus was growing there.
- Waterhyacint (Eichornia crassipes) has waterpurifying capacities (Nautayal, p.i.).
- Himalayan cederwood (Cedrus deodara) is used against dysentery. It is a sacred tree which contains many aromatic oils. The root-system plays a role in purifying the groundwater.
- Nardostachus intermansi works antibacterial and mosquito repelling. It is also a sacred tree which contains aromatic oils. The roots are used to purify the air. This tree grows in watery areas at high altitudes.
- Studies revealed that use of tamarind from the Tamarinde tree in the diet can prevent fluorosis. Several cultural homogenic groups traditionally used ripe tamarind. (Financial Express, 1987).
- Leaves of amla tree, neem tree (A. indica) and citrus were used together to prepare water for washing small babies and their mothers (L.N. Reddy, p.i.).

The effect of these plants and trees on water is not exactly known. At the Ayurvedic Research Institute only effects on the human body are studied. Trees play a key role in Ayurvedic medicine and in agriculture. Nowadays this is neglected by the academic world (Singh e.a. 1987).

Around wells and ponds often trees are found (Bathia, p.i.). These trees hold the soil so they prevent siltation of the pond. Besides they limit evaporation from the water surface (Kanga, 1983).

Possibly trees also reduce the amount of pathogens via falling leaves or exchange of materials with the groundwater. The repellant effect of some trees on insects checks the spread of diseases. According to Golpelwal (p.i.) amla is planted around ponds to purify the water.

3.4 TRADITIONAL LANDUSE

As in the use of water also in the use of land many customs are related to religion and seem to have no reason. However, Schwarz (1988) warns us: There was method in the superstition.

The myth exists that Ganga, the river-goddess, didn't want to come down to earth because of her destructive forces. She only agreed when lord Shiva, who lived in the Himalayas, would tie her down by using the locks of his hair, the trees. (Schwarz, 1988; S.N. Mishra, p.i.).

Nowadays people are rediscovering the truth behind the myth: Trees have protected the country against floods for centuries. The conviction that sacred trees should not be cut down or grazed away, has proven its value.

Special qualities assigned to two important trees are:

Banyan-tree: Gives a lot of shade and has a very deep root-system. Near a Banyan-tree often a temple is built. This tree is especially worshipped and maintained by women. (Bathia, p.i.)

Neem-tree (see section 3.3): It grows quickly and has a very extensive root-system. It has capacities to grow on nutrient-deficient soil, to stand long periods of drought and high temperatures, and to enrich the soil with Nitrogen-rich twigs and leaves. (Basa, 1989).

According to Sengupta (p.i.), the development of traditional agricultural techniques was based on considerations about water availability. Following examples come from L.N. Reddy (p.i.) if no other source is mentioned.

- The cropping pattern was determined by the monsoon.
- In regions with little or erratic rainfall only dry crops were grown.
- In Rajastan one grass-species which is considered holy is never taken away. It serves as fodder for animals in drought-periods (Kawarana, p.i.).
- To water new planted trees, a covered earthen pot with a small hole was put in the soil, next to the tree. It slowly supplied the tree with for example 1 litre water a day. A 15-litre pot thus had to be refilled only twice a month. Direct watering of the soil needs more water and more time.
- Compost was stored in pits, in between trees. The humid compost provided water and nutrients to the roots of the trees before it was brought to the land. In parks in Bangalore these pits still exist but they lost their traditional use as they are now cementized and filled with waste and leaves.
- The organic manure added to the soil increased its water-retention capacity. (Kale, p.i.).

- When people in Karnataka needed soil, they dug small road-side pits. The water that came into the pits afterwards was only used in stress periods. The pits further served for recharge of groundwater. Many small pits give more effective recharge than a few big ponds.
- Before cultivating the land, it was terraced.
- On the slopes of hills contour-trenches and -bunds were made (fig. 3.5).
- Shrubs or grass held the soil on the borders of the fields or on the bunds.

According to L.N. Reddy, before the green revolution a farm was a self-sufficient, self-contained body.

Earlier, many common lands existed that were not used for agriculture, like forests and wetlands. For centuries the natural resources of these common lands provided subsistence to the rural poor, shepherds and artisans. Effective management of the resources by village communities prevented erosion, exhaustion and drying up of the soil (Ramaswami, 1989).

Wetlands need special attention. They included lagoons, tanks or reservoirs. They did not only provide material for life support, but also served as a barometer for the health of the ecosystem (Vitrayak, 1988).

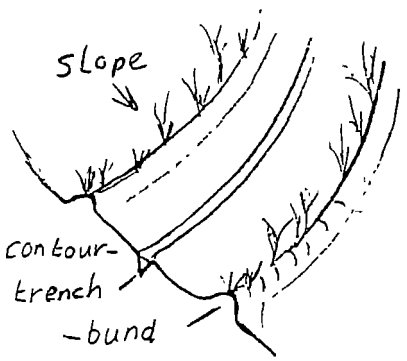

Figure 3.5: A slope with contour-bunds and contour-trenches.

4 CHANGES IN WATERMANAGEMENT

In this chapter is explained how traditional systems for water-supply, both technical and social, could disappear, and why traditional knowledge has been neglected (section 4.1). Section 4.2 gives examples of actual applications of traditional knowledge.

4.1 CHANGES SINCE COLONIZATION

Before colonization by the British, the system for watersupply served the benefit of the community more than individual gains. Maintenance of the systems was a collective responsibility and little dependence of the central government existed (Reddy & Subbalakshmi, 1989), see also section 3.2.

The British introduced property-rights on land, and thereby a market for land arose. The government also interfered in water-supply. (Reddy & Subbalakshmi, 1989). With this the community-responsibility for land- and water-management decreased. The government officials who were appointed for maintenance of the old water-supply systems, had no experience with the old village institutions. Local governors were eliminated (Sengupta, 1985).

The state did not stimulate anymore the maintenance of the old community systems. She was more interested in big irrigation works (Reddy & Subbalakshmi, 1989; Sengupta, 1985; Krishnan, 1989). The conception of trapping water where it falls, changed into storing water in big reservoirs and piping it over long distances (Monte, 1988).

Canal irrigation was extended towards areas where no canals existed before, like in the plains of Uttar Pradesh. Where it was possible cheap (public funded and subsidized) canals were laid for irrigation (Sengupta, 1985; Reddy & Subbalakshmi, 1989). Canal seepage and waterlogging caused soil deterioration and salinity in many areas (Sengupta, 1985). Canal seepage and salinity also occurs now in Bikaner district as a result of canal water-supply (Urmul Trust, p.i.).

A new irrigation project on the Cauvery-river almost destroyed the old system. Sir Arthur Cotton renovated the old Grand Anicut (see section 3.1). Sengupta (1985) quotes him:

'..There are multitudes of old native works in various parts of India... These are noble works, and show both boldness and engineering talent. They have stood for hundred of years... When I first arrived in India, the contempt with which the natives justly spoke of us on account of this neglect of material improvements was very striking; they used to say we were a kind of civilised savages, wonderfully expert about fighting, but so inferior to their great men, that we would not even keep in repair the works they had constructed, much less even imitate them in extending the system.'

In 1900 an Irrigation Commision was set up to draw attention to minor irrigation works for neglected areas (Sengupta, 1985). This commission did not have much influence. Fortunately the village institutions were in many villages strong enough to persist as they did not need much support from government. (Reddy & Subbalakshmi, 1989; Krishnan, 1989).

Since independence (1947) water-supply shifted completely from a community responsibility towards a government responsibility (Monte, 1988; S.M. Pattanaik, p.i.). For the government it was not possible to maintain and control the old decentralized, local systems. Therefore she opposed these old systems. Nowadays the old systems for watersupply are neglected, broken down or filled with rubbish (Akileshwary,1989; Monte, 1988).

The government got more interested in large, multi-purpose river-valley projects like big dams. In the big waterprojects more attention was paid to enhancing utilisation of water, than to a sustainable level of water-use (Bandyopadhay, 1987). Much of the traditional knowledge concerning water-management is forgotten (L.N.Pattanaik p.i.).

Because of the availability of electricity from the hydro-power stations (dams), there was an explosive growth of tubewells and pumps. Pumps were installed in dug-wells. Even in water-scarcity areas construcion of private wells was encouraged. This caused quick lowering of groundwater-levels and drying up of water-sources (Sengupta, 1985; Akhileshwary, 1989; Monte, 1988).

Tubewells were often privately owned. Farmers who could afford it, constructed deeper wells. They knew the concequences on the long term, but on the short term this was for them the best solution (Swaminathan & Kandaswamy, 1989). There was a good market for water-consuming crops and irrigation increased the yields.

With the water-supply seen more and more as a state responsibility and with traditional systems suppressed more by modern or individual systems, the village institutions could not persist anymore. Without the social system to control the use of water, uncontrolled privatisation of groundwater occured. (Bandyopadhay, 1987). The balance between surfacewater storage and groundwater exploitation totally disappeared (Reddy & Subbalakshmi, 1989).

With the neglect and break down of the small, decentralized water-reservoirs, the recharge of groundwater has decreased in many parts of the country. This is one of the causes of desertification and drying up of wells.

In Rajastan people neglect their old systems although they know that these are better than the pumps provided. But as their first care is survival, they prefer to depend on governmental water-supply. Taps are easier than kunds, which they have to maintain themselves. (Rai, 1987).

The many leakages in the pumpsystems, the defect taps or the continuous watersupply don't stimulate the villagers not to waste water and to use it economically, as they were used to earlier (Rai, 1987; Urmul Trust, p.i.).

Agriculture became more important at the costs of forest and grazing-lands. Food-production, food-processing and market-economy were stimulated on behalf of industries and cities. Research was done to increase yields and to develop market facilities. Higher inputs from the industries were needed in agriculture and for this money was necessary. (Prasad p.i.) At the same time, with the growth of large industries, small industries in the rural areas disappeared (Custers, 1984; Ragunandan, p.i.).

This development made villagers like shepherds, artisans and poor farmers go to the urban area in search of paid jobs. The villages were no longer self-sufficient as they were before. They became dependent on employment in the urban area and of products from industries and cities. (Prasad, p.i.).

People with money, land or power could make use of the modern techniques to reallocate the natural resources in their favour (Gupta, 1989). The newly introduced cash crops like sugar-cane needed more water. (Bandyopadhay, 1987; Shukla, 1984). The quick growth as a result of fertilizers not only increased the needed amount of water but also resulted in a shallow root system that could not improve the soil structure (Kale, p.i.).

Also the urban and industrial demand for water increased.

The protection of common lands like forests and wetlands, became a state responsibility. The connection between the use and the control of these lands disappeared (Ramaswamy, 1989). This also resulted in overexploitation of forests and disappearance of wetlands.

4.2 APPLICATIONS OF TRADITIONAL KNOWLEDGE

As many forms of traditional knowledge exist, even more ways to apply them are possible. In this section applications are mentioned in the fields of soil and water conservation, rainwater harvesting, sand filtration, ponds, village communities and transfer of information.

Soil- and water-conservation

~~Nowadays many technologies~~ for soil- and water-conservation are promoted, which are presented being new:

- The Central Soil and Water Conservation Research and Training Institute in Chandigarh makes use of land terracing, contour-bunds, checkdams, vegetation on dams and afforestation (Bansal, p.i.).
- In situ water harvesting by land-configuration into ridges and furrows on a grade is applied in Akola, Hyderabad, Anantpur, Bangalore, Jodhpur and Dehradun. Patel et.al.(1988) proved it to be efficient. Furthermore they mention run-off recycling and an integrated use of farm-ponds, wells, percolationtanks and a drainage network.
- AFPRO (see chapter 2) pays much attention to the watershed approach. In this approach water should be kept within the watershed as long as possible. Traditional methods for land- and water-conservation are studied and, if thought to be usefull, stimulated or recommended towards the governments.
- Nowadays some state governments have set up programs for watershed management. In the drought relief programs in Tamil Nadu, check-dams are built (Khanna & Gupta, 1989).

In fact the methods which are now used in the watershed approach, have existed for centuries. Sengupta (p.i.) remarks that a lot of technologies are not recognized as being adaptations or applications of traditional methods. Many governments would even deny the existence of tradititional methods. For example on the map of India from the Central Board for Irrigation and Power, only the big waterworks in the plains are indicated. Many hilly areas with traditional methods are kept white on this map.

L.N. Reddy, a farmer near Bangalore in Karnataka (chapter 2), does recognize that he makes use of traditional methods. He has just acquired a new piece of land on which he plans to try several methods for optimal water-management:

- ponds in the depressions of the land,
- check-dams in the small river which passes his land,
- the silt from the ponds and the river will be used for making contour-bunds (see section 3.4, figure 3.4).

- Around the ponds and along the river trees will be planted like Neem and Amla (section 3.3).

L.N. Reddy has already dug pits and filled them with compost. Trees will be planted in these pits. Furthermore he doesn't use fertilizers or other chemicals (e.g. pesticides) on his land.

P.R. Sarkar has shown methods for optimal land- and water-management, which are applied in Ananda Nagar (chapter 2). According to Sarkar these methods are based on traditional knowledge or local customs (Anandamitra, 1988; Sarkar, 1988). Jai Ante (p.i.), a spokesman of Sarkar, mentions:

- maximum storage of surface-water in systems of ponds, tanks and small lakes,
- series of dams in small rivers and streams,
- irrigation based on capacities of these dams,
- maximum plantation or forestation along rivers or around ponds,
- maximum terracing of land, especially for agriculture,
- small scale farming without use of chemicals and with use of crop rotation, mixed cropping or supplementary cropping,
- returning the drained water to the waterstream.

Sarkar descibes systems of plantation (Ananda Mitra, 1988). Plants with different capacities are planted on different locations: on slopes, in, near or further away from the water, in combinations with other plants, etc. For example trees with an extensive root system are planted on the slopes to prevent erosion (banyan, neem, tamarind and amla). He also uses some plants, mentioned in section 3.3, having special capacities concerning water-purification: neem, tamarind, olivera, eggplant and waterlilies.

Development of rainwater harvesting techniques.

Nowadays the Indian government is getting more interested in the use and improvement of traditional and existing systems (Economic Times, 1989):

- In Tamil Nadu the government is concerned with remodelling of traditional rainwater harvesting systems and development of new techniques. At several places around Ramanathapuram new ponds are being dug or remodelled. Also a pilot roofwater harvesting system has been constructed (Jayaram, 1988).
- In Karnataka a project has been set up by the government in cooperation with the Indian Institute of Management (IIM) and the Worldbank to construct new irrigation tanks in drought-prone areas. The new tanks differs from the old ones in their lined canals, the improved distribution system and the government control. The government appoints the supervisors, decides about the water distribution, gives suggestions for the crops, etc. (Hussain, p.i.) The introduced rotational system for water-use was presented as new. In fact it comes from the traditional 'muray' (section 3.2).

Sand filtration

Filtration through sand occured for example in the 'chua' and in the traditional pot-filtration method (section 3.1 and 3.3). The concept of sand-filtration is applied in many technologies for water-treatment.

At the National Environmental Engineerings Research Institute (NEERI) the 'Slow Sand Filtration' method is developed to treat wastewater (Belsare, 1976). In this treatment the next processes take place:

- attachment of particles to the sandgrains, - sedimentation,
- bacteriological degradation of organic material,
- growth-limitation of pathogens through low temperature,
- algae growth.

These processes all occur in natural systems but are optimized for better purification. The purifying capacities of algae will be explained later.

Also charcoal, a traditionally used material for filtering water, is applied by NEERI in treatment systems.

Kardile (1974) recommends simple treatment plants for the rural area, based on filtration. In these plants the conventional pre-treatment could be replaced by a gravel-bed filter. Filtration through coconut-shells and fine sand appears to be a simple and effective solution to purify water with low turbidity (kardile, 1972).

Some methods for rural areas to chlorinate water also make use of the principle of pot-filtration (Kardile, 1977):

- In a pot with holes in the bottom is put: pebbles, pea gravel and above this a mixture of sand and bleaching powder. The pot is filled up with stones and put in a well.
- A pot with holes in the middle peripheri ( ) is partly filled with coarse sand and bleaching powder below the holes. The mouth is covered with foil. This pot is put in a well, one metre below water level. It chlorinates 900 to 1300 litres a day for maximal 10 days.
- A pot is filled with a moistened mixture of sand and bleaching powder. This pot is put in a bigger pot with a covered mouth and put in the water.

DST (1979) describes a household sandfilter (see figure 4.1). Before use the filter is chlorinated. The system has a 200 litres steel drum which contains charcoal, fine sand and gravel.

The Centre for Technology Development Research (CTD) of the Delhi Science Forum has developed a waterfilter for desinfecting water, made out of white clay (see figure 4.2). These filters offer relief work to unemployed potters in rural areas (Ragunandan, p.i.).

In slums and villages around Nagpur, pots with sand are used to filter the wastewater before it comes into a soakpit (see figure 4.3). This method is introduced by the Indian Institute for Youth Welfare in Nagpur (IIYW). They also try to re-introduce pot- and cloth-filtration in slums.

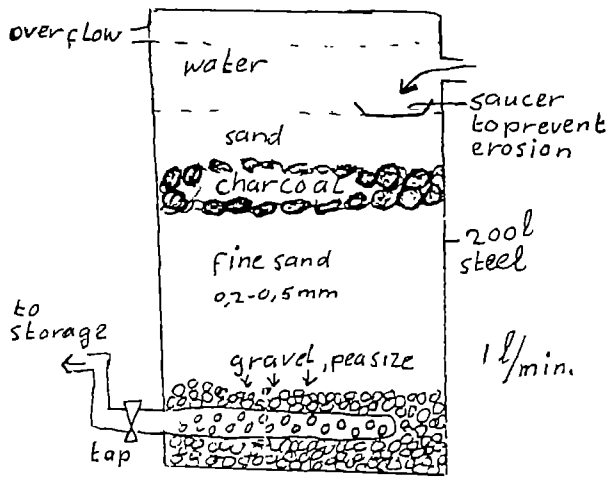

Figure 4.1: A household sandfilter (DST, 1979)

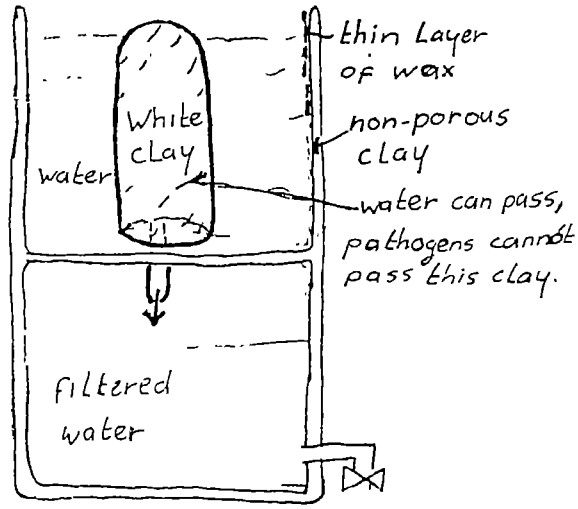

Figure 4.2: A watercandle for desinfecting water.

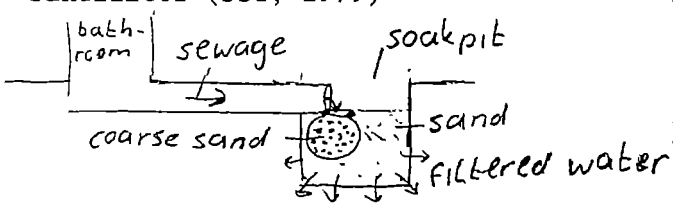

Figure 4.3: Sandfiltration in a soakpit.

Stabilisation ponds and re-use of the effluent

In fact the conception to make use of the purifying capacities of a pond does exist since long. At NEERI experiments are done with stabilisation ponds to purify domestic wastewater and with the use of its effluent.

In stabilisation ponds organic material settles and is degraded by aerobic and anaerobic bacteria. Carbon and Sulfur are eliminated in the gaseous phase (CO_2, CH_4 and H_2S) and nutrients like Phosphor and Nitrogen are taken up by algae. The algae can be eliminated. At NEERI and at the National Botanical Research Institute at Lucknow, research is done into the reuse of algae for example as fodder for animals.

Parhad & Rao (1972) proved that the increase of alkalinity in a pond, caused by algal growth, was responsable for elimination of E.Coli bacteria. Joshi e.a. (1973) proved elimination of Salmonella, Coliforms, E.Coli and faecal streptococcae in stabilisation ponds. Removal varied with the number of ponds, interconnecting arrangements like surface overflow, load, detention period and other design features.

Near Delhi the Delhi Sience Forum has set up experiments to use waterweeds for purification.

Hopkins & Hopkins (1963) compared stabilisation ponds with other treatment-systems. They found the ponds to be more flexible: The retention-time of the water can be raised to store water for irrigation. The operation and maintenance are simpler and cheaper, the Coliform reduction is equal or better and there is more production of molecular oxygen. With the control of emergent vegetation and floating solids, mosquito breeding can be prevented. They stated that knowledge of the effects of local conditions on ponds is essential for construction and maintenance of stabilisation ponds.

Kale & Bal (1987) proved it to be possible to use the effluent of stabilisation ponds for irrigation of Citrus reticulatus and of various roadverge plants and trees.

At NEERI various flowers, shrubs and fruit-trees, irrigated with untreated wastewater, grow very well (Kale, p.i.). Further experiments are done with different effluent streams for different types of land and crops. Wastewater was found to be better for the structure of the soil than groundwater, which often has a too high salt content (Kale, p.i.).

Village institutions

The social division of NEERI studies the social organization in villages in the context of the Water Technology Mission (WTM) of the government (Gadkari, p.i.; film about WTM). These studies are also used for better application of their technologies in rural areas.

Several NGO's like AFPRO, Lokayan, Prarambha, GPF and DSF (chapter 2) try to stimulate the formation of new institutions,, organizations or committees in rural areas. A study done at the Indian Institute of Management (Hussain, p.i.) revealed that community management of tanks in Karnataka works quite well.

Arun Kumar (member of Lokayan, chapter 2) has motivated people in the Thar-desert to organize a protest march along many villages against bad watersupply, a 'Pani March'. Aim was also to make people aware of their environment, the flora and fauna, the people and their culture, and to stimulate them to make efforts for better watersupply themselves. This resulted in the set-up of several organizations, especially by women.

The Centre for Technology Development of DSF (chapter 2) has shown the possibility to make use of the traditional organization structure of villages to form groups of artisans (section 3.2). These groups have proved to be able to compete with large scale industry.

Transfer of information

Traditions in general, appeal more to people in rural areas than new ideas or methods. Therefore many NGO's make use of traditions to transfer certain information. At Uma Niwas, the women-project of Ananda Nagar, and at the IIYW (see chapter 2) traditional songs and puppets are used in health education programs.

The Environment Cell of the GPF also encourages the use of socio-religious festivals to draw peoples attention to the problems of pollution and the necessity to keep sacred rivers physically clean and its surroundings beautiful.

The 'Pani March' or 'Walk for water', held in Rajastan, made use of an idea used before by Mahatma Gandhi: Water as a basic human necessity, closely related to culture and religion could be a reason for cultural awakening. A walk emphasizes peoples relationship with environment, with nature and with other people. Besides, a walk is a movement or action of the villagers themselves, with which they show their wish to contribute to a common aim (in this case better water-supply) or their conviction that they have the knowledge and power to contribute to this. (A.Kumar, p.i.)

Also the Indian Institute for Youth Welfare organized a walk with slogans nearby Nagpur.

This 'cultural awakening' is comparable with the Chipko movement (K.Kumar, 1983). Their strategy of communication was, like the Pani March, simple and direct: They embraced the trees as they did not want them to be cut down. This also was a collective action, part of a struggle for better living-conditions and closely related to culture. The Chipko movement has become known world-wide because of its great succes (CSE, 1985).

Other applications of traditional methods

To make technology accessible for more people, the CTD developes technologies adapted to situations in rural areas. These technologies are based on local skills, resources and markets. Workshops are organized to demonstrate these technologies to rural people.

Rao (1984) describes an individual experiment to improve the environment around his house in Jaipur, in the desert of Rajastan. With the vegetation in his garden he could decrease the local temperature with 5 degrees and increase the humidity. He led his wastewater through a drainage system to stabilisation ponds.

5 ATTITUDES TOWARDS TRADITIONAL KNOWLEDGE

5.1 OPINIONS CONCERNING THE USE OF TRADITIONAL KNOWLEDGE

Restoration of traditional methods

The importance to restore traditional systems for watersupply is mentioned by many people, often involved with NGO's, by newspapers and by people from the rural areas (The Hindu, 1989; Monte, 1988; Rai, 1988; S.K.S.Reddy, 1988; Schwarz, 1988).

Prarambha, an NGO (chapter 2) has set up the following activities to stimulate tank-irrigation:

- a centre for collection and dissemination of information,
- training of rural people and others in maintenance and repair of tank systems,
- meetings on village level,
- involvement of the governmental 'employment guarantee' scheme in reforestation and water-management and
- evaluation of governmental and international projects in this field.

In some cases the local government approved the restoration of old systems (Business Standard, 1987; Rai, 1987; The Hindu, 1987). Some officials from the U.P. State Pollution Control Board mention the importance of restoration of ponds for drinking-water supply (Jaitly, Sikandar, p.i.).

It is not necessary to go back to traditional systems. Old systems can be improved or adapted. The traditional concepts should be applied in the development of new technologies (Kawarana, p.i.; Monte, 1988; Palanasamy, 1989; B.Sen Gupta, 1989; N.Sengupta, p.i.). This is also mentioned at the 'workshop on management of renewable resources' in Bangalore (see chapter 2).

The government is getting more interested in the use and improvement of old and existing systems (Economic Times, 1989; Jayaram, 1988). Again an official from a State Pollution Control Board agrees with the importance of traditional systems (Pattanaik, p.i.). There is no further attention for traditional systems at these Boards. According to Dr. R.C. Trivedi (p.i.), traditional systems are beyond the scope of the Central Pollution Control Board. Many other government officials whom I have spoken did not see the use of traditional systems (S.M.Mishra, p.i.; A.K.Pattanaik, p.i.; S.M.Pattanaik, p.i.; Pattra, p.i.; Rama Rao, p.i.). They mention some disadvantages of traditional systems:

- In open systems no good waterquality can be guaranteed.
- Tanksystems are too expensive.
- Slow Sand Filtration is too expensive for villages.
- A government-controlled watersupply is difficult.
- The water is too highly polluted for these systems.
- The waterpollution is different nowadays.
- Villagers are not motivated.

The concept 'traditional knowledge' appears to be new to several government officials. Danida, a Danish organization that cooperates amongst others with the state government of Orissa, started thinking about rainwater harversting recently. This organization looks for solutions where tube-wells give problems. The central government is thinking about including traditional methods in the Water Technology Mission, since Dr. N.Sengupta emphasized the importance.

Urmul Trust, an NGO (see chapter 2) stimulates maintenance of traditional systems for collection and storage of rainwater, but is partly dependent on the government. It also links up with the governmental 'drought- relief' program. In this program the villagers are employed to dig large, open, cementized reservoirs to store the pumped water. These reservoirs are not as ingenious as the traditional systems. They are not covered and no recharge to the aquifers is possible.

Watershed management

The watershed approach for improvement of soil- and water-conservation, mentioned in section 4.2, is recommended at the workshop on management of renewable resources and in several articles (Patel et.al. 1988; Patriot, 1989; Ranganathan & Sastry, 1988; Ragunath & Samray, 1989). This approach has been applied already by several NGO's, farmers and by the government (section 4.2). Some methods for soil- and water-conservation are recommended by Paranjpye (1987) as alternative for big dams.

Sarkar (1988) and Prasad (p.i.) are clear about groundwater exploitation: No well-water at all should be used for irrigation. According to A.Kumar (p.i.) optimal utilisation of rainwater is the main solution to problems with water in the desert of Rajastan.

The ecological aspects of traditional farming systems and traditional systems for soil- and water-conservation are emphasized in many articles and by many different people. These systems are more in balance with nature than modern systems (Ananda Mitra, 1988; Kale, p.i.; A.Kumar, p.i.; L.N. Pattanaik, p.i.; L.N.Reddy, p.i.; Sarkar (Jai Ante, p.i.); Gupta, 1989; Ramaswamy, 1989). Also plantations should be based on indigenous knowledge (Patriot, 1989; Sarkar (Jai Ante, p.i.); L.N.Reddy, p.i.).

A source of knowledge

Academics can learn from traditional systems and from the people in rural areas (Bansal, p.i.; S.Kothari, p.i.; Monte, 1988). For the renovation of the Grand Anicut, Cotton (section 4.1) made use of the knowledge of the native Indians:

> '..It was from them (the native Indians) we learned how to secure a foundation in loose sand of unmeasured depth. In fact, what we learnt from them made the difference between financial succes and failure, for the Madras river irrigations executed by our engineers have been from the first the greatest financial successes of any engineering works in the world, solely because we learnt from them..''With this lesson about foundations, we built bridges, weirs, acquaducts, and every kind of hydraulic work.. we are thus deeply indebted to the native engineers...'

From the above can be concluded that more investigation should be done in traditional systems. Sengupta (p.i) suggests to investigate:

- if traditional systems for watersupply are hygiënic enough in actual situations and
- how certain traditional systems are related to certain areas.

The Environment Cell of the Gandhi Peace foundation (GPF) is making a survey of traditional systems of irrigation in Karnataka.

The theme of the National Environmental Awareness Campaign, organized by the Centre of Science and Environment (CSE) in 1989 is the Water Technology Mission. Journalists and scientists are asked to study the effects of this mission and to study existing traditional methods for drinking-water supply in the rural area.

Village institutions

In case of problems with watersupply, technological facilities alone do not work, even if they are traditional (Suri, 1989). Villagers have to contribute to solutions and to cooperate. Therefore village institutions are essential for good land- and water-management (Bansal, p.i.; Kawarana, p.i.; Kumar, p.i.; Paranjpye, 1987; S.K.S.Reddy, 1988; Schwarz, 1988; Gupta, 1989).

According to L.N.Reddy (p.i.), there is a growing individualism among farmers which is related to the fading away of religion. This individualism is one of the reasons for the collapsing of the traditional village communities and for the increased number of tubewells (section 4.1). The governmental schemes are inadequate to generate collective action for the benefit of the community as they emphasize the benefits of the individual (Patel et.al., 1988).

In this context the use of traditions to transfer information must be seen (see section 4.2). This might make villagers aware of their common culture once again, and might motivate them to organize themselves. Especially the 'water' theme is appropriate; water is a basic need and it is closely related with culture and religion (A.Kumar, p.i.). A social action at village level might catalyse social action on a higher level (Gupta, 1989; Prasad, p.i.).

Villagers have lost control over their basic resources. India's middle class, cities and industries profit from the exploitation of the environment (section 4.1). Water should be seen again as a common, societal resource which should be available for everybody (Prasad, p.i.; Schwarz, 1988).

For a long-term solution traditional systems should therefore be controlled by the village institutions again (A.Kumar, p.i.; Prasad, p.i.; Ramaswamy, 1989). The simultanuous decentralization of watersupply systems and of their control is also necessary (Bahuguna, 1987; S.Kothari, p.i.; Sengupta, p.i.). S.M. Pattanaik (p.i.) on the contrary thinks the control of watersupply should be kept with the government.

Often projects on a local level can not be carried out or continued because of the many institutes involved and the official routes to be followed (Palanisamy, 1989; Paranjpye, 1987; Prasad, p.i.). This was also mentioned at the workshop on management of renewable resources (chapter 2).

5.2 ATTITUDE OF VILLAGERS

If traditional methods are so important for the development of rural areas, then why are villagers not motivated to use them? With the use of two examples I'll try to answer this question. Both examples are raised in several parts of this report.

In Bikaner district in the desert of Rajastan I have visited several villages and discussed the situation with people from Urmul Trust (see chapter 2).

Although the villagers prefer rainwater to groundwater, they don't maintain the traditional kunds anymore to collect the rainwater (section 3.1). Since the government has interfered with the water-supply by drilling tubewells, the government is seen as responsible for water-supply. Nevertheless, problems with water-supply occur regularly: the water is saline or the pumps don't work as a result of electricity fall-out. Sandstorms, which cause these electricity fall-outs, are common in this area.

Maintenance of the traditional systems might contribute to a solution of these problems on the long term. But the need the villagers feel for water, food and money, is so urgent that they are not interested in long-term solutions. The situation in the villages is such that the people want to see direct benefit of their activities.

The government-approach is a short-term solution as well. The water-supply by tubewells and pumps is easy and direct, but it doesn't take into account the necessary recharge of groundwater and development of water-bearing subsoil-layers. Other disadvantages of the pumps are:

- The pumped water is saline in many areas (chapter 1).
- The many not-used or defect pumps make a sieve from the deeper soillayers.
- Water is used in a less economic manner, even water is wasted (section 4.1).
- Groundwater over-exploitation stimulates desertification.

Even the drought-relief action to build 'diggies' (section 4.2), is a short term solution. With these cemented, open reservoirs no recharge of the groundwater is possible and additionally a lot of water will evaporate. The villagers are motivated to build these diggies as they are paid for it. The reservoirs are a supplement to the pumps and both are maintained by the government. Maintenance of the traditional kunds is too closely related too local climate and culture to be maintained by the government. Therefore they are not included in a drought-relief program.

Another case of rural development happens in Chandigarh. This case has been discussed with Dr. Bansal from the Central Soil and Water Conservation Research and Training Institute, the CSWCI, and with Mrs D. Suri from the Tribune (see chapter 2).

The Sukhna lake, used for recreation, was silting up. The silt came from the severely eroding hills, north of Chandigarh. To stop the erosion the CSWCI started building dams and planting trees in the water catchment-area. For this, villagers from amongst others the village Sukhomajri were employed.

Nevertheless, the same villagers grazed their animals in this area. The young trees were damaged and additionally the villagers collected the wood from the dams for fuelwood. The villagers destroyed these systems as they had no choice. This is shortly explained below.

Sukhomajri was originally a community of cattle rearers. They paid the owner of the land where their cattle grazed in natura. When this land became government-property, after independence, grazing was prohibited. The villagers continued grazing where possible, as it was their source of subsistence, but the community-control of the land had disappeared. At the same time the population increased. Erosion occured as a result of overgrazing. With this other means of support (good soil for agriculture, water) decreased. There was no more sufficient water and food for the growing population. The villagers did not have any direct benefit from the dams they had built, as they lived outside of the catchment area. Additionally they were in urgent need of grazing land and fuelwood.

Nevertheless, finally a better solution was found with the aid of the villagers from Sukhomajri themselves. After an accidental, spontaneous discussion between the villagers and Dr. P.R.Mishra from the CSWCI, some of their problems were revealed and they gave suggestions to improve their living conditions. The villagers, the CSWCI, people from the foresty department and other officials cooperated for this solution. The villagers traced suitable places to build dams to improve their own watersupply. Furthermore they were assisted in the set-up of stall-feeding of cattle.

The prospect of water-reservoirs and healthy cattle motivated the villagers to form a society. This Hill Resource Management Society took the responsibility to maintain the water-reservoirs and to control the landuse. The society later expanded its concern to other fields of development, for example:

- generating a revenue with products from the hills and
- setting up a tree nursery.

Although problems do still occur, Sukhomajri has become a more self-sustaining unit of growth. As all villagers have benefit from the society, they are all motivated to cooperate. Up to now succes was only possible because some officials agreed not to stick to official rules and procedures.

6 EVALUATION

Traditional knowledge does exist and is still alive in rural areas. Traditional systems that have been found during this study include (chapter 3):

- systems for rainwater harvesting and groundwater exploitation,
- systems for water-storage, recharge of groundwater and prevention of floods,
- systems for irrigation and drinking-water supply and
- methods for soil- and water-conservation.

Besides these technical systems also social systems based on traditional knowledge existed:

- social systems for maintenance and repair of technical facilities and
- social systems for decision making about land- and water-management.

These social systems were not only essential for maintenance and development of technical facilities, but also for the motivation of all villagers to co-operate. Especially the involvement of women was important as they would be the first to notice occurrence of diseases, lowering of groundwater table, etc. They had knowledge about the purity, treatment and domestic use of water. They will transfer their knowledge to the next generation. This knowledge includes:

- customs to prevent contamination of drinking-water and
- methods to treat water for drinking or bathing.

Many traditional practices in land- and water-use are disappearing or have disappeared. The main reason for this seems to be the change in government policy concerning land- and water-management.

Technical, traditional systems have been neglected during development of technologies for large-scale irrigation and drinking-water supply, for higher crop-yields, for hydro-power, etc. Most of these technologies were introduced by the British and stimulated by the Indian government after independence (section 4.1). Centralization and scale-enlargement was not only necessary for government control, but also for generation of foreign exchange.

The traditional systems needed a decentralized control. For this, village institutions like Panchayats existed (section 3.2). These institutions disappeared after interference of the government with the use and division of land and with water-supply. Traditionally the village institutions took care of land- and water-management. In turn, the traditional systems and customs sustained the communities. The government had little influence on this.

With the break-down of village institutions, the maintenance of community systems collapsed too. Villagers became more dependent on the government for water-supply. At the same time the dependence on products from cities and industries increased. This was also a result of the introduction of new technologies in agriculture (section 4.1). Another reason was scale-enlargement in industries: Artisans and people working in the small industries in the rural area got unemployed.

The above can be summarized as a shift from **mutual dependency** and **self-sufficiency** within a village, towards **dependency on government and money**. This shift led to a growing individualism in rural areas. The fading away of social control, traditions and traditional conceptions seems to be closely related with the changes in control and use of land and water and with the government policy in this.

Large-scale technologies and their necessary government control cannot take into account the diversity of the soil, climate and cultures in rural areas. Therefore many of these technologies have had negative effects on availability and quality of land and water (chapter 1).

Especially the poor people in rural areas are affected by this development: They have lost the possibility to use the common lands, their land lost its productivity or they lost their jobs as artisans or as labourers in small industries. In their situation it is comprehensible that these people do not undertake efforts which might improve the water-supply or soil quality on long-term. They are in direct need of money, food and water, and want to see direct benefits from their activities (section 5.2). Additionally they see the government as responsible for water-supply.

Many people and organizations are concerned with improvement of living-conditions in rural areas. Projects have been set up by the central and state governments and by NGO's. In general, NGO's search for solutions in a decentralized approach, whereas the governments stick to a mass-approach (large-scale construction of tubewells).

NGO's working on village-level (grass-root organizations) often try to make the villagers aware of their own situation and of the possibilities to improve their own situation. The villagers are stimulated to organize themselves and to continue the activities that are started by the NGO's.

Other NGO's, often coordinating grass-root organizations, have a more comprehensive approach: creating awareness among various layers of the population about the situation in rural areas and their possible contribution to this. Several of these organizations consider it essential to link up with traditional knowledge. Reasons for this are:

1 Traditional methods are time tested and are in balance with the environment.
2 Systems based on traditional knowledge can be understood better by the rural population.
3 Villagers can maintain and control these systems themselves.
4 Traditions appeal more to villagers than new technologies.
5 Emphasizing their traditional knowledge will make villagers aware of their own relation with their environment and their own possibilities to contribute to better living conditions. This also stimulates formation of new village communities.

ad 1: Nowadays, poverty in rural areas is also seen in relation with the deteriorating environment. Therefore some people and NGO's emphasize the development of small scale, adapted technologies without negative effects for environment. Traditional knowledge might contribute to this as traditional knowledge included knowledge of nature.

ad 2 and 3: Technologies in land and water management based on local resources, local skills and local knowledge, will make villagers less dependent on products from the urban areas. Additionally it will motivate them again to maintain their natural resources and to control the use of these resources.

ad 5: This aspect is mentioned by many development workers as being most essential: People in rural area have to organize themselves to decide together what they need and to show it to local governors.

In different ways NGO's make use of traditions, traditional systems or traditional knowledge (section 4.2):

- Traditions are used to attract attention and to transfer messages (plays with puppets or songs).
- Traditional organization is studied for a better approach.
- Local resources and local skills are used.
- Traditional systems are restored, methods are re-introduced.
- Traditional concepts are applied in new technologies (sand-filtration).
- Villagers are asked about their ideas to find a solution (Sokumajri).
- Villagers are stimulated to use their own knowledge (Pani March).

It is not at all necessary to go back to traditional systems. But some concepts of these systems might be applied in modern systems. Applications of traditional knowledge have existed for a long time. Often traditional knowledge is applied even unconsciously, especially in modern techniques stimulated by the government. For example in methods for improvement of soil- and water-conservation and in water-purification systems (section 4.2). Nevertheless, conscious use of traditional knowledge might be important for a better connection with the needs and skills of the people in rural areas.

Nowadays also some government officials recognize the existence and importance of traditional methods. Nevertheless, they consider the NGO's more appropriate to pay attention to these decentralized systems and to spread knowledge. To my opinion government too should consider the existence of traditional knowledge in her approach for better water-supply and better soil and water-conservation.

From this study appears that neglectance of traditional knowledge is one of the reasons of the actual problems in rural areas. Traditional knowledge could contribute both to better water-supply in rural areas as to rural development in general. Organizations or individuals that are involved with application of traditional knowledge deserve more recognition and support from the government. More research should be done in the value of traditional systems and customs for soil- and water-conservation and for water-purification. Also possibilities to apply or improve traditional concepts in a modern approach should be investigated.

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APPENDIX A

In this appendix the addresses and general activities of the visited organizations, institutes and projects are given. Also activities concerning water-supply and waterquality of these organizations and of some movements are described. The aims of the visited organizations are described in chapter 2.

Centre for Science and environment, **CSE**, F6 Kailash Kolony, New Delhi.

The CSE consists mainly of journalists and scientists. They study different aspects of the environment, gather information and publish it in magazines. Two large reports have been composed that describe the state of the environment in India, including social and political aspects. A third report is in preparation.

They organize meetings and workshops to keep contact with governors on village and state level, development organizations and scientists. The themes concern an environmental issue in a special region, like erosion or shortage of drinking-water. The causes of problems and possible solutions are discussed.

Every year, a one or two months lasting campaign with a special theme is organized, the National Environmental Awareness Camp. Grass-root organizations, working on village level, organize activities concerning this theme. The Government provides money which the CSE divides among projects or studies for this theme.

The theme of the campaign in 1989 is the Drinking-water Technology Mission of the government. Journalists and scientists are asked to study the effects of this mission and to study existing traditional methods for drink-water supply in rural areas.

Other activities of the Centre for Science and Environment are:
- composition of a monthly television programme,
- collection and classification of articles from magazines, concerning all aspects of the environment, which are published in the monthly Green-Files.
- keeping contacts with organizations abroad like the India Committee of the Netherlands and
- maintenance of a library.

Delhi Science Forum, **DSF**, B1 2nd floor, LSC building, J-Block, Saket, New Delhi 110017.

DSF organizes seminars for scientists, academics from different fields, government officials and people working in industries. Discussions are held about the social, economic and political implications of science and technology. Themes were for example:

- the effects of import of technology on development,
- drinking-water supply and technology and
- scientific policy.

Part of DSF is the Centre for Technology Development Research, CTD. The CTD studies existing local activities, skills, sources of income, organizational structures, etc. in rural areas, and publish their findings. In this context they also work for the Water Technology Mission of the government.

To make technology more accessible to the people, technologies adapted to situations in rural area are developed. These technologies are based on lokal skills, local resources and markets. Workshops are organized to demonstrate these technologies to rural people. Examples are (see section 4.2):

- introduction of waterfilters consisting of clay so that potters can make them (see figure 4.2),
- water-purification by water weeds and
- reuse of wastewater for irrigation.

The CTD has done research in some villages to find a solution for leather tanners who lost their work because of a large leather industrie. An individual approach didn't work as no competition was possible with the leather industry. They found a special organizational structure of villages, described in section 3.2. By making use of this structure it was possible to form groups of leather-tanners. For 20 villages one tannery was set up from which the managers, local people, were trained by CTD. The same is set up now for processing fruits.

Gandhi Peace Foundation, **GPF**, 221 DDU Marg, New Delhi 110002.

GPF studies the violence done to nature and the environment and the possibilities for a new, holistic world-view. In this context new developments in science starting with quantum mechanics and relativity theories are studied.

Findings are published and also books are written about the relations between the ideas of Gandhi and actual problems concerning economy, environment, disarmement, social conflicts, etc.

The involvement of the whole population in actual problems is thought essential. Meetings are organized for academists, social workers, governors, policy makers and others. For these meetings GPF works close together with CSE.

A special group within the GPF is concerned with environment: The Environmental Cell. This group keeps close contact with movements which work for rural development and improvement of environment in villages, like the Chipko movement. These movements are assisted by means of courses, fellowships, education programs and/or publications.

The environmental Cell also encourages the conduct of socio-religious festivals to draw peoples attention to the problems of pollution and the necessity to keep sacred rivers physically clean and its surroundings beautiful.

At the moment a survey is made of traditional systems of irrigation in Karnataka.

Other activities of GPF are:

- Organization of camps with special themes, for young people,
- publication of their monthly 'Gandhi Marg',
- keeping contact with international movements and with Gandhian groups in other countries,
- maintenance of a library

The GPF is spread all over the country; Only a loose network of members exists.

Lokayan, 13 Alipur road, New Delhi 110054,

Lokayan organizes dialogues and starts research in those fields where it appears necessary from the dialogues. Publications and other documentation are translated into various Indian languages to make it readable for all people concerned.

Studied subjects concerning watermanagement and quality are:

- effects of big dams and irrigation projects on hydrology and waterquality,
- deforestation,
- use and maintenance of local systems for water-supply,
- urbanization and industrialisation,
- sustainability in rural areas,
- disturbance of ecological balances and
- disturbance of the balance between national and local interests.

In Lokayan-Bulletin dialogues and studies are reported. There's also room to bring to light unacceptable situations of oppressed people and of inhuman living-conditions

Lokayan has many contacts with the rural population as the activities are based on problems and knowledge in rural areas. She wants to create awareness among the rural people about social injustice and stimulate organization and mobilisation of them.

Arun Kumar has motivated people in the Thar-desert to organize a protest-march along many villages against bad watersupply , a 'Pani March'. Aim was also to make people aware of their environment, flora, fauna, people and culture and to stimulate them to make efforts themselves for better water-supply. They can show themselves how technology should be applied for better water-supply in the desert.

This march started with a meeting organized by Lokayam. Furthermore a meeting of GPF resulted in a committee to plan the march and prepare campaigns. Other NGO's were involved to mobilize villages in towns in the desert.

Other activities are:
- to assist groups in lawsuits and
- a two-weekly publication in the column 'Survival' of Illustrated Weekly.

Lokayan doesn't organize actions herself, but is like CSE, GPF and DSF a coordinating organization that brings individuals and organizations into contact with each other.

Action for Food Production, **AFPRO**, 25/1A Institutional area, Pankha road, D-Block, Janakpuri, New Delhi 110058,

AFPRO assists voluvtary organizations to set up foodproduction projects. They provide services like:
- technical advice,
- laying contacts with international aid- and financing organizations,
- training project-leaders or other members of voluntary agencies, in specific fields,
- assisting in the set up of development programs,
- organization of seminars and courses and
- collection and working out of information.

AFPRO also organizes projects herself and stimulates organization of rural communities. With the bulletin News Notes information is spread about the projects, food production and related subjects.

In New Delhi and in 7 locations in rural areas, scattered about India, teams of hydrologists, hydrogeologists, civil engineers and geofysists are working to improve water-management and water-supply. At present much attention is paid to the watershed approach: to keep the water within the basin of a waterbody as long as possible. Models are developed to demonstrate optimal wateruse in dry, medium dry and humid areas.

New technologies for development of agriculture are tested and transferred to the rural population with demonstrations, training, etc. Also traditional methods for land- and water-conservation are studied and , if thought usefull, stimulated or recommended towards the governments.

AFPRO is involved in the Water Technology Mission of the government. She cooperates with the central and state governments in the 'drought-relief' programs for employment and water-supply and identifies voluntary agencies for implementation of the programs.

Urmul Rural Health Research and Development Trust, **Urmul Trust,** Sri Ganganagar road, Loonkaransar, Bikaner district, Rajastan,

Urmul Trust is a voluntary agency, assisted by AFPRO, working in the Thar-desert in Bikaner district for rural development. In 30 villages she pays attention to:

1 creating awareness among the villagers about their own possibilities to improve their situation,
2 employment,
3 health education,
4 watersupply and
5 reforestation.

ad 2: Some villagers are trained to become a weaver. Their prducts are sold.
ad 5: Villagers are involved in planting and maintenance of trees.

For these activities meetings are held with local, districts and state governors.

In an area of 10 hectares a foodcentre, a hospital, a weavery, a pump and a water-reservoir are built. Furthermore there are houses for the people working there, a guesthouse and an office.

Urmul Trust stimulates maintenance of traditional systems for collection and storage of rainwater but is partly dependent of the government. She also links up with the governmental 'drought- relief' program. In this program the villagers are employed to dig large, open, cementized reservoirs to store the pumped water. Kunds are repaired where the government pays for it and the villagers are motivated to maintain it.

Prarambha, Ali Asker road, Bangalore 560052, Karnataka.

At first Prarambha worked directly in rural development. At present she supports individuals and small action groups that start with initiatives from rural people.

These initiatives concern the following points:

- create awareness of possibilities to improve the own situation,
- supply and development of the basic needs in rural areas water, land and village committees,
- education for children and adults,
- development of agriculture and cattle breeding,
- save- and credit systems and
- application of government programs.

In 5 drought-prone districts in North-Karnataka 100 groups have been set up. Prarambha lays contacts for them with other groups and with financing organizations. Furthermore Prarambha compromises unjust situations through villagers that are involved, other people concerned and newspapers. In this way contacts with different groups of the population are kept.

To stimulate tank irrigation Prarambha has set up next activities:

- a centre for collection and dissemination of information,
- training of rural people and others in maintenance and repair of tank systems,
- meetings on village level,
- Involve the governmental 'employment guarantee' scheme in reforestation and water-management.
- evaluation of governmental and international projects in this field.

Ananda Nagar, P.O. Baglata, Purulia District, W Bengal

At Ananda Nagar many different development project have been set up, concerning education, health care, ecological farming, natural energy resources, industrialization, preservation of endangered species of plants and animals and water-supply.

For water-supply and recharge of groundwater many ponds, tanks and small lakes have been dug. An integrated water-management programme has been set up, which includes intensive plantation (see section 4.2).

Central Water Pollution Control Board, CPCB, 6th floor Skylark, 60 Nehru Place, New Delhi 110019.

The main domain of the CPCB is the assessment and control of pollution in water-bodies all over the country and of air pollution in cities and around industries.

In the organization, assessment of pollution is divided in survey and monitoring. Survey implies inventories of sources of waterpollution and of the disposal of hazardous chemicals on land. Monitoring is done in effluents of large industries, in rivers, wells and in coastal waters. Pollution control concerns planning and implementation, and includes:

- preparation of guidelines on effluent discharge and on land treatment with liquid wastes,
- assessment of standards,
- supervision of implementation of these standards,
- enforcement of guidelines and legal actions,
- priorization of control activities,
- planning of pollution control programs,
- setting up a databank for pollution control and
- assistance in Environmental Impact Assessment and in location of industries.

National Environmental Engineerings Research Institute, NEERI, Nehru marg, Nagpur 440020.

According to the director of Neeri, Prof. P.Khanna, the main objective of Neeri is twofold (annual report '86-'87):

- To develop scientific and technological tools.
- To bring about compatibility between ecology and economics by inter-analysing environmental concerns in the process of planning for economic development.

The different research and development divisions are:

- life science,
- waterquality (involved in the Water Technology Mission of the government).
- water engineering,
- waste water engineering,
- air pollution control,
- recalcitrant wastes and hazardous wastes,
- solid wastes,
- Environmental Impact Assesment concultancy,
- instrumentation,
- technology administrationa,
- technology utilisation extension and
- basic research and training.