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KENYA-FINLAND WESTERN WATER SUPPLY PROGRAM

CASE STUDY ON KENYA-FINLAND WESTERN WATER SUPPLY PROGRAM, KENYA

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September 1991

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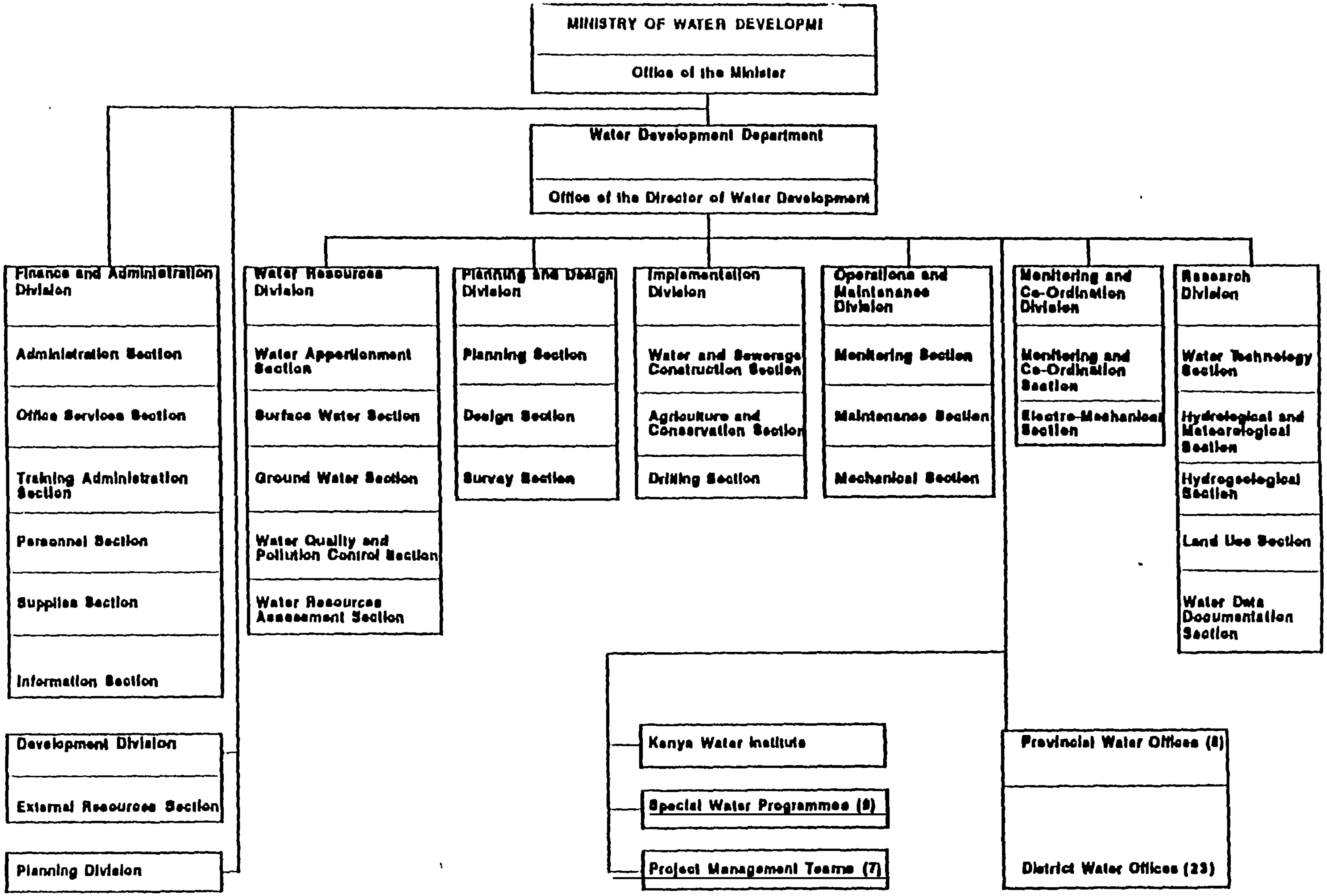
ANNEX 1

ORGANIZATION CHART - MINISTRY OF WATER DEVELOPMENT, KENYA



KENYA-FINLAND WESTERN WATER SUPPLY PROGRAM

FINNISH CASE STUDY FOR UNCED 1992, NORDIC INITIATIVE ON FRESHWATER RESOURCES

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5.9.1991

KENYA-FINLAND WESTERN WATER SUPPLY PROGRAM

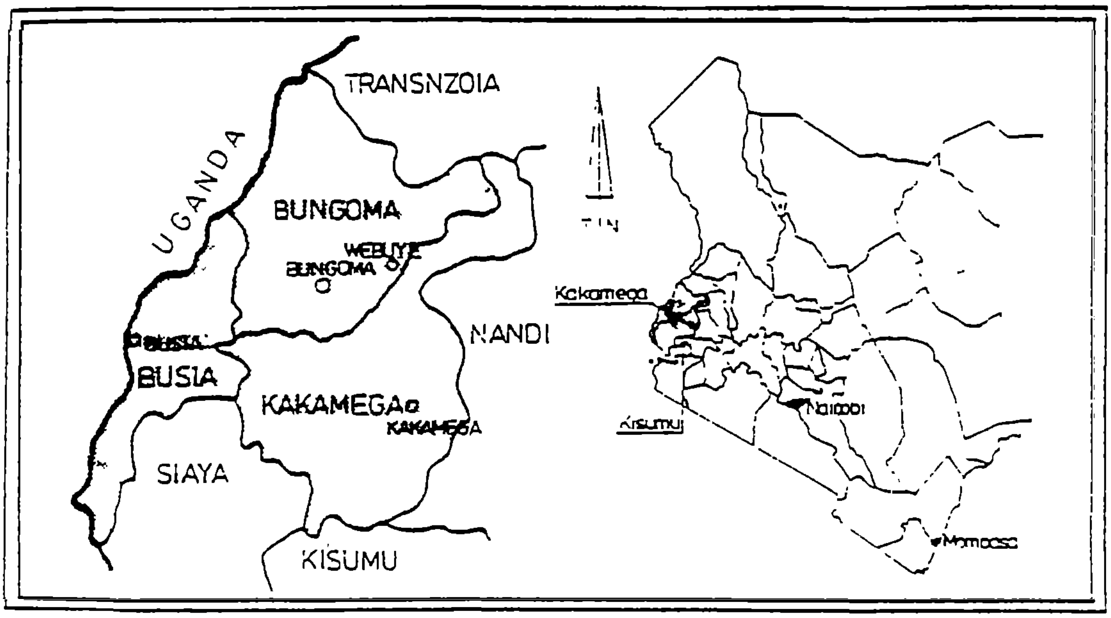
FINNISH CASE STUDY FOR UNCED 1992, NORDIC INITIATIVE ON FRESHWATER RESOURCES

1. PROJECT AREA

1.1 Geographical setting and climate

Kenya-Finland Western Water Supply Program extends 53 locations within four districts: Kakamega, Bungoma, and Busia in Western Province and partly also Siaya District in Nyanza Province. The total project area is 5230 km^2. It extends in latitude from 0 up to 1 10'N and in longitude 33 55' - 35 10'E. The location of Western Province is illustrated in Figure 1.

Figure 1. Administrative boundaries

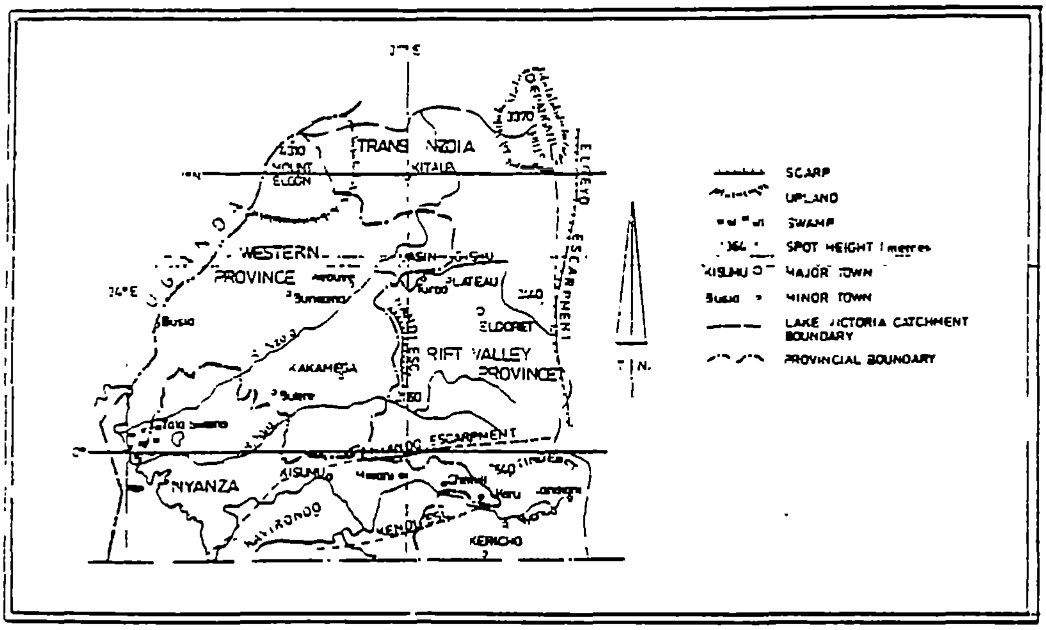


Topographically, the area is situated on a gently sloping peneplained surface, south of Mt. Elgon and east of the Nandi Escarpment with a general elevation between 1200 and 1700 meters the highest point by the slopes of Mt. Elgon rising over

2500 m above sea level. Undulation characterizes the landscape with abundant hills and valleys, rivers and rivulets. In the south–western corner of the area lies Lake Victoria on the elevation of 1130 m above the sea level. Altogether, the characteristic of small scale topography is rather challenging in siting different kind of water supply systems. The physiography of the area is shown in figure 2.

The climate in the project area is tropical. The mean daily minimum temperature is 14 – 16 degrees celsius, maximum 26 – 30. Annual rainfall is quite abundant varying between 1000 – 2000 mm/year.

Figure 2. Physiography of Western Kenya

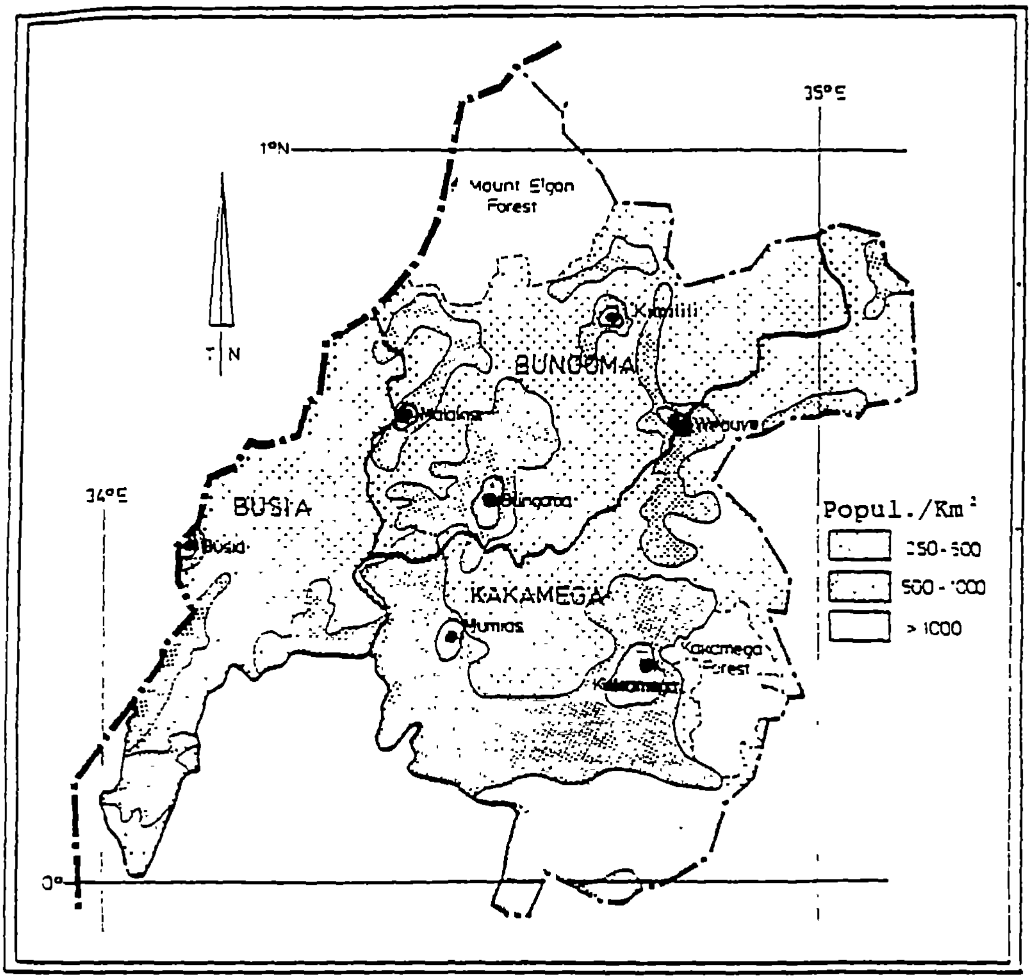


1.2 Population

The total population within the project area is estimated to be around 1,75 million in 1990. In Western Province the total population is about 2,9 million. The average density is about 310 persons/km^2 including several areas with population density over 1000 p/km^2. Population growth rate is one of the highest in the world, ~3.5 %.

District	No. of locations	Population 1988	%
Kakamega	18	662,000	41
Bungoma	13	294,000	18
Busia	16	446,000	28
Siaya	6	189,000	13
Total	**53**	**1,591,000**	**100**

Figure 3. *Simplified population density map*



1.3 Economics

Western Province is almost totally rural; more than 95% of the population earn their living from agriculture and livestock. The plots are generally privately owned their size being in average only a few hectares.

The realized income is mainly generated through the sell of farms products. Other less significant sources of income are wage–employment and commerce. The biggest industries are the paper mill at Webuye and the sugar factories at Mumias and Nzoia. In addition, there are numerous minor sugar factories, coffee roasteries and cotton ginneries.

The annual per capita GDP is in the program area fairly low (KES 1200 - 1400) compared to the national average of KES 3,447 in 1988 (Economic Survey 1990).

1.4 Cultural and socio-economical aspects of the project

There lives several ethnic groups in Western Province the dominant group being the Huhya. Other major groups are Luo, Kalerjin, Teso and Pokhot. Each group has its own language and specific cultural features. The official languages, English and Swahili are adequately understood and spoken by 50 - 60% of the population.

The most important socio-economic features affecting the water development are, besides the overall poverty of the area, the following:

1) About 20 % of the households are women-headed. The main reason for this is the migration of men to towns after job-opportunities.

2) Men and women have usually separated economical responsibilities within the family. For instance, cash-crops are "men's crops" whereas food crops are mainly women's property/responsibility. Water supply in rural areas is usually seen a women's responsibility, both in water fettering and economical terms.

3) In villages the main decision-makers are the chiefs and village elders, both mainly men. Hoverer, women may also have significant role in common decision-making.

4) Self-help work (harambee) is a major way to improve jointly the living conditions. For instance primary schools are usually constructed by harambee-work.

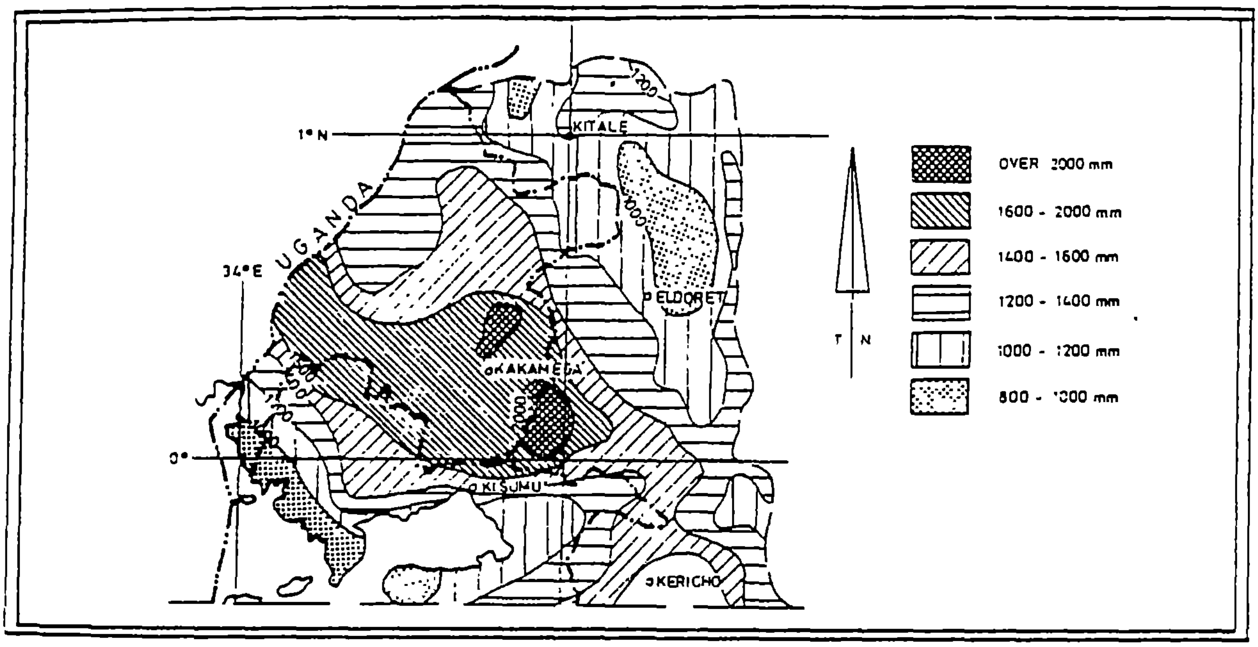
The health situation in the area is somewhat lower than the national average. The infant mortality rate is 150/1000 births (national average 87/1000 births) and the life expectancy between 54 and 60 years. There is a high percentage of choreic malnutrition in the area especially among children. Major diseases are malaria, respiratoring diseases and hygiene-related diseases.

2. WATER RESOURCES

2.1 General Hydrology

The rainfall in Western Province is relatively high. The mean annual rainfall varies from 1000 mm/year in the south-western part to about 2000 mm/year in the eastern part (Figure 4). The actual evaporation from free water surface is about 1100–1500 mm.

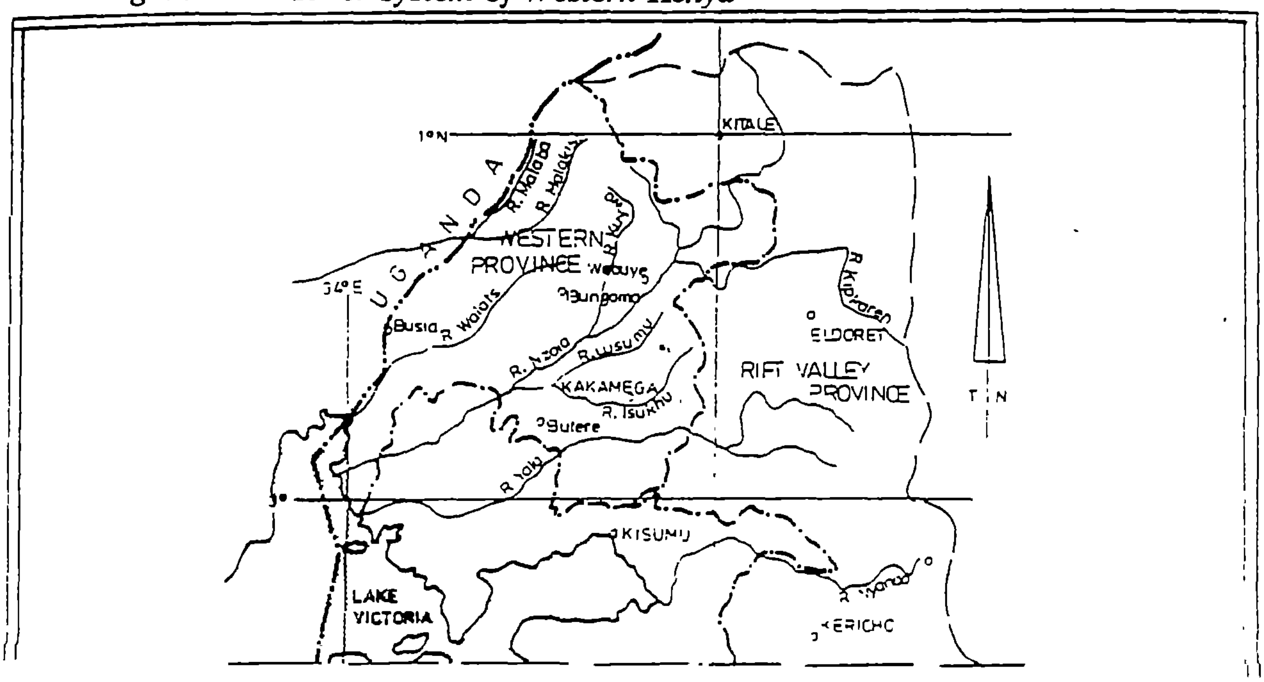
Figure 4. Mean annual rainfall



2.2 Surface Water Resources

The area of Western Province belongs to Lake Victoria Basin. The river system is shown in figure 5. The most prominent river in the area is the Nzoia River. The Western Province is steadily sloping from Nandi Escarpment in the East and from the Mount Elgon in the North towards the South–Western corner. The estimated values of mean runoff vary between 5.3 l/s km^2 and 21.5 l/s km^2. The surface water resources are abundant and fairly evenly distributed. Practically all rivers are perennial having, however, quite high seasonal fluctuations.

Figure 5. River system of Western Kenya



The general characteristics of water quality are high color and turbidity almost throughout the year, low dissolved mineral content and pH usually above 7.0 (in Lake Victoria 8.0). As the rains are usually quite heavy, the water quality fluctuates a lot during rains. During heavy ones the quality of surface water is poor and creates severe problems for water treatment. There are some seasonal variations in pH, COD and BOD caused by industrial effluent discharge along the rivers. The main causes of pollution in the rivers are the following:

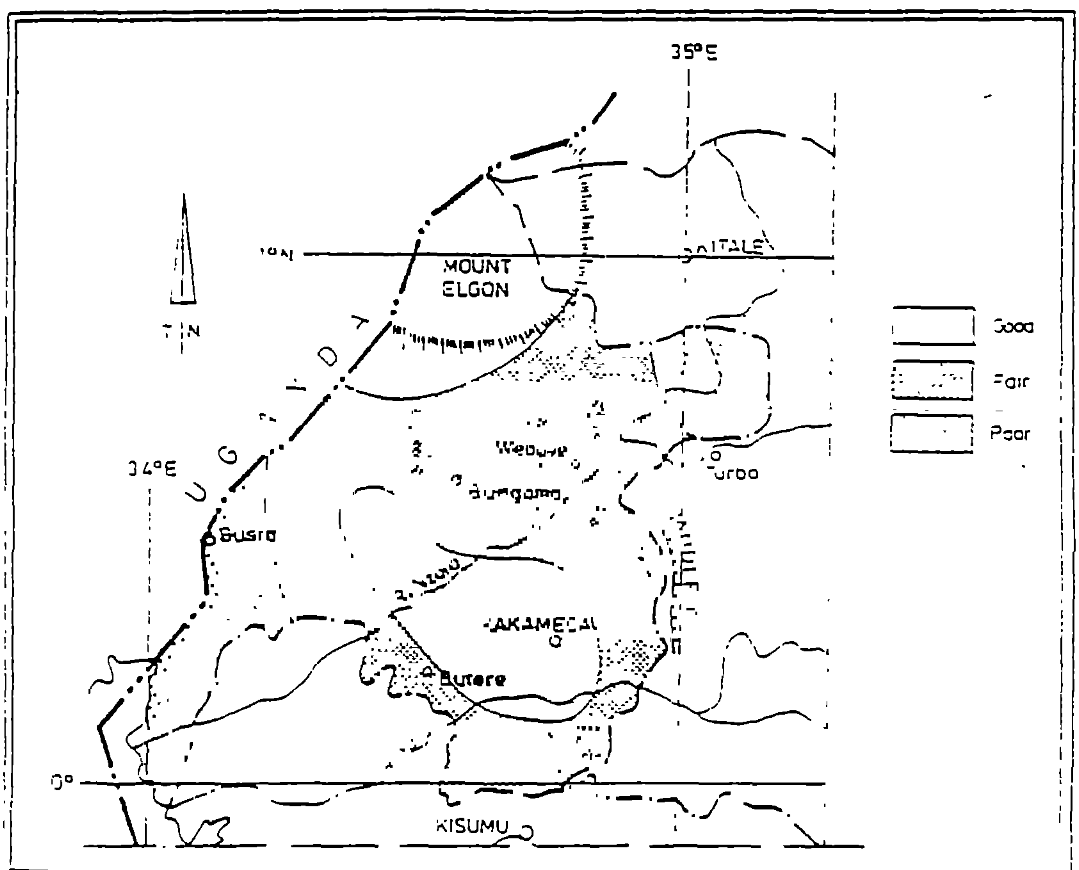
1) Paper factory at Webuge discharges all of its waste water to river Nzoia. The amount of waste–water is about 10.000 m^3/d.
2) Sugar factories in Mumias and Nzoia,
3) Coffee factories along the main tributaries of the river Nzoia,
4) List of fungicides, herbicides, and fertilizers in coffee, sugar and wheat farming (upper Nzoia),

The pollution effect of the rivers drawing into Lake Victoria has been reflected in lake water quality which has been manifested by proliferation of blue–green algae, raised pH, COD and organic load.

2.3 Springs

In Western Province the springs form an important source of water. Throughout the area, with the exception of South–Western Busia, perennial springs are common and springs yielding up to 500 m^3 per day are found. Altogether over 5000 springs have been registered and measured. The spring potential is shown in figure 6.

Figure 6. Spring potential



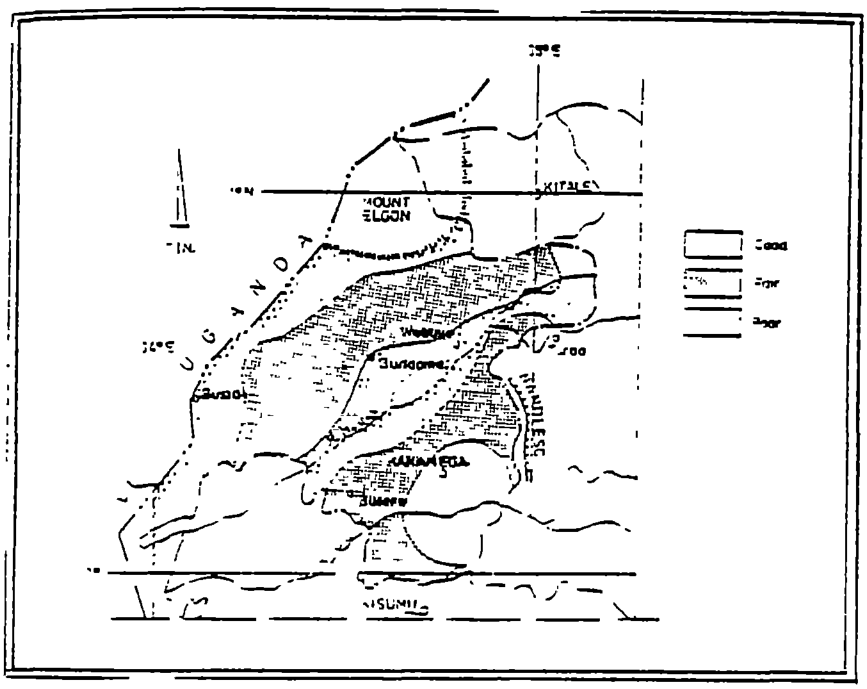
The quality of springwater is the same as groundwater with the shallow. Bacteriological contamination is common in unprotected springs caused by surface water entering the spring or by unhygienic water abstraction practices. Even with the protected springs the bacteriological quality is not always safe. This has usually been caused by failures in the supervision during the construction of the well or by the unsuitable standard design of the spring protection. During phase III of the project, the design has been developed to take into account the specific features of the spring site which has reduced the pollution risk. Especially during the wet season the water quality in poorly protected springs is questionable.

2.4 Groundwater

Shallow Groundwater

In most parts of the Western Province shallow groundwater level lies between 2.5 and 5.0 meters from the surface. The seasonal fluctuations of groundwater are considerable, often 2–3 meters, resulting frequently in need to deepen some of the already constructed wells. The potential of shallow groundwater is fair (Figure 7).

Figure 7. Swallow Groundwater potential



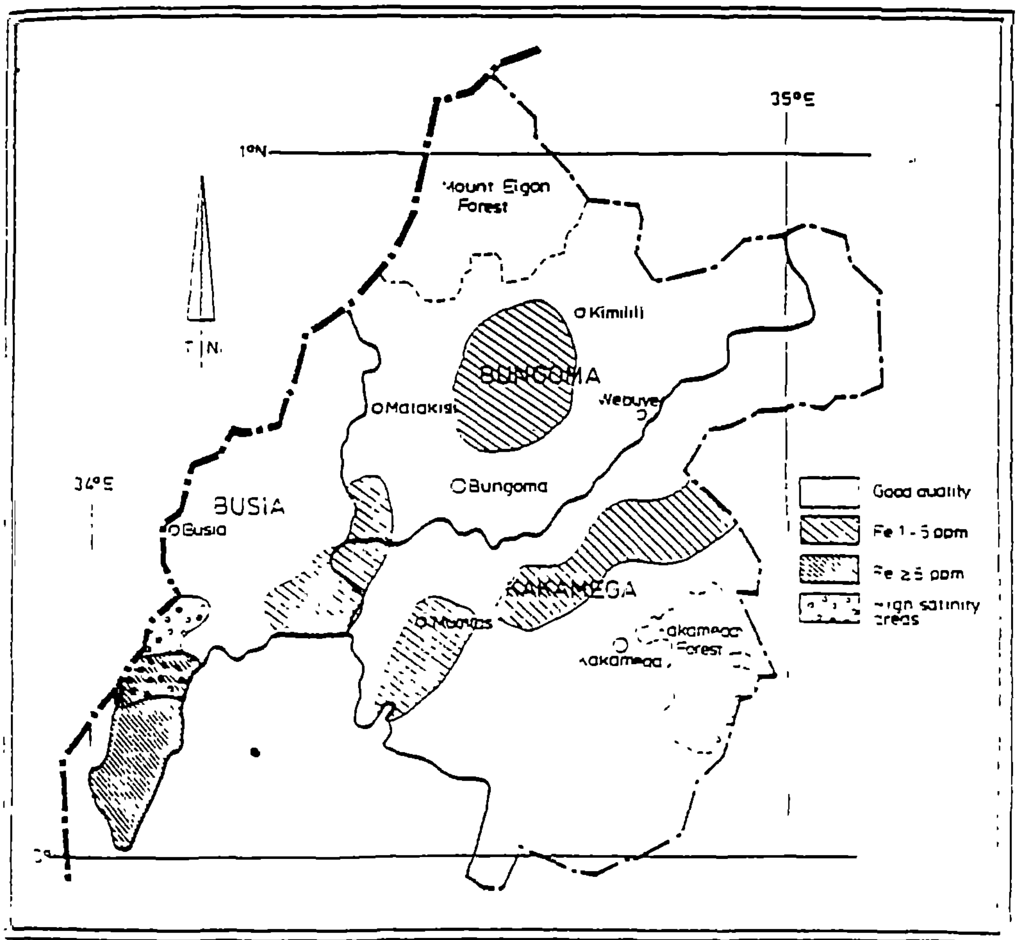
The shallow groundwater has usually a very low concentration of dissolved solids, and it is soft and has high concentration of dissolved carbon dioxide. The turbidity and color increase in the rainy season mainly due to the intrusion of surface runoff. Apart from very local pollution (e.g. latrines) the shallow groundwater is bacteriologically safe. In shallow wells the quality is, however, often unsatisfactory due to the penetration of the surface water into the well. Even 30 – 40% of the shallow wells have sometimes faecal coliform bacteria level 10 per 100 ml. The reasons for this are the faults in the old design of the wells, poorly supervised construction and the soil conditions. Besides bacteria, shallow wells have also problems caused by high iron and/or manganese contents in some areas.

Deep Groundwater

The deep groundwater potential is in most parts of the Western Province good or moderate. Sites for bareholes can be easily found, the yield of which are high enough for submersible pumps and handpumps. Only in southern parts of Busia District and in Bungoma District the groundwater potential is low.

The quality of groundwater meets in most cases the drinking water standards. Generally, the deep groundwater has a low content of dissolved solids, it is soft, high in dissolved carbon dioxide and the average pH lies in acidic range. In some areas the high iron or magnesium content prevents the use of otherwise adequate groundwater. There are also some areas of exceptionally high salinity in it. The hygienic quality of deep groundwater is normally perfect. It has seldom color or odor problems. The overall groundwater quality is illustrated in figure 8.

Figure 8. *Simplified groundwater quality map*



2.5 Water resources assessment and monitoring

Assessment of water resources was one of the key efforts of the project during the planning phase (1981–83). An inventory of water resources was included in the Water Master Plan which was prepared as a result of the planning phase. Because the project was originally planned solely as a rural water supply project, the inventory concentrated mainly on groundwater resources and the surface waters were studied only of rather overall level.

During the two first phases of the project (1983 – 88) a lot of additional data and new knowledge of the water resources was gathered. However, the evaluation of the project in May 1988 found out that the obtained knowledge was not actually used and analyzed, and recommended therefore that the Water Master Plan (WMP) should be revised according to the gathered experiences. The plan for phase III (1989 – 1992) included the revision of the WMP and development of a continuously updated, computerized data–base for the planning. By August 1991 the project had prepared a draft for the updated WMP and analyzed the results of the vast data of geophysical soundings, test drillings, test pumpings and construction of wells and boreholes. This data has now been processed to a computerized data base which gives continuously updated knowledge of the water resources.

The basic idea behind this computerized, continuously updating data base has been the development of an effective monitoring system which can be used as a practical tool for the planning and design of new water supplies. However, as the project has concentrated almost solely on the utilization of groundwater, the data base doesn't include methods to effectively utilize the surface water monitoring data.

The sustainability of the computerized data base is still questionable, as well. Computers are not common in the Western Province as such and the Ministry of Water hasn't been able to nominate adequate Kenyan staff to run the data systems. Also the availability of support services (assistance in programming, operation and maintenance) is poor in the province. On the other hand, the amount of data requires computerized systems as otherwise there is no possibility to update and use the data effectively, as was seen during the second phase of the project.

In water quality monitoring the earlier procedure was to monitor the raw water for piped water supplies and treated water according to the guidelines of MoWD and take random samples from the rural point sources. The latter proved, however, to be ineffective and didn't bring any really useful information. The present practice is to analyze the point sources according to the visible problems, i.a. the samples are taken by request or if there can be seen some structural problems with the wells or spring protections (cracks, polluted surroundings, etc.). The requests for monitoring come either through MoWD supervisory staff, health workers or the water committee of the community.

2.6 Trends in the water resources

Both in groundwater and surface waters there is a clear fluxuation with the availability as well as with the quality of water caused by the normal climatological changes during the year. As the industrial development in the area is still quite weak and the farming is mainly small-scale subsistence agriculture and the erosion is still quite weak, there cannot be seen any drastic man-made trends and changes in the catchment.

However, the first signs of the future problems have already been noticed. For instance, by the slopes of Mt. Elgon there have been a couple of cases where the yields of some springs have changed due to the cutting of trees in their catchment areas. Also the extremes in rivers have increased due to the slowly proceeding environmental degradation. As the rains are abundant, this doesn't cause availability problems for piped water supply schemes. However, as the increasing surface runoff increases the amount of solids and pollutants in the rivers, the treatment requirements increase as well which worsens the technical and operational problems in treatment plants, thus reducing the liability of the already poor services even more.

In the long run there may also occur influence on ground water quality and availability due to environmental degradation and infersifying agriculture. However, as present there doesn't exist any data on the issue as systematic groundwater monitoring has lasted only some years and no studies have been made on the effects of agricultural pollutants.

3. WATER USE

The present population in the Western Province is 2.7 mill. increasing by 3–3.5 % p.a. The amount of population is estimated to be in 2005 about 4.2 mill. The growth is more rapid in urban centers than in rural areas. In major urban centers the growth is estimated to be 5 – 8 % per annum and in minor centers 3.5 – 5 % per annum. The population estimate of Western Province is given in table 1.

Table 1. Population estimate 1989 – 2005, Western Province

DISTRICT	1989	1993	1998	2005
Bungoma	760,000	870,000	1.020,000	1,200,000
Busia	440,000	500,000	580,000	670,000
Kakamega	1,500,000	1,700,000	2,000,000	2,300,000
Western Province	2.7 mill	3.1 mill	3.6 mill	4.2 mill

This extremely high population growth especially in urban areas where piped water supply is practically the only possible solution for water supply, creates severe problems for developing the services according to the growth of needs. Also in rural areas the population growth worsens the situation as ever with the present, heavily donor supported development speed the construction succeeds only to keep the pace with the population growth. Also the environmental degradation worsens as the population density increases. The average population density is estimated to be 570 p/km^2 in 2005 meaning that vast areas will be covered with population density well over 1000 p/km^2.

Another main contributor to water use in addition to population is livestock. It is estimated that the number of cows is about 1.0 million and of goats about 0.4 mill. At the present the livestock is mainly watered from rivers and water ponds. There are, however, plans and projects going on with the aim of developing the quality of cattle through "zero–grazing", i.a. through grazing more high–quality cattle in cattle yards in stead of the present practice of free grazing. This will increase the water supply needs for cattle dramatically as zero–grazing requires quite high–quality water both for drinking and washing at the cattle yard.

The other significant water uses relate to institutions as schools (0.9 million students in 1989 growing to 1.4 million in 2005), health units and commerce and industry. The industrial water use in the main urban centers is still quite small, as the industries are mainly small ones and don't require high amounts of water for the production. So, in the foreseeable future the main industrial water users will be the paper, sugarcane and coffee industries which all have their own water supplier.

Unit water demand has been estimated to be in urban centers 75 l/c/d; market centers 60 l/c/d; rural areas 20–50 l/c/d and for livestock unit 50 l/c/d. With these values, if the whole province is planned to be provided with improved water, the total domestic water demand in 2005 will be about 220.000 m^3/d and in 1989 140.000 m^3/d. The non–domestic water demand is estimated to be in 2005 about 25.000 m^3/d and was estimated at 21.000 m^3/d in 1989.

The unit consumption estimated for rural areas seem to be, however, very high compared to the actually measured water consumption rates. In a water use study prepared in 1987 it was found out that with point source water supplies (wells, protected springs) the actual water usage was 8 – 12 l/c/d, which also complies with respective studies in other similar projects.

In addition to the above water uses there exists some small–scale vegetable irrigation. The irrigation demand is, however, rather small as the abundant rains secure the adequate irrigation of crops anyhow.

In urban areas the poor condition of networks causes relatively high losses through leakage. Illegal connections are another major cause for the high amount of unaccounted-for-water, which is estimated to be 40 - 60 % in urban areas.

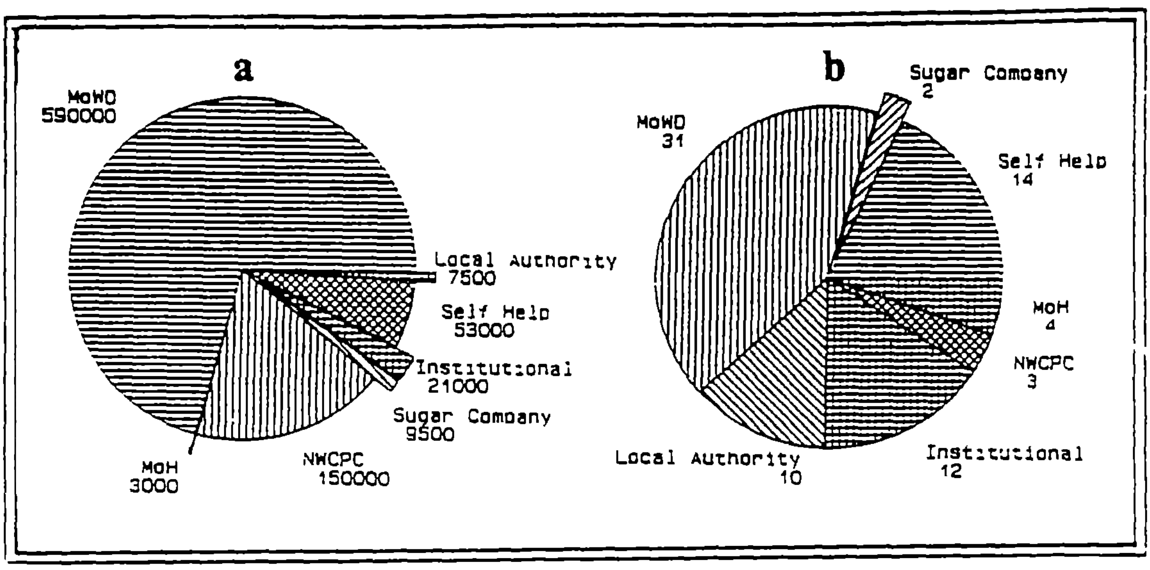
Due to the abundance of the water sources, the technological choice in the Water Master Plan has been made on the basis of the expenditures of different sources and willingness to pay for water by the communities. The solutions will in present circumstances be based on the utilization of groundwater and community management of the schemes.

4. EXISTING WATER SUPPLY AND SANITATION SITUATION IN WESTERN PROVINCE

4.1 Water Supply

There are altogether 76 piped water supply schemes in the Province covering an area with a population of 830 000. Ministry of Water Development (MoWD) and National Water Conservation and Pipeline Corporation (NWCPC) operate and maintain 31 and 3 schemes respectively, serving population of 740 000. The rest of the schemes are managed by communities, industries, institutions or local government (Figure 9).

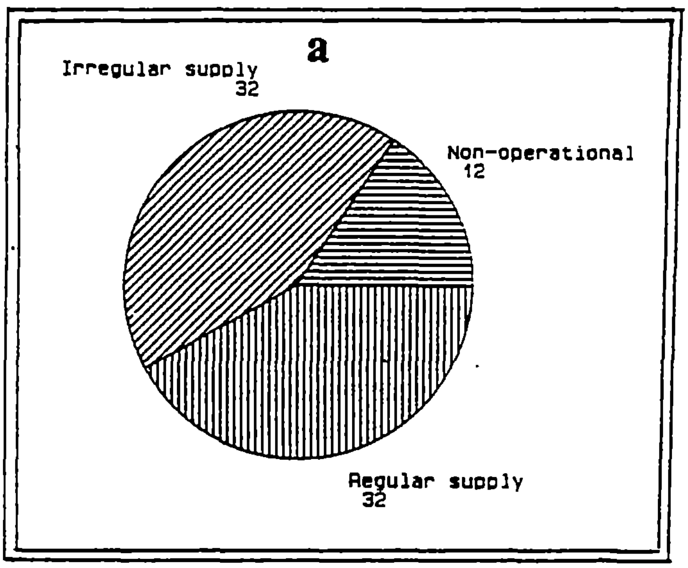
Figure 9. Organizations responsible for operation and maintenance of piped supply schemes, (a) Number of consumers per organization, (b) Number of schemes per organization.



Most of the piped schemes use surface water (population served by these schemes totaling 37 is 720 000). Surface water plants have full treatment, but treated water from most plants does not meet the minimum water quality standards due to lack of skills in operation and maintenance; inadequate supervision; lack of necessary tools and spares; irregular supply of flocculants; overloading of treatment works and inadequate water quality control. Furthermore, nearly all the schemes produce less water than the demand due to reasons such as inadequate capacity utilization; irregular operation and inadequate skills, motivation, supervision and incentives. Extensions are not made in time due to inadequate investment funds. There is also a severe lack of finance for operation and maintenance and lack of standby units. Only about 54.5 of the served get fairly good regular supply (Figure 10).

The present plans for phase IV of the Programme include extensive components for improvement of operation and maintenance of piped water supplies in addition to the present point source orientation.

Figure 10. Operation of piped Water Supply Schemes; Status of piped water supply schemes.



Point source water supplies are mainly constructed by KFWWS Program and include 2347 water points (March 1990) serving about 704100 rural people in the Western Province. Point sources include boreholes, dug wells and protected springs. Because the development of a comprehensive water point register is still under preparation (1991 – 1992), there is not at present any complete picture about state of the point sources, but a sample covering all the four districts of the Province gives the following picture

(a) boreholes and dug wells

- 10–25 % of the sources fall dry in the year. However, from the ones constructed after 1989 only a few have fallen dry because of the improved construction methods;
- in 10–25 % of the sources the pump breaks down often and was not operating at the time of the survey in 15 % of the sources within one district;
- almost half of the breakdowns last at least one week (more than one month are not rare);
- construction and drainage conditions are reasonably good although in some districts cracks of aprons, poor construction quality and poor drainage maintenance were common. During phase III of the project a major renovation of previously constructed wells has taken place which, with the improved construction methods and design, has decreased the problems at least at the moment;
- 10–40 % of the sources had serious pollution problems which is an alarming figure. The pollution is mainly due to surface runoff to the wells through cracks in the slab or inappropriate protection of well surroundings;
- unclean sites are quite common (about 10 %) and some sites have erosion problems;

Altogether, the functioning of the pumps as well as the cleanliness and condition of the wells reflect directly to the success of community participation. The problems are worst with the wells constructed during the first years of the project, when community participation was not yet introduced as a working approach. In spite of several attempts the project has not been able to establish functioning community management to those wells which were lacking participation in the first hand.

(b) springs

- condition varies largely;
- the covers have often leaks, poor fittings, poor accessibility and poor drainage (varies from district to district between 10 and 60 %);
- quite often the sites are not clean and operation and maintenance are neglected;
- often the sites are not fenced, and erosion problems exist.

Out of the population of 1 534 100 about 57 % are within the service of improved water supply. To which extent the water supply is reliable and safe is difficult to say, but according to the survey results, a significant number of this population is exposed to polluted water due to the use of polluted water either because of continuing use of polluted sources, interruption in supply of improved source or pollution of the improved sources.

4.2 Sanitation

Most communities are living in unhealthy conditions and there is low latrine coverage and usage, especially of ventilated improved pit latrines. In general 65–80 % of the households have latrines; 60–70 % of the latrines are clean; 80–90 % of the houses are clean and most households have adequate water storage.

However, in 10–40 % of the households, the probability of contamination is high due to inadequate sanitation.

5. WATER USE CONFLICTS

At present there exists only a few conflicts between various water users the reasons for these being the abundance of water. The lack of obvious conflicts has also been the cause of neglecting the conflict assessment within the project. However, even at the present stage, following minor conflicts can be identified:

1) The paper, sugarcane and coffee industries pollute the downstream waters quite far from the discharge points of their wastewaters. The polluted rivers are extensively used both as a source for household water and cattle watering, and in some cases, even as sources for piped water supply schemes.

2) As described in the previous chapter, livestock development (especially the zero–grazing) may increase drastically the water supply needs of cattle. As the rural water supply has mainly been based on simple point sources, the amount of water or rather the capacity of a handpump might become a limiting factor for increasing water needs if the density of wells is not increased.

3) The high population growth will either decrease the service level of water supplier or increase the need to increase their density. The construction of new wells quite near the old ones to keep the service level acceptable (n:o of people using one water point ~200) may in some cases cause problems of lowering of the groundwater level. This is especially potential if the new water points will be equipped with motorized pumps.

4) Source protection (wells, springs) requires often protective measures in the surroundings of the water points. For instance, the cutting should be avoided in the catchment of a spring and extensive use of agricultural chemicals

should be avoided around the well surroundings and above the spring projections. As all the land is privately owned, this may cause conflicts between the land-use practices and the requirements of safe water supply. The reason for such conflicts not yet occurring might be that the matter has not yet been touched anyhow. However, the increasing population pressure clearly increases the pressures to utilize all land as effectively as possible which on the other hand is controversory with the protective measures.

5) Small scale conflicts have been identified also between water supply and sanitation needs. The problem is caused mainly through the need to construct the wells as near as possible to the water users to a spot where the site can be handed over to the community (acceptance of the land owner, good access to the well). In some cases there already exists latrines in the neighborhood of the site that otherwise is suitable for the community or there is a need for certain households to construct ones near the wells in the future. Even though this kind of problems occur only case-wise, in those cases they endanger the actual objective of the water development, the reduction of water-related diseases.

The project has not yet considered much of these possible conflicts, as they at the moment are not common or are outside the present project scope (industrial pollution). However, with the increasing population and environmental pressure, these problems might, with the worsening economical situation, endanger the long-term sustainability of at least some water supplies. Because the conflicts have not yet been very evident, there doesn't neither exist any methods and mechanisms to deal with these conflicts, expect for the industrial pollution which is dealt in the legislation and within the permission process for the discharge of effluents.

The permissions for industrial effluent discharge follow basically same kind of principles as in industrialized countries. However, the poor manpower, technical and financial resources prevent effective wastewater treatment by the industries themselves as well as adequate monitoring from the water authorities.

For other problems, the theoretically available mechanisms to deal with the conflicts include the District Water Boards (established in 1990), District Development Committees, and at the community level the established water committees. The most relevant bodies to cope with the problems seem to be the District Water Boards and water committees. However, because the District Water Boards are just starting their work there isn't yet any experience of their capability to solve problems. The village water committees have on the other hand not handed any of these kind of problems and there doesn't exist yet any rules or methods in how to do it.

6. WATER MANAGEMENT SYSTEM

6.1 Central Government Level

Administratively, the country has been organized into 7 provinces. In addition, Nairobi and its environs have a status of a province. The provinces are sub–divided into a total of 43 districts, which are the major level of rural development. The districts are sub–divided into divisions, locations and sub–locations.

The Ministry of Water Development (MoWD) is in charge of water development, catchment protection as well as water quality and pollution control in the country. The ministry also operates and maintains most water schemes of the country totalling over 300 schemes out of which 30 are in the Western Province. MoWD has national headquarters where the offices of the Minister, Permanent Secretary and Director of Water Development are located. In the provinces, the ministry is headed by a Provincial Water Engineer (PWE) who is reporting to the director of Water Development. PWE is responsible for coordination, monitoring, development, operation and maintenance, control and supervision functions of schemes and water resources. The districts are headed by District Water engineers being responsible for different functions of schemes and water resources at district level. District Water engineers are also technical advisors on water related issues to the District Development Committee. The organization of MoWD is presented in Annex 1.

The National Water Conservation and Pipeline Corporation (NWCPC) was established in 1988 to manage, develope, operate and maintain water schemes assigned to its responsibility. The corporation was established to allow flexibility and improved financing through better cost–recovery in the operations of major water schemes. At the moment NWCPC is responsible for 26 water undertakings, 3 projects under construction and 14 projects in the planning stage, out of which 3 water undertakings are located in the Western Province (Kakamēga, Shitoli and Bungoma). The Corporation has regional and district structure as MoWD. The organization structure has been developed with an aim for efficiency and effectiveness.

The Ministry of Local Government (MoLG) works in cooperation with MoWD. Some local governments operate and maintain their own water supply, waste disposal, sewerage and revenue collection (10); some operate their own sewerage, waste disposal and collect revenue as well as purchase water in bulk from MoWD, undertake distribution of water and collect revenue (5 including Bungoma in the Western Province) and some operate only for sewerage, waste disposal and revenue collection (5 including Kakamega in the Western Province). The rest of the about 100 schemes are under the responsibility of MoWD or NWCPC.

There are also numerous other public sector organizations involved in development, operation and maintenance of water schemes and water resources including the Ministry of Agriculture; Ministry of Tourism and Wildlife; Ministry of Environment and Natural Resources; Ministry of Lands and Housing; Water Apportionment Board (monitoring and revoking of permits for abstractions of water); Catchment Water Boards (5 pcs); Ministry of Energy particularly through Lake Basin Development Authorities; Ministry of Culture and Social Services; Ministry of Health and Ministry of Reclamation and Development of Arid, Semi-Arid and Wasteland.

6.2 District Level

Many industries have water schemes which may serve also population. Furthermore, there is a huge amount of small schemes developed, managed and operated by different institutions as schools (11 in the Western Province); local authorities as divisional authorities (10 in the Western Province) and communities. Most of the schemes of the institutions, local authorities and communities have been developed and are operated and maintained on self-help basis.

Self-help or harambee activities are in Kenya of utmost importance. Self-help activities in water sector as also in other sectors are heavily based towards the use of local resources such as human labour and use of donations. The choice of projects is guided by the principle of satisfying the immediate need of the participating members of the groups. MoWD started to support self-help programs in mid 1970's by establishing a section which is in charge of coordination of the government efforts to develop and assist in operation and maintenance of self-help water systems through technical assistance. With the introduction of District Focus for Rural Development Strategy in June 1983 this section has been decentralized to District Water Offices. The sources of funds for the self-help water programmes have been: local finance (Government of Kenya through the Rural Development Fund or through the budget of MoWD; the beneficiaries contribute time, money and labour); non-governmental organizations' finance; and finance by external support agencies. In the Western Province all these forms have been used the major financiers being FINNIDA, NORAD, Rural Development Fund, Cooperation of American Relief Everywhere, Kenya African National Union, Kenya Water for Health Organization, Action Aid Kenya and International Fund of Agricultural Development. Many institutional, local authority and community schemes experience operational problems due to lack of skilled staff and lack of funds for operation and maintenance.

The strategy of District Focus for Rural Development is based on the principle of ministries and districts having complementary responsibilities. Responsibility for the operational aspects of rural development – including water resources development – has been delegated to the districts, while the responsibility for broad policy, the planning and implementation of multi–district and national projects has remained with the ministries. The coordination and co–operation between the various organizations and water undertakers requires still improvement, even though the District Focus Policy in theory provides an effective means to coordinate the various activities in the sector. The inadequately coordinated situation is worsened by donors (both multilateral, bilateral and non–governmental donors) which are assisting overlapping organizations with sometimes even contradictory approaches. For instance in Western Province the project is run under the responsibility of MoWD whereas in the neighboring Nyanga Province a Dutch funded, similar kind of project is under the responsibility of the Lake Basin Authority (LBA). The coordination and co–operation between MoWD, LBA and the projects seem to be inadequate even though the projects are within the same catchment area.

At clearly local level the coordination seem to be getter improved due to the district focus strategy. The District Development Committees are responsible for the definition of priorities of locally identified projects coming through the Divisional Development Committees, identification of district wide needs, preparation of District Development Plan and the design of projects which fit within the priorities. The lack of trained and experienced professionals especially at management level, inadequate funds and centralized budgeting system, however, weaken the performance of District Development Committees. Due to the poor financial resources the District Development Plans exceed usually the de facto possibilities which thus reduces also their value as tools for practical and effective coordination and management.

6.3 Legislation

The most important legislation related to water resources include the Water Act, Cap 372, 1972; the Public Health Act, Cap 242, 1986; Building Code, 1968 and National Water Conservation and Pipeline Corporation Order, Cap 446, 1988. The Water Act originating from 1925 has been revised in 1551 and 1972 and covers the following areas:

- Ownership and Control of Water
- General Powers of Minister
- Water Resources Authority
- Local Planning
- Water Apportionment Board and Local Water Authorities
- State Schemes
- Water Permits
- Abstraction of Groundwater and Permits
- Procedure on Issue of Permits

- Dams
- Execution and Maintenance of Works
- Variation and Cancellation of Permits, etc.
- Easements
- Water Undertakings

The Water Act gives inter alia the authority to the Minister of MoWD to decide the water rates or charges on the advice of the Water Resources Authority. These rates and other charges are payable to the Government. The Minister of MoWD after consultation with the Water Resources Authority may appoint water undertakers to supply water. The water charges are regulated by the Minister.

6.4 Allocation of Water Resources

The Water Apportioned Board (WAB) under the Minister of Water issues, monitors and revokes permits for the abstractions of water in Kenya. The Board is supported by MoWD through technical advice, manpower for the Board's secretariat, and water bailiffs who are the Board's field workers.

In addition to WAB there exists five Catchment Water Boards for each of Kenya's five major catchment areas. These Catchment Water Boards advice the WAB on the use of water supplies and adjustment, cancellation or alternation of permits. The share of roles and responsibilities between CWB's and MoWD seem to be somewhat unclear and overlapping.

A permit for water abstractor is always required when surface water is abstracted or a borewhole constructed. The principle with surface waters usually is that the permit allows abstraction only above the minimum flow. With boreholes the criteria is the effect to the neighboring boreholes, i.e. in practice the distance. The only water abstractions which don't require permits from the WAB are construction of hand–dug shallow wells and, naturally, rainwater harvesting.

The water applications for water abstraction permits are given to the District Water Engineer who assess the application and directs it to the Water Apportionment Board in Nairobi with his and/or District Water Boards Comments.

Depending on the case, WAB asks for assessment and comments from the Catchment Water Boards as well. This is done especially in cases when the impacts of the abstraction overlaps the administrative boundaries.

Besides water abstraction for water supplier, also other forms of abstraction (industrial use, irrigation, etc.) are handled by the WAB.

In principle, the system for allocation of water resources is well developed. In practice, however, several problems occur the main being the lack of experienced professionals at district level for assessing the permits, the slow and long decision making chain and the poor availability of reliable long-term data for trustworthy assessment of the impacts of water abstraction on wasterwater discharge.

6.5 Local Water Management

At local (community) level the water is usually considered as a common good which is not owned by anybody. In places where there has been a scarcity of water resources several different types of common rules and practices have been developed among the water users. In Western Province such rules, i.e. "community water management practices" have, however, not been developed earlier because of the abundance of the water resources.

The only local water management practices developed earlier have been related to the construction of some self-help water supplies (mainly spring protections) but even with these the management has in practice meant purely local self-help (harambee) work in the construction. For the operation and maintenance and for the actual community water resources management there hasn't been developed any systems earlier.

When the Kenya-Finland Western Water Supply Programme (KFWWSP) was originally initiated the role of the communities was rather small. Quite soon, however, the need for full community participation was noticed and a strategy to involve the communities in the operation and maintenance and construction of water supplies was developed. According to the project's experiences and recommendations of several reviews/evaluations the community involvement was developed further by involving the communities more also to the planning of their water supplies. The present approach in community participation is the following:

1) The project allocates funds to the districts and locations according to their present water supply situation.

2) District Development Committees agree upon the more detailed allocation within the districts and locations.

3) The selected communities are mobilized through awareness building (extension work, public meetings), water committees are selected and trained.

4) The water points are sited jointly with the community and the project and the needs of the community are discussed upon and taken to the design as possible.

5) Before the construction starts the water committee must have opened a bank account and collected a maintenance fund, the land easement question for the site must have been cleared and two pump attendants (mainly women) must have been chosen for the training.

6) During the construction phase the role of the communities varies in the following way, depending on the water point:

   * With shallow wells the community must dig the well up to the water level from which a locally recruited small contractor (artisan) continues with a motorized pump beneath the water level. The construction of the concrete structures and the installation of the pump is done by the contractor as well. The community then fences the site and develops it according to its own interests (vegetable garden, washing slab, etc.).

   * With spring protections the community clears the site, assists in the construction work and provides local material for the protection. The concrete works are made by local contractors hired by the project.

   * Boreholes are constructed almost solely by the project. The role of the community is limited to the construction of a possibly needed "road" to the site and some minor assistance during the construction.

   * The project has recently also started to develop small gravity schemes using suitable springs as their sources. With gravity schemes the communities dig the trenches and assist in the laying of pipes as well as in the construction of slabs and the actual spring protection.

7) The operation and maintenance of the point source supplies and simple gravity schemes is supposed to be the responsibility of the community itself. When needed the communities can get technical assistance from the districts.

This procedure has been fairly successful in achieving the quite high production targets of the project. However, the sustainability of the results seem to depend a lot on the community's original interest in the project. The project is just starting to transfer this supply–oriented approach towards more demand–oriented strategy, where the initial actions should be taken by the community, based on its felt need. According to the present plans the phase IV of the project (1993 – 97) shall concentrate on the institution building aspects at community as well as at District/Province level.

As seen from the above description the community management hasn't included yet any aspects concerning the actual water resources management. Only recently there have occurred cases with problems requiring some kind of community water resources management methods. For instance in the construction of one gravity scheme the users of the original spring have been left out of water as the spring was developed for the community downstream. In another case the yield of a spring seem to have reduced due to the cutting of trees in its upper catchment area. With the growing population density and increasing environmental degradation the need for effective community water management approach seems to increase. Thus it seems that this approach would be beneficial even in cases when the acute need for it isn't evident.

6.6 Kenya–Finland Western Water Program Management

Sectoral responsibility of the Program rests with MoWD. Together with the Ministry of Culture and Social Services (MCSS), Ministry of Health and other agencies MoWD is monitoring and supporting the project mainly through provincial and district level.

Although the Program has done a lot in training of personnel to be capable to continue the Program, it has not yet been able to institutionalize the systems and procedures. Several evaluations and studies have revealed that the prioritization of physical progress and community extension have not been in balance. A major lesson learned is that any Program should have a clear strategy and action plan for the development of institutional capacities for sustained and autonomous continuation of the activities of the Program.

7. ECONOMIC AND FINANCIAL ASPECTS

7.1 The Economic Value of Water

The economic value of water is not commonly realized in Western Province. The reason for this is naturally the good availability of water in all of its forms. Thus the availability of water hasn't been a limiting factor for the life of the people, expect in some extent in the urban centers. The industries depending in their production on reliable water supply have on the other hand developed their own water supplies.

This low priority of water reduces its priority in the investments as well. As the overall economic situation among the population is poor the scarce resources should, from the individuals' point of view, be directed towards the most urgent priorities which in the Western Province are housing, agricultural development (buying of fertilizers, seed and tools), food supply, clothes and schooling of children. Water supply and sanitation come quite far after these priorities.

The overall low priority of water combined with the poor affordability requires extensive awareness building on the health factors and realization of at least some positive economic value for water. This requires the use of such appropriate technologies which are both affordable for the users and suitable for some productive usage of water. Further on, the solutions should be based on the possibilities and priorities of those who actually are responsible for water supply. The Program has, for instance, held an assumption that the male household head is responsible for the payment of the household's expenses, the recurrent of O&M included. Reports prepared by the Socio–Economic section of the Program indicate that the water costs are affordable for the incomes of the household. However, on the contrary to this assumption a study prepared as a part of the mid–term review revealed that the responsibility for water, including the financial responsibility, is mainly with the women (75%) who already are financially overburdened. Thus the technical solutions are, in fact, in many cases over the financial capacities of the actual water users. This could to some extent be solved through the development of some concrete economic value for water, which should be directed to those who in actuality are responsible for water supply.

However, the actually available possibilities to utilize the improved water supplies for economic benefits are very limited in Western Province. The only activities that at present seem to have any marginal value are small scale vegetable irrigation, brick making and fish ponds. However, fish ponds by the springs don't require water supply and also the connection with brick–making is quite vague. So, the only real economic use is the possibility to have irrigated vegetable gardens. Even with these the benefit is limited to the few months of December–March when the rains are smaller and the price of vegetables higher. Even then the value in most cases is not an economic one but a dietary one as the products are usually used by the farmers/pump–attendants themselves.

In the future the development of zero–grazing seems to bring about the first direct economic values for improved water supplies in the area. At present the motivation and need for improved water supplies should be created by health awareness as well as by better convenience and usability compared to the traditional polluted sources.

7.2 State Financing of Water Supplies

The basic policy in Kenya is to cover development, operation and maintenance costs in urban schemes, and direct operation and maintenance costs in rural schemes with charges. The real outcome, however, is far from the objective. MoWD was able to cover between 1979–89 only 17 % of recurrent expenditures and 6 % of total expenditures. The plan figures for 1990–93 are 23 % and 6.5 % respectively. Local authorities bill about 46 % of the recurrent costs but are able to collect only 9–36 % of this amount (average 30 %). Fee collection by MoWD is 50–70 % of total billed.

Another striking feature in financing is the dominance of the donors in financing development expenditures, which has been 32 % in 1979–89, and is steadily increasing. Total investment for the water sector has been 9.4 % of the total investment budget of the country (K£ 1006.5 million). Harambee contributions have been about 3.5 % of MoWD development expenditure, which was in 1990/91 K£ 63.5 million.

The tariff structure is reasonably well developed, but the tariffs lack significantly behind the target figures of cost–recovery. In Nairobi the tariff per m^3 was 2.65 KSh, urban tariff 2.5–3.0 KSh and MoWD urban water supplies tariff 2.0 KSh.

The tariffs of public organizations are regulated by the Parliament, which has not kept the tariffs at adequate level. The tariffs have been adjusted in 1971, 1975, 1979 and 1981. The latest tariffs were submitted to the Parliament for approval in 1990.

The water tariffs applied in rural self–help water supply systems vary a lot and in some cases exceed considerably the tariffs used for MoWD managed systems. Furthermore, some large urban areas have their own tariffs.

7.3 Community Based Financial Management in Rural Water Supplies

The Program has followed a strategy where after the construction stage the communities are fully responsible for their water supplies. The water committee is supposed to have a bank account with sufficient funds for operation and maintenance. The cost–sharing among the community is expected to be solved by the community itself and the Program just gives guidelines on the amount to be collected for O&M.

The present experiences indicate that the question of financial sustainability is still mainly unsolved. Firstly, the supply-oriented approach of the Program hasn't in many cases created adequate basis for community ownership and responsibility. Secondly, the solutions seem to be at least in some cases beyond the financial capacities of the beneficiaries (borehole wells and piped schemes in rural areas). Further on, the financial arrangements and their reliability seem to be sometimes poor from the user's point of view. Also the poor possibilities to utilize the improved water supplies for productive purposes weakens the possibilities to create financial sustainability (chapter 7.1).

The mid-term evaluation of the Program assessed that the following factors influence the consumer's willingness to pay and participate in cost-sharing:

- an acceptance and high degree of user satisfaction with the improved water supplies;
- a feeling of community ownership and responsibility for operation and maintenance of water points;
- the existence of a water committee which instills the confidence of the community members and acts as an effective financial management system that provides for accountability;
- a thorough understanding of the reasons for cost-sharing; the community's and the Government's responsibilities in payment of the O&M costs, the purpose of the community's maintenance fund and a realistic appraisal of the annual recurrent maintenance costs and
- a sufficient economic base and income-earning capacity to afford the water tariffs without placing a heavy financial strain on the income and household budget.

The experience from the previous stages of the Program indicate that in many cases both the affordability and the willingness of those principally responsible for paying – the women – is rather low. This has resulted in an adequate amount of cash on hand in the maintenance funds to cover the costs of repairs.

The survey also revealed that the level of utilization of the improved water points is in some areas far below the target. Women continue to use alternative contaminated water sources. In such cases this points to insufficient awareness as well as to low level of satisfaction on the part of the women with those improved supplies.

Women make the economic decisions as to the choice of which water source they will use. These decisions are based on whether the improved water supply offers a better level of service according to the women's perceptions. However, improved sources do not seem to offer a sufficiently better service. Alternative (non-improved) water sources available at a convenient location and reasonable distance from the women's home continue to enjoy a fair degree of utilization. Many of the alternative sources are situated in close proximity to the improved point or are even more conveniently located. This all defeats to quite some extent the purposed objective of health improvement through the improvement of the supplies.

The low health awareness of women does not give any economic motivation to pay for water. They do not realize the hidden price tag attached to the utilization of contaminated water. On the other hand, its pricing is extremely difficult. Another reason for low willingness to pay is the lack of additional facilities to enable the use of water for all water usages. For instance, laundry and bathing may be possible at the alternative source but not at the improved one. Furthermore, low willingness to pay is contributed by inadequate amount of cash on hand by women; inadequate confidence on maintenance fund management; poor understanding of the role and inadequate information about the amount of O&M costs.

It also seems that the women do not benefit much from the time savings which have been achieved through the use of improved more near–by sources. Firstly, in Western Province the time saving is usually minimal because of the adundancy of traditional water supplies. Secondly, according to the survey the saved time is used mainly for farming, gardening and work in women's groups which do not bring immediate cash.

The major benefits of improved water schemes reported by women themselves are good quality; reduction of collection distance; quantity increased and better taste. It looks that the transfer of these benefits in the minds of the women is very difficult.

The quantitative situation in terms of the tariff contributions varies from district to district and from scheme to scheme. In general, about one fourth of the women do not pay. Only very marginal number of consumers pay more than 10 KSh per month although in some cases the share of this group may be even 30 %. There is usually a clear correlation between the willingness–to–pay and timing and intensiveness of community involvement.

8. SOCIO–CULTURAL ASPECTS

The main reason for the earlier poor development of water supplies has been the abundance of natural sources. When the population was still scarce, industries didn't exist and chemicals were not used in the agriculture the use of unprotected water supplies was not that dangerous, at least compared to the other health problems. However, as the surface waters have become polluted their use has become a major health risk. When starting to develop new water supplies one should ask why the development has not been started earlier and spontaneously. Besides the financial constraints and the low priority of water supply among the population there can be identified certain socio-cultural aspects as well.

The most important factor seems to have been the overall poor awareness and understanding of the health impacts of water. However, as the population has already for quite long time had at least some basic education (60 % of the population has some basic education and the present school enrollment rate is almost 100 %), at present the basic hygiene understanding is quite common, even though inadequate. So why the spontaneous development has been so poor even during the last twenty years?

Private wells or other private water supplies have previously not been constructed in Western Kenya, expect for some major farms. The few water supplies which have been developed have been "community owned", i.e. seen as public goods. The ownership of the community has been commonly understood even though there hasn't been any official forms for it.

One of the reasons for the non-existence of **private** water supplies must be the fact that water is regarded as a common good which can not be owned by anybody personally. Thus the development of private sources has not been favored. On the other hand, if one would have developed his own water supply it would have been used by other community members as well, as the water is for everybody. Even the fear for someone poisoning the wells has prohibited the spontaneous construction of developed water supplies. Further on, there exists in some parts of the area strong, partly superstitious beliefs that groundwater is not good and that the water must have been in touch with the sun.

Why then the **communities** have not been developing spontaneously their own water supplies? The low priority of water development compared to the other community-based activities (school construction, etc.) is certainly one reason. Another major reason is, however, the national policy which declared after the independence that the government shall provide all Kenyans with safe piped water by the year 2000. This, with the assistance of local politicians, has led to a situation where the otherwise potential harambee-work has been directed towards other efforts, as the government will anyway provide the people with safe water. The introduction of major donor-funded projects has lead to the same direction as well. Why to bother to develop one's own water supply while there can be seen a possibility to get the development for free?

Unfortunately the Water Supply Program in Western Province, as almost all other donor-funded projects as well, has not touched these reasons for the underdevelopment in water supply, expect for the raising of health awareness. If the objective is, as it should be, the boosting of spontaneous, not project dependent development these matters should be dealt with, as well.

9. CONCLUSIONS AND RECOMMENDATIONS

The Kenya–Finland Western Water Supply Program seems at the first hand to be such that there doesn't exist any actual needs to consider the Program as an watershed management project, as there can be seen only a few acute conflicts between the water users, and as the allocation of water resources is not a problem at present. Thus the Program hasn't considered the needs for a wider water resources management approach.

However, when the subject was studied a bit more deeply, several issues arose which may hamper the success of the project in the long run. Most of these subjects are of such nature that they require either wider approach in the project to cover both land use and water resources management in an appropriate way for source protection (watershed management) or decisions at the policy level. Thus it seems that it would be relevant to study any water supply project from that angle as the issues are potential, although hidden, even in such project as the Kenya–Finland Western Water Supply Program.

9.1 Master Planning

The present master plan covers well the rural and, in a bit limited way, the urban water supply needs. The groundwater resources are assessed in detail and an effective data–processing system for the continuous updating of data is under preparation. The surface water resources are, however studied quite overally, as they have not been regarded as a priority water source for the Program.

The used approach reveals one typical problem which is common with most major donor–funded projects: the Program has been planned partially as a separate exercise and the plans serve the implementation of the Program itself, not adequately enough the needs of the respective authorities (MoWD). Thus for instance the master plan does fulfill the Program's immediate needs but not adequately the water resources management needs of MoWD. Compared to the amount of work done, the additional surveys needed to cover MoWD's wider needs would have been reasonable. The development of the master plan towards a comprehensive master plan and a management tool of MoWD is a major challenge for the next phase of the Programme.

In order to improve the master plan according to the needs of MoWD the systemacy in data collection and processing should also include the data from surface water monitoring. The monitoring program should be developed consequently.

Another weakness in the master plan is the inappropriate connection between land use planning, actual land use practices and water supply. Some land use-related threats towards the safety and sustainability of the developed water supplies can already be identified. For instance, the intensifying agriculture and tree-cutting endangers the quality of water resources and increases the flow extremes, and in this way creates problems with the utilization and treatment of surface waters. The reliability and quality of groundwater resources is reduced as well. Foreseeable development options in cattle breeding may also have severe impacts on the water supply.

All these connections with land use, industrial or agricultural development and water supply could and should be tackled by proper impact analysis: what are the impacts of certain development trends within a sector towards the water supply and vice versa. In order to improve the reliability of the water master plan a thorough impact assessment should be included within it.

The aim of the above criticism is not, however, to undervalue the master plan as it, inspite of the improvement needs, already well fulfils the international standards.

As a conclusion, following recommendations for water supply projects in general can be derived from the lessons learned by now:

(1) Planning in projects, whether it be master planning or more detailed planning, should be developed in such way that the plans and supporting systems (data processing, etc.) serve the planning and monitoring needs of the respective water authorities in the long run. The planning and data-processing methods and systems should be developed according to the long-term capacity of the respective authority to maintain and use them and according to the principles used in the country. Good donor coordination should be required in order to avoid the development of overlapping or contradictory systems which can not be combined within the national water resources assessment system. This donor coordination should be done in close cooperation with the country's respective authorities and as far as possible based on their own initiative.

(2) The scope of the plans should be widened from the one serving only the project's needs to a more universal one so that a better basis for comprehensive water resources management and land use planning could be

developed. Especially the options and trends in land use should be assessed in detail in accordance to the water supply development.

(3) The planning process should include a thorough impact assessment covering the environmental, economical, technical, organizational as well as socio-cultural impacts of the proposed options and vice versa.

9.2 Water Resources Management Policies and Instruments

The long-term sustainability of water supply projects depends on the quality and availability of the water resources upon which the technical solutions in the project are based. Even in cases where the availability isn't, at least in the foreseeable future, a limiting factor the weakening of the water quality might endanger the long-term sustainability. The quality may be affected either through direct pollution or through changes in the land use.

If a water supply project is based only on the present condition and availability of water resources there exists a serious threat of the solutions lying on weak basis. To solve this threat there can be seen two main options: the conditions should be kept as they are through protective measures or the solutions should be based on the future conditions.

Taking into account the actual economical, technical and manpower resources and possibilities in developing countries one can easily analyze that the improvement of technical solutions to meet the requirements of, for instance better water treatment caused by the decrease of water quality, is not possible in wider scale. Also the possibilities to reduce the pollution loads through wastewater treatment are often very limited.

Thus the most sustainable solution seems to be the protection of water resources through effective watershed management practices which cover all the levels from the land use planning and decision making at regional level to the actions taken by the water users themselves, be they industries, communities or individuals. In the KFWWS Program this would require the development of a **water resources management approach** instead of the present water **supply system** management approach. The benefits for this could be a better understanding of water and its value among the population, a more comprehensive environmental monitoring base, and hopefully a decrease in the environmental degradation. As this approach would require also better co-operation between various sectors and organizations, the overall development planning could be improved through better coordination as well.

In practice this would require the widening of the planning scope (see chapter 9.1) and establishment of a community based water resources management system. The latter could be developed around the present water committees through widening their responsibilities to control the community's water resources and developing their working practices through training. In order to expect any actual results from this also the "environmental laws" of the community should be specified and agreed upon by the community, which itself is already a huge effort. All this development would be contradictory at least with the Program's present construction targets. Still, even if a functioning community based water resources management system would be established, several problems would remain caused by the fact that very seldom do the administrative boarders follow the watershed boarders. To solve the problems between various communities a district-level management system is required as well.

As a conclusion of the lessons learned, following recommendations can be derived from the experiences of the Program:

(4) The sustainability of the water supply systems require effective protection of water resources in order to maintain them at least at the level which is required by the technical solutions. The management systems should be developed for all levels from the regional (in some cases even national) administration and decision making to the community level so that there would be mechanisms to direct both the land use planning and the individual's practices.

(5) Effective water resources management at the regional level requires, besides a realistic and comprehensive water master plan, reliable monitoring of the water resources and changes in the land use as well as good coordination of activities affecting the water resources. Water supply projects should be planned and implemented in such way that they support and strengthen the development of water resources management systems instead of being separate, donor-run efforts.

(6) Effective water resources management requires also clear roles and tasks for various organizations involved. In most cases this requires at least some organizational readjustment in order to avoid unnecessary overlapping and unfunctioning bureaucracy. At the same time it might be necessary, however, to establish also new bodies to solve the problems caused by the increasing need for coordination of activities affecting/affected by the water resources. This might be necessary in cases when the watershed or catchment boarders extend over several districts of provinces and the possible conflicts require catchment-level problem solving.

(7) The regional level water resources management may solve the main conflicts in the use of water resources caused by large–scale industrial, agricultural or water supply development. The ensuring of the sustainability of rural and small urban water supplies requires, however, actions at the local level as most of the threats for such water supplies are local ones. Protection of the sources of community owned water supplies can best be ensured by giving the community an authority and responsibility to manage their water resources.

This requires, however, extensive awareness building among the community and development of fair and acceptable rules, compensation mechanisms and management/decision making procedures according to the appropriate community management practices. Mechanisms to solve possible conflicts between several communities (up– and downstream effects) should be developed as well as the effects of water use or land use usually don't stop at the administrative boundaries. This requires functioning linkages between the community level and regional level water resources management.

In practice the community level water resources management may be developed through widening the tasks (and composition, if needed) of the organizations responsible for the management of the water supplies, be they water committees or community councils.

9.3 Management of Water Supplies

The Kenya–Finland Western Water Supply Program has, as several other similar kind of projects, proved that the technical and economical sustainability as well as a good user acceptance of water supplies can only be achieved through the development of community (municipality) based management of water supplies. Only in this way there in larger scale exists possibilities to develop the operational responsibilities and capabilities as well as the financial viability of the supplies to an acceptable level.

Functioning and effective management of water supplies requires that the water supplies should be operationally fully responsible for their services towards the water users. On the other hand, in order to be able to take this responsibility, the water supplies should also have a full financial authority on their charges from the setting of tariffs to the use of collected charges.

It is evident that especially with small water supplies the capabilities of the operators and managers remain quite poor in spite of any training given by the projects. Thus they require continuously supporting services from the water authorities. If the policy of the development of independent, community (municipality) owned water supplies is taken into use, the water authorities are required to develop their role as supporting agencies which provide technical or managerial assistance to the water supplies when required.

It seems that the donor–funded projects have in vast extent worsened the situation as they have in most cases not developed local capabilities but instead supported central government–dependent development. As the approach, methods and technologies of donor–funded projects have often been even contradictory, or at least poorly coordinated, the institution building effect on the water authority has also remained quite weak.

The above can be seen also with the KFWWS–Program in which an effective management system for the implementation of the project itself has been developed whereas the capabilities of the water authority have remained weak. A positive effort has, however, been the introduction of a community based water supply management system for the rural supplies. Also at the district level the project has started to strengthen the operational resources.

At community level the main problem endangering the sustainability of the Program is the poor willingness and affordability to pay for services. The main reasons for this are (1) the technology selection which has not taken into account the affordability of the actual payers (in Wester Kenya mainly women), and (2) the supply–oriented approach of the project. A better awareness of the advantages of the improved water supplies as well as a better responsibility to manage them properly would have been created by a demand–oriented approach, especially if the communities would have had to finance partly also the actual investment.

According to the experiences of the Program, following common features could be identified with successful community mobilization:

a) a community–wide demand for an improved water supply existed. Hence, community mobilization was to a large extent a response to a "felt need" and a request to improve the water supply situation;

b) sufficient time was allowed for the initial community mobilization and social preparation process to ripen. Extension work and siting meetings were organized over a period of several weeks with adequate intervals between meetings to allow for community reflection and discussion;

c) the extension workers performed the role of facilitator and promotor;

d) a broad consensus was reached by the community members in the selection of the members of their water committee. Hence, the committee commands the respect of the community in enacting regulations for the utilization and financing of the water point;

e) the information required to make informed decisions was available to the community;

f) the community was involved from the very start in identifying the choice of technology and level of service they wanted, taking into account their needs and capacity to finance, manage and maintain the water point;

g) the community understood its options. The choices were made in a consultation with Program staff, based on an awareness of costs and benefits of alternative options;

h) the community shared information on its water use needs with the Program staff. Subsequently additional facilities were constructed, enhancing the acceptance of the water supply and increasing user satisfaction;

i) the community's willingness to pay for and utilize the improved water supply has been positively affected by their active participation in the planning process as they have obtained a water system they want and are willing to sustain;

j) training inputs and tools for community management and maintenance were provided in time.

Another lesson learned is the importance of institution building around community management. Although the communities can do some basic construction and repair, they need specialized skills, equipment and spares. This will require private sector services as well as extension service from the public sector.

The continuous operation and maintenance problems have also raised a question why community management is not used wider in urban water supply and sanitation in small and medium centers. In many cases, the privatization of these schemes and handing over to communities seems to be the only way to safeguard hygienic environment, safe water and local water resources from pollution.

As a summary, the following recommendations can be derived from the experiences gained in the KFWWS–Program:

(8) The role of a national water authority should be developed from that of an implementor to that of a promoter as it is not possible to develop and ensure the operation of water supplies centrally in a nationwide scale. The role of a promoter requires the development of supporting services for water supplies (planning, water resourçes studies, technical assistance, managerial advice).

(9) A local (municipal) management system should be applied for all water supplies with full operational and financial responsibility. The development of full financial responsibility (scheme–based tariffs, full control of the charges, etc.) requires, however, in many countries (for instance Kenya) legislative changes as the tariffs are at present national and approved by the parliament.

(10) The selection of technology should be done according to the affordability of the ones responsible for water supply. This should be studied as a part of socio–economic analysis prepared during the project planning.

(11) The project implementation should be based on the felt needs and active participation (both monetary and physical) of the community in order to have realistic possibilities to create any sustainability. This demand–oriented approach requires usually the cutting of the physical targets in the short term, but creates on the other hand an environment for independent development in the long run. The demand should be increased through awareness building and water supply promotion, which is the task of the water and health authorities.

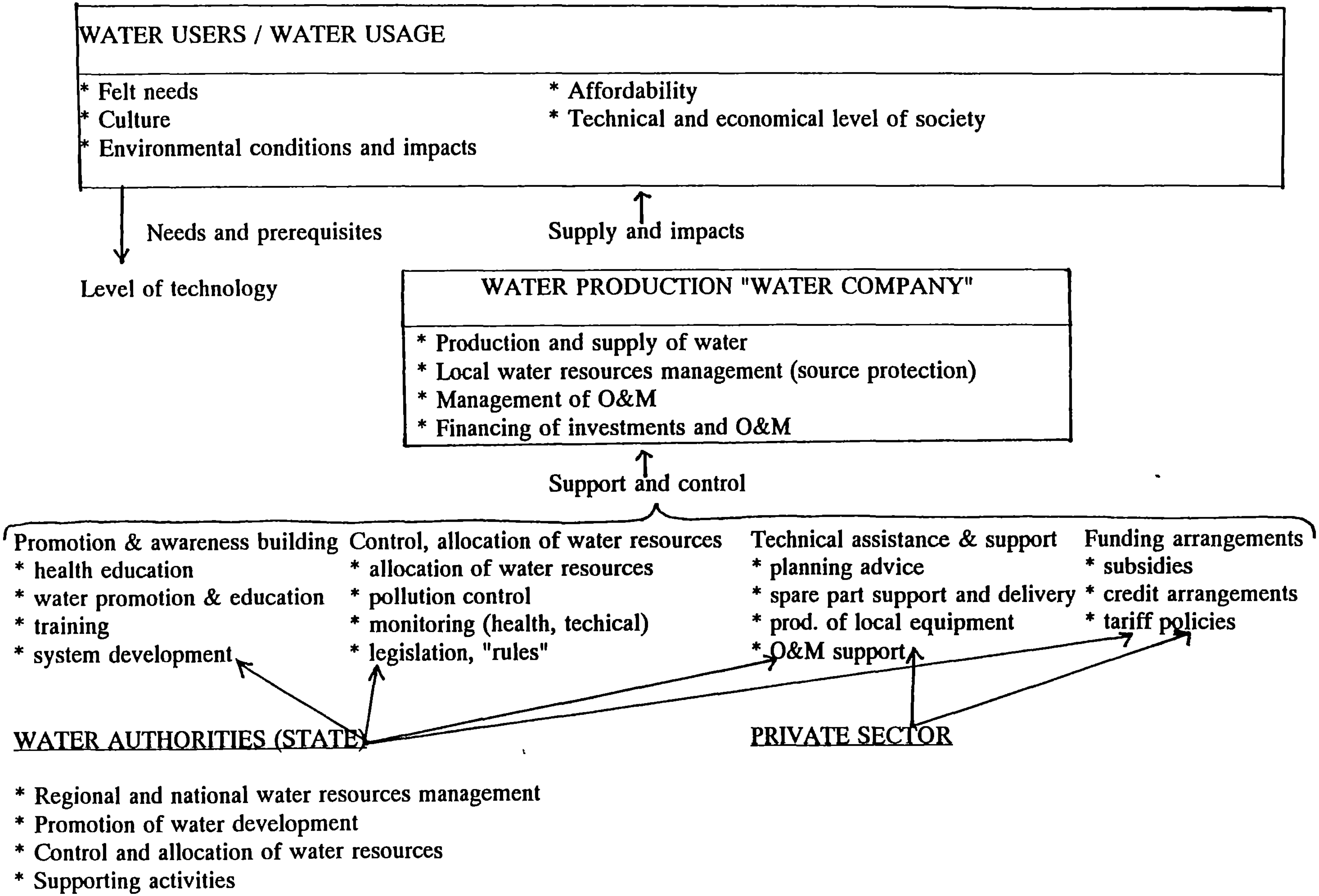
(12) The practical management of community managed water supplies requires a thorough development of management– and decision–making systems and procedures, the active involvement of the actual water users in the planning and management of the supplies, reliable methods for fee collection and book–keeping and provision of advising and supervising support from the respective authorities. The technical requirements include public education on water use, training of operators and maintenance personnel, securing of sparepart supply, etc.

The management structure and the share of responsibilities between the community (water supply scheme), (national) water supply authority and private sector could be illustrated as the following:

10. FINAL CONCLUSION

The study on the Kenya–Finland Western Water Supply Program revealed that it could be beneficial to consider any regional water supply project from a water resources management point of view, as the changes in the land use, agriculture and/or industry might endanger the results of the water supply development, even if there at the moment wouldn't seem to be any obvious needs to widen the project scope from the pure water supply orientation. The widening of the scope would also bring about several other advantages; the information gathered within a project could be more easily used in the overall development planning and environmental protection; the project would improve the inter–sectoral coordination; and better environmental awareness and means to cope with environmental issues would be created among the communities and population.

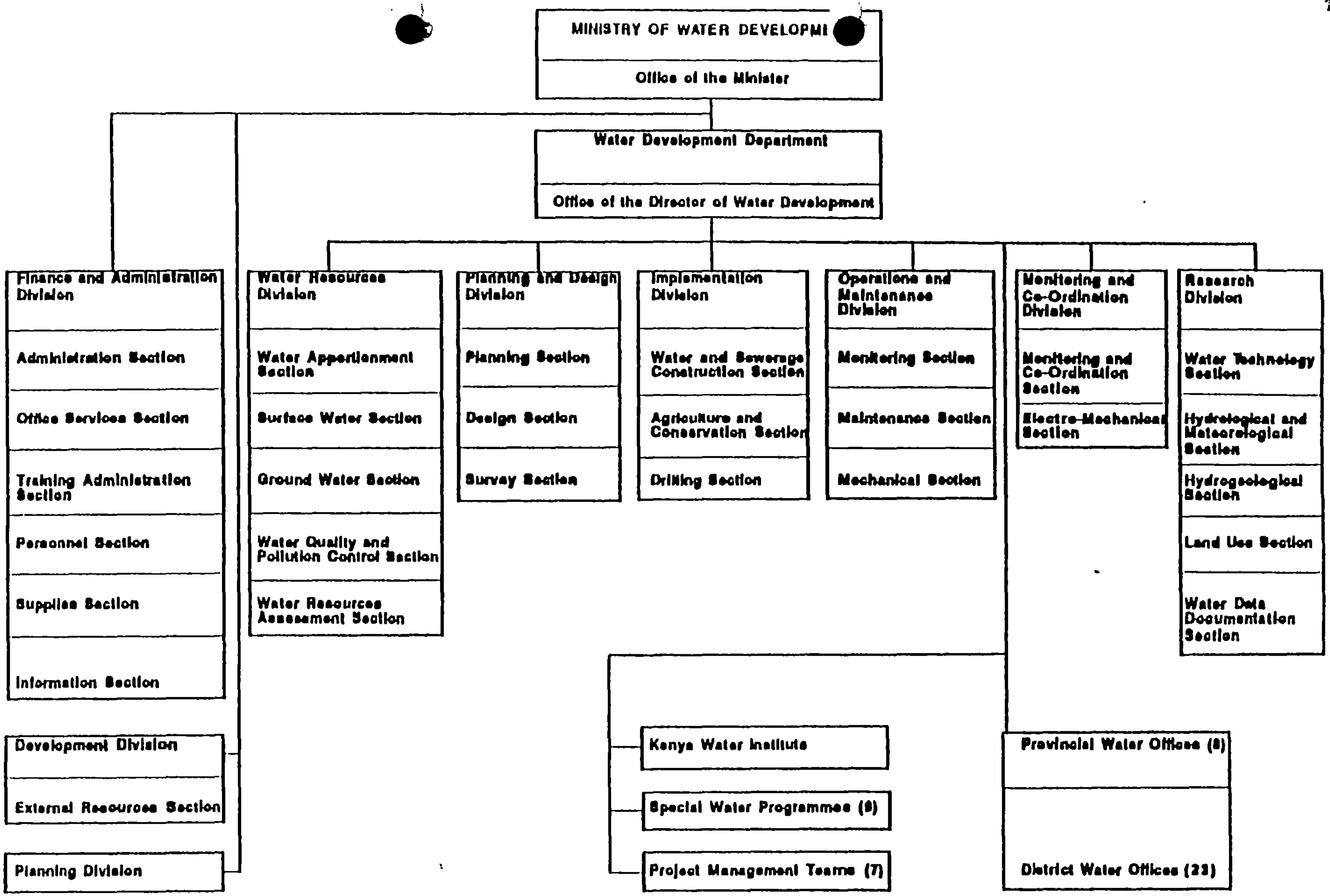
The approach seems to be, however, quite unknown within water supply projects. In order to improve the awareness among the water supply professionals and give practical tools for the projects (national and donor–funded), development of appropriate guidelines on water (resources) management within water supply projects is required. This could be done through analyzing the issue further in more detail in various kind of projects by introducing more comprehensive water management practices to on–going projects, analyzing their effects (problems and advantages) and developing the guidelines according to the experiences gained.


WATER USERS / WATER USAGE
* Felt needs
* Culture
* Environmental conditions and impacts
* Affordability
* Technical and economical level of society
Needs and prerequisites
Level of technology
Supply and impacts
WATER PRODUCTION "WATER COMPANY"
* Production and supply of water
* Local water resources management (source protection)
* Management of O&M
* Financing of investments and O&M
Support and control
Promotion & awareness building
* health education
* water promotion & education
* training
* system development
Control, allocation of water resources
* allocation of water resources
* pollution control
* monitoring (health, techical)
* legislation, "rules"
Technical assistance & support
* planning advice
* spare part support and delivery
* prod. of local equipment
* O&M support
Funding arrangements
* subsidies
* credit arrangements
* tariff policies
WATER AUTHORITIES (STATE)
PRIVATE SECTOR
* Regional and national water resources management
* Promotion of water development
* Control and allocation of water resources
* Supporting activities

In the above illustration the water company may be community based, private, munical or state run. The basic principle is, however, to consider improved water supply always as a productive activity, be the water supply system a well or a large piped water supply scheme. The running and management of this kind of production requires organization which can be regarded as a water company. Its responsibility and role in management should be developed as independent and self–sustainable as possible whereas the role of national water authority should be seen as promoting, controlling and supporting. The role of private sector as a provider of effective supporting services should be recognized as well.

ANNEX 1

ORGANIZATION CHART - MINISTRY OF WATER DEVELOPMENT, KENYA



UNCED 1992, FRESHWATER RESOURCES

Water Conservation and Integrated Resources Management

A case study on Interface Forestry Programme in Allikuli Watershed, Thiruvallur Division, Tamil Nadu, India.

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PREFACE

This report was prepared during the summer of 1991. Apart from reviewing documents describing the Social Forestry projects in India and, in particular, the Interface Forestry Programme of the Tamil Nadu Social Forestry Project, an intensive field work was carried out in the Allikuli watershed in August. A number of people have taken an active part in the preparation of the report. It is not possible to give names of all the villagers who contributed with their views on the project, but we are pleased to report that they expressed a very positive view on what had been done so far. They were also eager to know what will happen with the programme in the future.

We like to thank the following colleagues and project staff for their help and constructive comments on earlier drafts of this report: Dr. S. Narayan, IAS, Commissioner and Secretary to Government of Tamil Nadu, Mr. M. Harikrishnan, IFS, Principal Chief Conservator of Forests, Mr. S. Sankaramurthy, IFS, Chief Conservator of Forests (Social Forestry), Dr. Åke Nilsson, Coordinator of the SIDA supported Social Forestry Project in Tamil Nadu, Dr. K. Balasubramaniam, R & D Manager, ISO/Swedforest, Dr. R. Roy, Extension & Training Officer, FAO, Madras, Mr. H. Rajagopal Shetty, Consultant, Bangalore and Dr. V. R. Pantulu, International Consultant, Hyderabad. A special thanks to Mr. Mirzaiudeen, Mr. Syedshamohideen, Mr. G. Narayanan and Mr. P. Jaganathan, Forest Rangers, who accompanied us in Allikuli and who spent a lot of their spare time during evenings and weekends to collect information that we needed. Finally, we owe Mr. Ingvar Andersson, Head of Water Section, Infrastructure Division of SIDA, Stockholm a sincere thanks. He supported the idea to prepare this report from the beginning. Through his support and a financial contribution from SIDA, the report could be produced in spite of a limited time at our disposal.

"If there is no water nothing can be done in the world. If there is no rain, even the character of the people will have no place. The world lives because of rains, therefore rains are a reviving medicine". Words from Thirukkural, poet and saint who lived in Tamil Nadu 2000 years ago.

1 A WATER RESOURCES PERSPECTIVE

1.1 Broadening the perspective on water

Efforts for water development have in the past tended to concentrate on water supply aspects. In this approach the principle question has been "how much water do people need and where do we take it". Various arrangements, basically of a technical nature, were developed through which interventions were made in the horizontal branch of the hydrological cycle. Comparatively little attention was given to the integrated character of water resources on a watershed basis. Concern for water as a finite and vulnerable resource did not fit into the water supply picture.

The experiences gained during development efforts in the water sector during the last couple of decades are noticeable in at least two principle issues. The omission to base water development projects on a watershed perspective lead to surprises in terms of the loss of a sustainable supply of water at a particular site as a result of large scale changes in land use and water withdrawal in upstream locations. Another problem is related to the tendency to single out various uses of water, and land, in projects with little coordination. The focus was on how much household water do people need. The amount of water needed for food production and for a livelihood security in general, was seldom asked. Not surprisingly, the effects on overall change and development from piecemeal engineering projects is limited.

With this experience in mind it seems that a more appropriate question is "how much water can be made available (in an area) and how can people best benefit from it?". With this question the watershed becomes a natural area of concern. For water management on a watershed basis it is important to consider how land use will effect the various components of the hydrological cycle. An important objective must be to augment the amount of rainwater that will be available for various uses by reducing the various unproductive losses (direct evoporation, flash floods etc.). Another objective is related to arrangments for water to various social groups and to various productive purposes. Moreover, the strategy must build on community engagement and needs.

In semi-arid regions in Third World countries, food and other biomass production consumes some 80% of available water resources. This water must to a large degree be secured through conservation and/or harvest of rainwater and some kind of irrigation. The rainfall occurs in a 3 or 4 month period with considerable seasonal and interannual variations. Water scarcity is thus often seasonal which is serious for food and biomass production. In addition, a very low dry season flow will seriously affect household water needs and be detrimental to water quality since the dilution effect is limited (Lindskog & Lundqvist, 1989).

1.2 Focus of study

The case study presented in this report is about a project designed to rehabilitate a degraded environment within a watershed in Tamil Nadu and uplift the socioeconomic cnditions of the people living in that area. Through a package of components, the Interface Forestry Project aims at a rehabilition by regeneration of the natural vegetation, afforestation and landscape engineering measures. The local communities have a key role in the project both in its implementation and subsequently in the management of land, water and other resources of the watershed.

It is relevant to discuss both hydrological and sociopolitical issues. One of the critical questions is the hydrological impact from afforestation and landscape engineering measures. In scientific literature, the tendency is to argue that afforestation will have a negative impact on groundwater recharge and base flow during dry season (see, for instance, Bosch & Hewlett, 1982; Hamilton, 1983; 1990). An alternative and basically opposite view is, however, also noticeable. Gupta (1980) reports an improved basin moisture regime and mitigation of effects of droughts as a result of afforestation, and other writers argue that a diminishing dry season flow will result from tropical deforestation (Eckholm, 1976).

In Interface Forestry projects, afforestation is done in combination with various soil conservation measures. It is of great relevance to discuss if and to what extent it is possible to augment the availability of water in the watershed with a concurrent increase in biomass production in the forest area. Another critical question is the perceptions and the role of the farmers. Their attitudes and sociocultural organization are significant aspects when designing, implementing and follow up the project.

2 SOCIAL FORESTRY AND THE FUTURE OF INDIA

2.1 No room for ignorance

Depletion and degradation of land, water and biotic resources are significant challenges to the future of India and its inhabitants. A complex set of factors contribute to a very harsh reality for a large part of India's expanding population. Today, some 850 million people are occupying the land and making their sustenance from its resources. Per capita availability of land for productive use was 0.9 Ha in 1951, i e just after Independence. Thirty years later, in 1981, it had shrinked to 0.5 Ha. Corresponding figures for the amount of cultivable land are 0.48 Ha in 1951 and a bare 0.20 Ha in 1981.

With an estimated population of around 1 billion in 2000 AD, the amount of cultivable land will decline to 0.15 Ha (NLU&CB, 1988). According to a demographic scenario, the population may continue to increase till it reaches a stationary level of 1.862 million (IBRD, 1990). The population of Tamil Nadu was about 48.4 million in 1981 and the amount of available land per person works out to 0,13 Ha (Govt. of T N, 1982).

Some 70% of the cultiveable land is entirely dependant on rainfall, that is, it has no irrigation facilities. Out of the total annually renewable water resources, the amount of water that can be used in terms of ground water and soil moisture is significantly much larger than the amount of water impounded through reservoirs and in tanks (Vohra, 1990). With large scale changes in land use, the replenishment of groundwater and soil moisture is, however, threatend. A truly illuminating example of the effects of large scale changes in the landscape on water resources was recently presented by the Minister of State for Rural Development, Govt. of India:

"Even in Meghalaya today in Cherapunji where the rainfall is highest in the world there is a drinking water crisis. Why? Because of denuded forest and our total neglect of natural resources" (Poojary, 1988, 3).

The example illustrates that water scarcity is not necessarily due to lack of rainfall. Indeed, mismanagement of the landscape is a more serious threat to common water resources in large parts of the world today.

When an increasing number of people have to share a given amount of increasingly scarce resources, a depletion is a logical consequence. But due to the complex interactions between soil, water and biota, the degradation of the productive capacity of the resource base may be more serious. It is also a more hidden and unpredictable problem. Degradation in terms of disruptions and instabilities of the eco-system will also affect adjoining eco-systems and areas in the form of erosion and siltation, floods and droughts, etc. The circle between population increase, resource depletion, poverty, further depletion and degradation etc. is not only vicious, but the loops may run faster and faster.

To what extent a surging population are sundering the ecological webs that support life is debated, for instance, in a number of articles in Science recently. It may be that depletion and degradation in themselves do not pose such an immediate threat. The real challenge is rather a third circumstance, namely the widespread omission to stimulate and practice appropriate conservation and management methods. Institutional arrangements and sociocultural forces are very much determining the sustainability and productivity in resource utilization.

A vast literature and various types of documents on these issues are available and circulated in India as well as outside. An impressive number of scholars, officials and the media have produced and compiled an abundant amount of facts and interpretations of the challenges that India faces in this context. The tasks to be taken up are comprehensively and cogently explained "One of the important steps to be taken is to slow down the rate at which we are losing soil due to water and wind erosion... [It is estimated that India is losing about 6,000 million tonnes of soil every year, equivalent to nutrient loss estimated of 5,37 to 8,30 million tonnes or about 18 tonnes per Ha.].. This will involve a total package for erosion control, drainage and scientific water harvesting based upon well designed land shaping and engineering works" (NLU CB, p.9). There is no room for ignorance about what are main challenges and hardly for an attitude of "we are not sure". The script on the wall is clear enough.

2.2 Social Forestry in India

Conditions can, no doubt, be improved. But it requires a multi-objective approach based on an understanding of the dynamics of the socioeconomic issues and their relationships to life support systems. With regard to deforestation, extensive lopping and felling of trees for commercial purposes, for fuel and for hutment material is one major menace. In addition, the seedlings and young trees are ravaged by overgrazing. Deforestation, in turn, is recognized as a serious threat to a conservation of the top soil and to the replenishment of soil moisture and the aquifers. The interconnections between resource depletion, ecological hazards and socioeconomic destitution is recognized at the highest policymaking level:

" ..continuing deforestation has brought us face to face with a major ecological and socio-economic crisis. Half of India, the poorer half, depends on its subsistence needs on the degraded land resources" (Broadcast to the nation by the Prime Minister of India on January 5, 1985.)

While launching the World Conservation Strategy in India the late Prime Minister Srimathi Indira Ghandi said: "The need of the poor for a livelihood, the greed of the middleman for quick profits, the demands of industry and the shortsightedness of the administration have created ecological problems. The manner in which we are encroaching upon our forests; wf are permitting the indiscriminate cutting of beautiful and old trees, is alarming. However, sanctity of trees has little meaning for vast number of our people unless we can guide them to other base of financing their basic minimum needs. All those interested in implementing the Conservation Strategy should give particular attention to technologies which can help to meet the daily needs of such people, especially in the rural areas" (Quote from Sivanappan, 1989).

Social Forestry (S F) has been launched as a strategy to deal with the kind of problems indicated above. It aims at an integrated programme to combat rural poverty and degradation and depletion of the forested areas. S F with its two-pronged objective was initiated in the mid 70's. But already at the beginning of the 60's, programmes evolved around the same basic concept. Tamil Nadu was a pioneer State to initiate a programme of afforestation in community lands, in the commons and wastelands outside the Reserved Forests (R F) which is Government Land, under the name of "Farm Forestry". S F Wings have now been established within the Forest Departments in most of the States and a number of external agencies, including SIDA, are involved in these activities.

In view of its multiple objectives and the acute and complex problems it seeks to tackle, it is not surprising that S F has shown shortcomings. One challenge, probably one of the most important ones, is to overcome the distrust that had been built up between the forest officers and the villagers. Instead of their previous duty to police the forest areas and crack down on people who, for various reasons abused the forest, the Forest Rangers are now to assist the people and collaborate with them. And the collaboration and assistance must be based on a proper identification of target groups, which means the landless, marginal farmers and poor. They are the target group both because they are in urgent need of support and also because they represent a threat to the R F since they have few other options for survival but to use the resources available in the R F.

In the current approach, much stress is laid on flexibility and adaptation and a desire to get away from standardized and bureaucratic approaches which were features of the first generation of S F projects. In an effort to translate the new principles into practice, a number of new S F components are now launched. One of these is the Interface Forestry Programme.

2.3 Characteristics of Interface Forestry Programmes (IFP)

The IFP concept was developed by the Tamil Nadu Forest Department during 1985-86. It aims at creating a basis for an improved management of resources within watershed areas through a number of treatments and support activities. More specifically it will include efforts of eco-restoration, eco-protection and eco-production (Sankaramurthy et al., 1989). S F used to be carried out in non-forest land (community plantations, agroforestry). The new thinking is quite radical as compared to the traditional forestry programmes. As compared to previous approaches in S F programmes, the IFP has thus a clear objective to include an integrated approach to soil, water and vegetative resources in its plan of operation, involving the people of the area (GoI & SIDA, 1989).

The concerned officers shall identify the specific micro-watersheds of appropriate size that can be treated. A large part of the treatment will be concentrated to the interface zone and "buffer zone" consisting of private and poromboke, that is, Government land. (Figure 1). Various efforts will also be done to improve the situation in the "buffer zone" and in the villages proper. Besides planting and supply of seedlings, the treatment includes: construction of check dams, percolation ponds and other smaller physical barriers in the landscape, planting of vetiver grass, agave and other vegetational barriers to check soil erosion and water run-off. In combination, these measures help to impound and infiltrate the surplus water from the monsoon rains to be available for agricultural production and drinking water purposes during the dry season.

The multipurpose character of the IFP also include employment opportunities for the villagers. The ambition is to provide job to one member per household throughout the year and to give priority to the poor and landless sections of the community. Finally, the IFP includes a number of other small but essential inputs to the communities: drinking water supply, health care facilities, creches, threshing floors, road improvement, help to get milch animals, training in basket making and tailoring, beekeeping for honeymaking (especially for the tribal community), material for adult education etc. A flexibility in approach is attempted so that a combination of these support activities can be chosen depending upon the conditions of the individual watershed selected for IFP.

In short, Social Forestry and especially Interface Forestry is quite different from the conventional afforestation programmes. It is sometimes referred to as a social contract between Forest Department and other development agencies on the one hand and the villagers on the other. It aims at eco-restoration of catchment areas for the benefit of the local communities and indirectly for the State and Nation. In all, there are three IFP divisions (out of 15) in Tamil Nadu and the number is being increased to eight in 1991-92.

3 PRESENTATION OF ALLIKULI WATERSHED - A PRE-PROJECT SCENARIO

3.1 Profile of the resource base and the inhabitants

One of the SIDA supported IFPs is carried out in Allikuli catchment, Tamil Nadu. Project operations commenced in 1988 and, according to the current plan of operation, the main

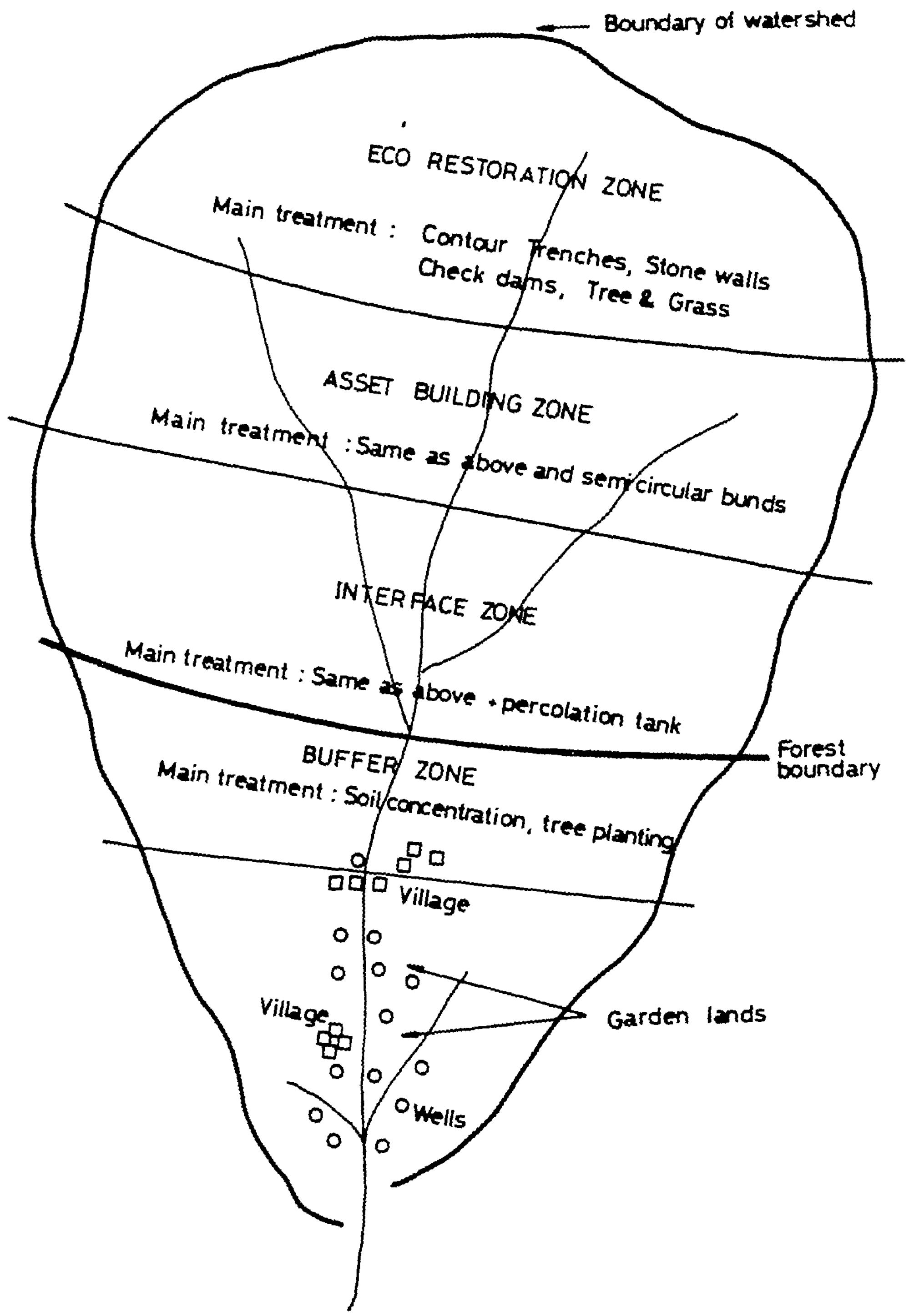


FIG.1a A SCHEMATICAL PRESENTATION OF VARIOUS ZONES OF A WATERSHED THAT WILL BE GIVEN VARIOUS KINDS OF TREATMENTS AND OTHER SUPPORT THRO' INTERFACE FORESTRY PROGRAMMES

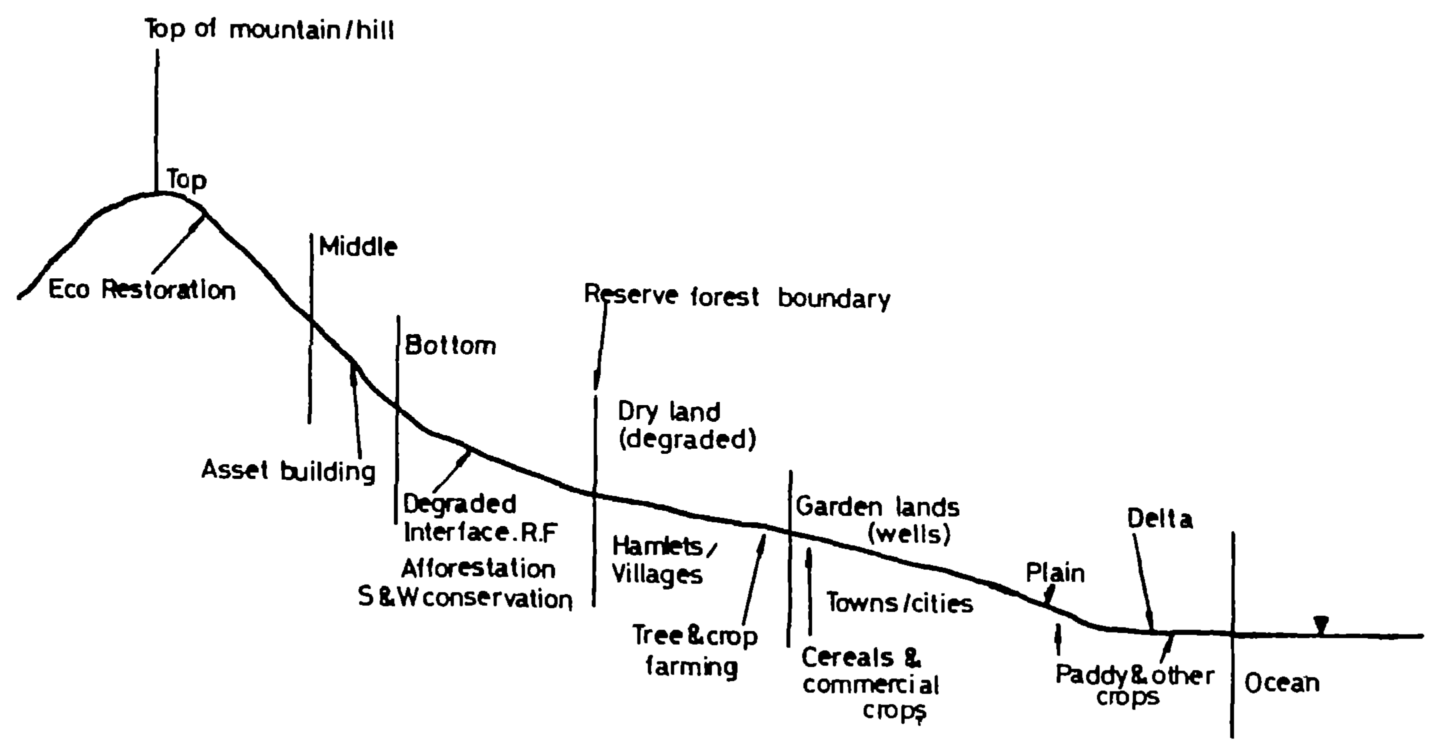


FIG.1b INTERFACE PACKAGE

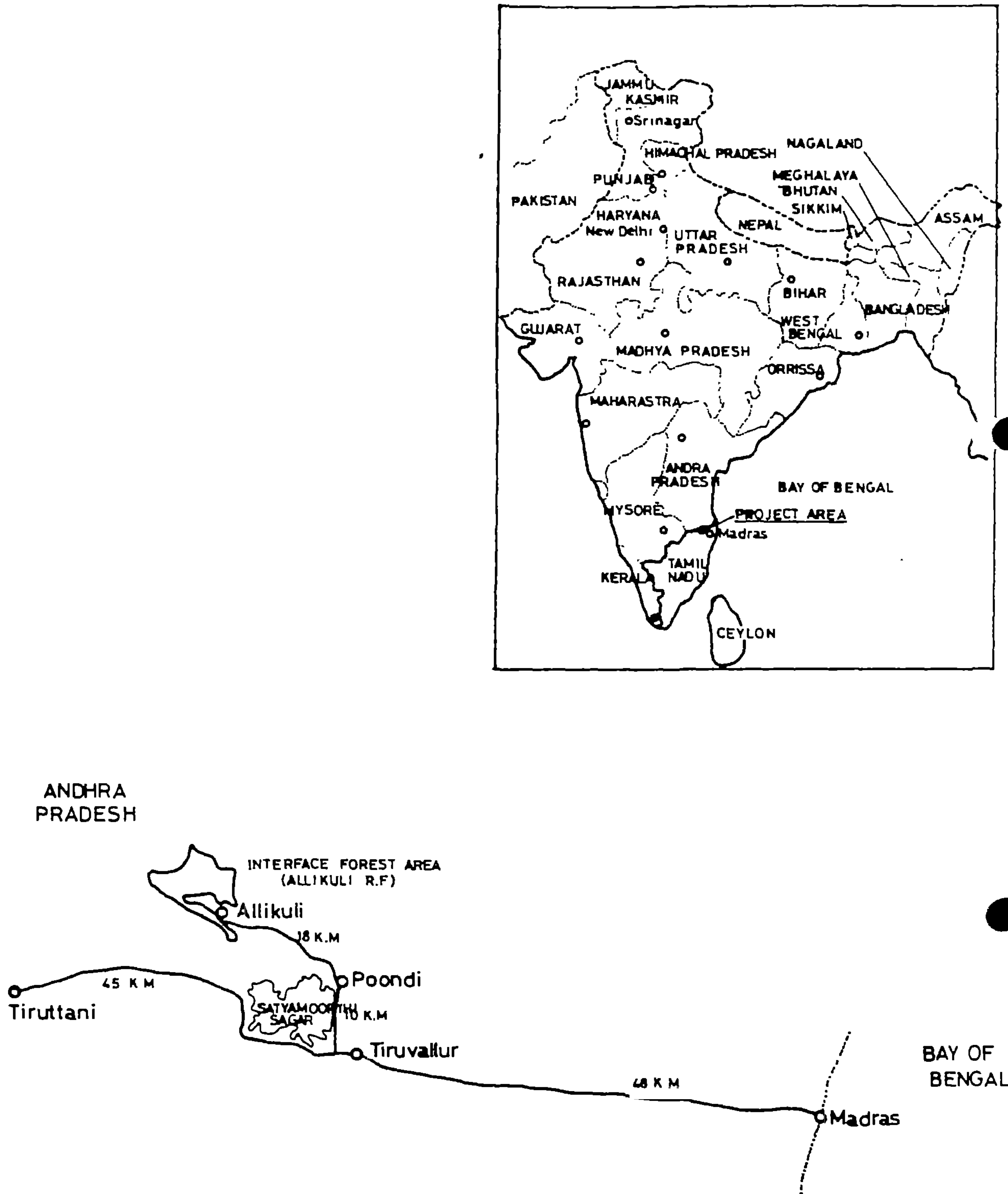


FIG.2 MAP SHOWING THE LOCATION OF THE SIDA SUPPORTED INTERFACE PROJECT IN ALLIKULI WATERSHED, TAMIL NADU, INDIA

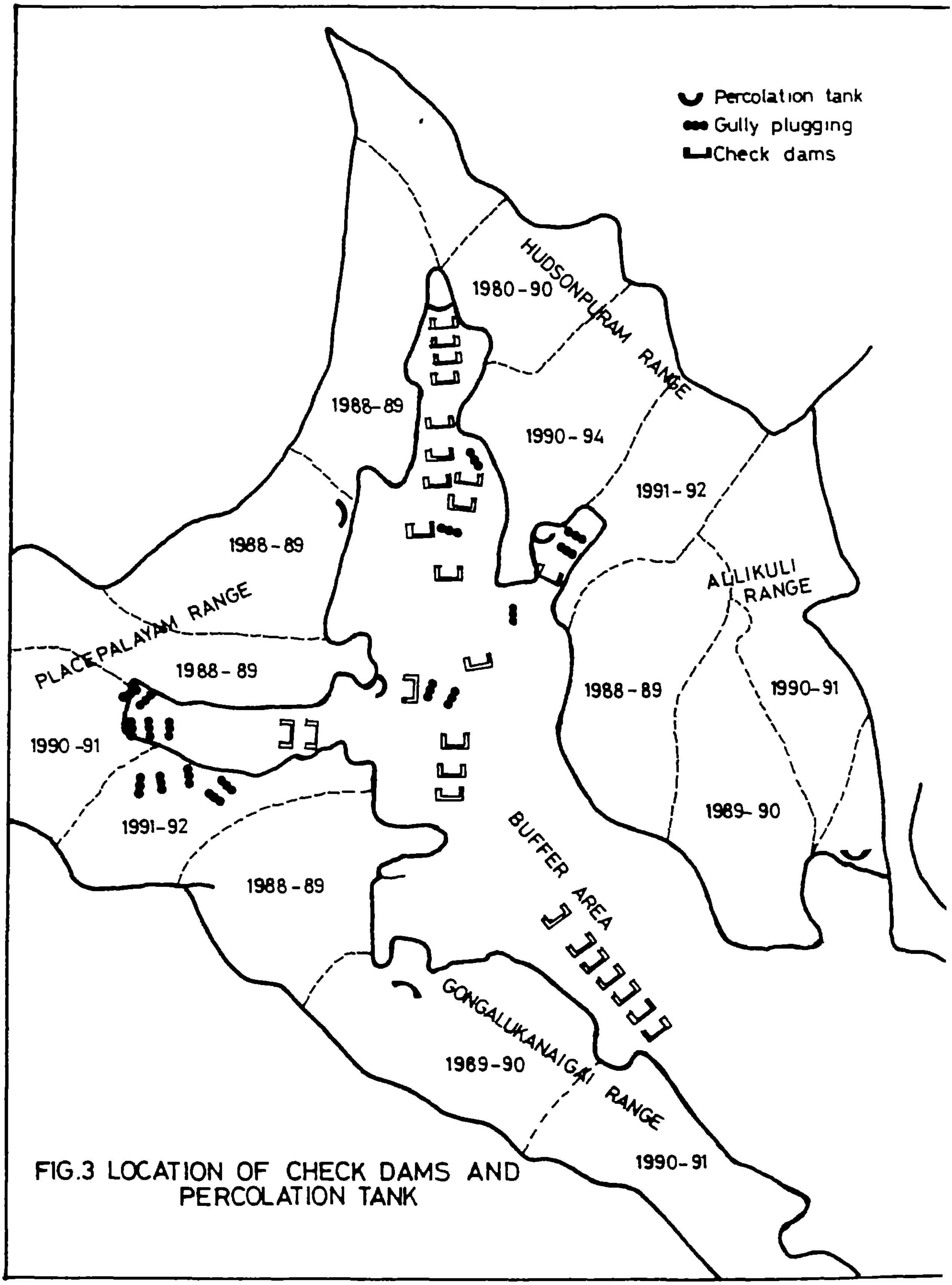


FIG.3 LOCATION OF CHECK DAMS AND PERCOLATION TANK

activities in this watershed will be completed by March 1992.

Allikuli is a well defined catchment located about 75 kms west of Madras, close to the Andhra Pradesh border (Figure 2). The size of the catchment area is 3,750 Ha. Out of these, about 2,650 Ha make up the Reserve Forest area (R F). The size of the main land categories of the non-forested area are shown in table 1, see also Figure 3. The total population of the area is about 4,440 of which the majority reside in 4 revenue villages, that is, villages having a panchayat (village development organization). The villages are composed of one or up to three hamlets inhabited by different caste groups. According to official figures there are 73 people belonging to the scheduled tribes. They are found within the R F or on Government land outside the RF, the so called Poromboke land. The people belonging to scheduled castes number about 1400 whereas the people from other castes are about 3000.

Table 1. Size of main land categories in Allikuli watershed.
(in Ha).

Reserved Forest (Govt. land)	Non-forested area				Total
		Private land			
	Govt. land	Drylands	Tank irr.	Well irr.	
2 650	350	170	230	350	3 750

Ownership of land is an important condition for livelihood, although it does not mean that landowners are well off. At the initiation of the IFP in the area, the landless farmers constituted some 20% of the population. The marginal farmers, defined as having less than 1.25 acres of irrigated land or 2.5 acres or dry land, is the largest group or about half of the population. Small farmers with holdings of between 1.25 - 2.5 acres of irrigated land or 2.5 to 5.0 acres of dry land are roughly 20% and 8 % are referred to as big farmers with holdings larger than 2.5 acres of irrigated or 5.0 acres of dry land. Ownership of land is not confined the upper castes although the average size of the holdings is bigger among them.

Poverty is not confined to scheduled castes nor to the landless people. In fact, 60% of the so called "big farmers" were counted as being below the "poverty line" in 1988 (Doraiswamy, 1988). This somewhat surprising circumstance is a significant sign of the resource situation. Equally important, it has implications for resource management and socioeconomic dynamics of the area. A main reason for widespread poverty among the landowners has been the lack of reliable water supplies. Yields have been low and failures of harvest have been common in the past. Due to sociocultural conditions, the landowners are also "tied" to the land; for practical and sociocultural reasons, they are excluded from an active search for employment opportunities outside their land. For the landless and the low caste farmers there are no practical hinders and no social tabu in this respect. Furthermore, among the households of the low castes and the landless, it is quite conceiveable that both the wife and the husband could take up jobs outside their homes whereas this is not the case among high caste groups and landowners.

Since there is virtually no other economic activity in the area except for those directly related to farming, the landless and marginal farmers are not only poor but are also forced to make a living through whatever opportunities they find. Quite a few people find temporary employment outside the area (there are daily bus services to Madras and to other nearby centres). During the agricultural season one or more members from 18% of the households were involved in "full migration" and another 16 % in "partial migration" to jobs outside the area. Corresponding figures for the non-agricultural season are 5% and 4% (Baskardoss, 1990). But many people have also resorted to making use of the opportunities provided by the RF. Illicit felling of trees for fuel, hutment material and timber and grazing of animals have been two of the most serious threats to the forest. It is through these practices that the RF is now classified as "Tropical dry evergreen shrub" though it had earlier been classified as "Tropical dry evergreen forest" (Doraiswamy, 1988, 11).

The goats, in particular, represent a significant threat since they browse the trees and especially the young seedlings very efficiently. At the same time, they are a paying proposition for the village communities since they will provide their owner with a good and quick income. Goats are easy to keep and they multiply rapidly. Cows and buffaloes are also found in the area but most of these are of traditional breed and yield little milch. A milch producing society was formed before the IFP started and six farmers were given loans lo purchase better breeds which have helped them to get some earning.

3.2 Economic activities vs. economic opportunities

The area has often been described as "remote" and that is still a common label among officials and people visiting the area. In addition, the communities were described as living below the poverty line although few efforts were made to change the situation until the IFP started in 1988. Poverty is certainly there, but the remote character must be interpreted more in socioeconomic terms than in terms of accessibility to/from urban centres and transport facilities. Electricity has been there for quite some time, about 15 years. It is used in the houses and to power some 50% of the pumps installed to lift water from wells (see below) but not for any other economic activity. In brief, the economic activities going on in the area, apart from farming and use of forest resources, are only petty ones like making of baskets and brooms and some carpentry work. There is only one small shop. No sewing machines, no handicraft, no teashop. Until recently, there were no public buildings where people could gather. Basic public services were limited to four elementary and one higher elementary school and a post office which also has a telephone.

Lack of economic activities outside agriculture and the forest area has been and still is one of the significant bottlenecks for development and an improved environment in terms of forest regeneration and improved water availability. Lack of economic activities is, however, not to be mixed with lack of economic opportunities. Realization of such opportunities for the generation of income requires a more efficient and productive management of available resources and that the forward linkages that have been strengthened to agro-based industries, are utilized. It is essential to consider the socio-cultural set-up of the communities and how they best can manage available resources, especially land and water. Technological options must also be included in the analysis. These aspects have been dealt with in the following chapters.

3.3 Lack of viable community organization

Social life in the villages is characterized by a lack of collaboration and joint effort.

Entrepreneurs venturing into new trades seem to be either lacking or unsuccesful. Aparently, people confine their energy and activities very much to their own piece of land or whatever livelihood opportunity they have secured. And, as already mentioned, land ownership has not meant wealth. Formation of cooperatives and other VO's were negligible in the past. A milch cow society was formed by six farmers some years back but that is about all. When asked about the possibilities of farmers helping one another, for instance, to dig a well - which in practice only requires manual labour and some simple structures for lifting the water - the answer was repeatedly negative. It would not be done unless the workers are paid, which in most cases requires bank loans. This is a common attitude even today when, according to all information, there is a widespread perception that the ground water availability has improved, and thus that the effort to build a well would be quite modest.

In a situation where there are a great number of landless people and where the people who control the land and water resources are reluctant or unable to intensify and diversify their agricultural operations, and where few other options to secure a livelihood exist, the potential to increase employment opportunities locally cannot be realized. Under these circumstances it is but logical that people will continue to abuse the R F. Poverty in combination with a reluctance or inability to diversify and intensify resource use will continue to be the main challenge to safeguard the common interest of environmental stability and care.

4 WATER RESOURCES OF THE CATCHMENT AND THEIR MANAGEMENT

4.1 Quantity and characteristic features of water availability

There are no rainfall data for the catchment which forms the project area. Data for the nearby Poondi and Thiruvallur have been used to estimate the total amount of water available to the area (Table 2). The average annual rainfall for the last 10 year period is 1,114 mm for Poondi and 962 mm for Thiruvallur. Compared to an average annual rainfall of 950 mm for Tamil Nadu, the threat of water scarcity is less acute than in many other parts of Tamil Nadu. However, as in other parts of the State and the rest of India, it is the erratic character of the rainfall and the seasonal and inter-annual variations that pose serious problems to the livelihood and the environment. Water availability in terms of soil moisture and ground water has been unpredictable and intercepted by long spells of dry periods.

As can be seen from Table 2 and Figure 4, the rains are concentrated to the period of the north-east monsoon, with a pre-monsoon period from June to August and the main rainy months are from September to November. The early part of the summer is the driest and hottest period. During this period, the wells located in the "buffer zone" (Figure 5) have frequently dried up. It is also during these months that the demand for fodder from the R F has been most intense since ordinary grazing in the "buffer zone" is not possible.

The normal number of rainy days in the area is between 40 to 50 days of the year. Heavy rainfall is the result of cyclones which often hit the tract during the period of the north-east monsoon (Doraiswamy, 1988).

With an area of 3,750 Ha and rainfall of 1,114 mm, the total quantum of water provided to the catchment is thus 42 million m3. Using a figure of 10% for recharge of the ground water aquifers, which corresponds to a figure used elsewhere in Tamil Nadu having similar geological and topographical features and without special soil and water conservation measures (Sivanappan, 1978), the annual ground water recharge is about 4.2 million m3. The utilisable ground water without depletion is about 3.36 million m3 (80% of the recharged quantity).

4.2 An estimate of water use in irrigated lands

Groundwater is extracted from about 185 wells that are scattered in the area as shown on map in Figure 5. The depth and diameter of the wells vary, with the smallest being 3 meter deep and 2 meter in diameter and the biggest 12 meter deep and 15 meter in diameter. Irrigation of about 350 Ha of land is achieved by pumpsets powered by electricity (50%) and diesel (50%).

It has not been possible to verify the information on the acreage brought under cultivation or on the amount of water withdrawn from the wells. The following rough calculations are therefore to be seen as hypothetical. They are based on information collected through interviews made at a number of occasions with different groups of farmers. Discussions have also been held with people from Forest and Agricultural Departments in order to arrive at realistic estimates.

The irrigated lands are used for three crops per year. This has been the case both before the IFP as well as today. During the rainy season most of the acreage was cultivated while during the second and third seasons, only a certain proportion of the acreage was cultivated. As will be discussed below, it seems as if the cultivation intensity has increased after the IFP. Principle features of the cultivation of the irrigated lands and water withdrawal from the wells are shown in Table 3.

Based upon the above assumptions the withdrawal of water from the wells is in the order of 3 million m3. If the water for household consumption is added, 0.16 million m3, the total annual withdrawal of water from the wells was about 3.25 million m3 before the IFP. Interannual variations are, of course, considerable. The assumed withdrawal of 100 liters/day, household is a rather high estimate since there are no house connections but it would include water for cattle. Corresponding figures for the situation after IFP was introduced are discussed in chapter 5.4.

4.3 Official policies and practices in water management

The water resources used in the area are either surface water directly from the rains or groundwater from the 185 private wells. A small amount is also pumped to water taps in the villages. There is one Government controlled tank and to use water from it the farmers had to pay a land tax of Rs 50/- per Ha per year, as compared to Rs. 10/- per Ha per year for drylands. Currently, the tank bed is heavily silted and the capacity of the tank is very limited.

There are no direct formal restrictions to withdraw water from the private wells. Indirectly, the use of groundwater, could to a certain degree be controlled through three means: (i) restrictions in the issuing of bank loans to dig (new) wells and for the repair of wells that have fallen apart. Most of the wells are having only earthen walls. (ii) incentives and disincentives through levying of taxes, subsidies and bonuses, especially applied to the use of electricity and diesel. They could also be related to crop selection, scheduling, etc. (iii) practicing "load shedding", that is, supplying electricity only for certain periods, and issuing of licenses for pumpsets. A combination of these measures would cater for the vital concern to consider the spatial as well as the seasonal variability in the availability of water. A candid

TABLE 2(a)

STATEMENT SHOWING MONTHLY AND YEAR OF RAINFALL PARTICULARS OF POONDI

FOR THE PERIOD 1978 TO 1990(mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total rainfall in m.m.
1978	Nil	9.00	Nil	55.00	4.20	32.20	89.80	193.80	201.30	104.20	233.45	302.60	1255.55
1979	6.20	Nil	Nil	10.00	56.40	82.85	85.20	41.80	113.55	104.90	552.40	30.50	1083.00
1980	Nil	Nil	Nil	Nil	Nil	24.00	129.95	146.15	10.00	74.00	380.60	119.25	883.95
1981	5.00	Nil	50.00	Nil	6.50	40.75	135.65	159.25	99.45	342.85	118.90	88.50	1046.85
1982	Nil	Nil	Nil	21.25	24.50	81.95	80.45	53.40	122.30	84.75	226.65	6.00	701.25
1983	Nil	Nil	Nil	Nil	34.00	72.40	135.00	239.50	329.45	210.60	664.25	245.45	1930.65
1984	6.00	123.95	5.00	5.00	Nil	12.00	213.70	27.00	282.85	125.75	204.65	112.00	1117.90
1985	35.00	Nil	Nil	4.00	7.00	59.50	164.00	72.25	151.75	72.00	398.00	76.50	1040.00
1986	153.00	Nil	Nil	Nil	74.50	35.25	19.00	45.50	23.50	203.50	112.00	54.00	720.25
1987	Nil	Nil	25.00	20.00	Nil	130.50	156.75	138.00	113.50	151.00	225.50	275.70	1235.95
1988	Nil	Nil	Nil	8.0	Nil	130.50	155.5	305.70	200.70	78.7	271.20	Nil	1150.30
1989	Nil	Nil	Nil	Nil	28.0	10.0	363.50	51.0	152.50	81.50	284.50	128.0	999.00
1990	Nil	Nil	Nil	40.00	374.25	49.75	87.00	57.50	161.00	289.00	275.25	12.80	1346.55

TABLE 2(c)

MONTHLY RAINFALL FOR TIRUVALLUR FOR THE YEAR 1980 TO 1990 (mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1980	-	-	-	-	-	6.00	135.60	113.0	12.00	40.00	292.00	138.00	736.60
1981	13.00	-	20.40	-	-	21.80	202.60	139.2	114.00	332.80	85.50	85.90	1016.00
1982	-	-	-	9.80	39.20	131.40	91.80	70.00	103.80	121.40	245.60	112.00	925.00
1983	-	-	-	-	15.2	12.1	53.3	229.4	83.8	296.9	42.80	233.90	967.40
1984	-	207.0	4.40	6.00	-	14.10	182.50	44.00	166.00	87.40	19.00	62.40	792.80
1985	26.80	-	-	-	13.40	48.40	262.40	83.30	210.60	97.80	51.30	107.40	901.40
1986	173.20	3.20	-	-	3.00	30.80	37.20	74.40	102.60	134.80	101.40	47.50	708.10
1987	-	-	-	38.00	-	121.60	33.20	146.60	84.40	228.50	148.00	258.50	1058.80
1988	-	-	-	60.00	-	68.50	217.90	213.50	139.40	27.20	269.00	136.00	1131.50
1989	-	-	-	-	-	59.00	122.00	68.00	61.00	100.00	228.00	141.00	779.00
1990	-	-	-	-	-	77.00	182.00	111.00	274.00	396.00	376.00	150.00	1566.00

TABLE 3

HYPOTHETICAL CALCULATIONS OF WATER WITHDRAWAL

FROM WELLS FOR AGRICULTURE AND HOUSEHOLD/ANIMAL

Prior to IFF work Commenced:

1st Season		
Main crop July/August-November/December	Paddy cultivation irrigated area is 300 Ha 50 Ha of dry crop	Water requirements for Paddy .. 120 cm Rain water-50 cm (Average) Irrigation water from well - 70 cm Total water drawn= 300x10,000x70/100 = 2.10 mm^3
2nd Season		
(Intermediate) December-March	Groundnut about 30% of the area-105 Ha 70% not cultivated	Water requirements - 65-75 cm Well water (Irrigation) - 65 cm Well water drawn = 105x10,000x65/100 = 0.68mm^3
3rd Season		
(Dry season) April-July	Millet about 20% of the area .. 70Ha 80% not cultivated	Water requirements - 4.5 cm Well water - 45 cm Well water withdrawn = 70x10,000x45/100 = 0.31mm^3

Total well water withdrawn for agriculture	=	2.10+0.68+0.31
	=	3.09 mm^3
Total well water for drinking and cattle = 4500x100x365/10,000	=	0.16 mm^3
Total Water withdrawn	=	3.25 mm^3

FIG. 4a TOTAL AND SEASONAL RAINFALL OF POONDI
1980 - 1990

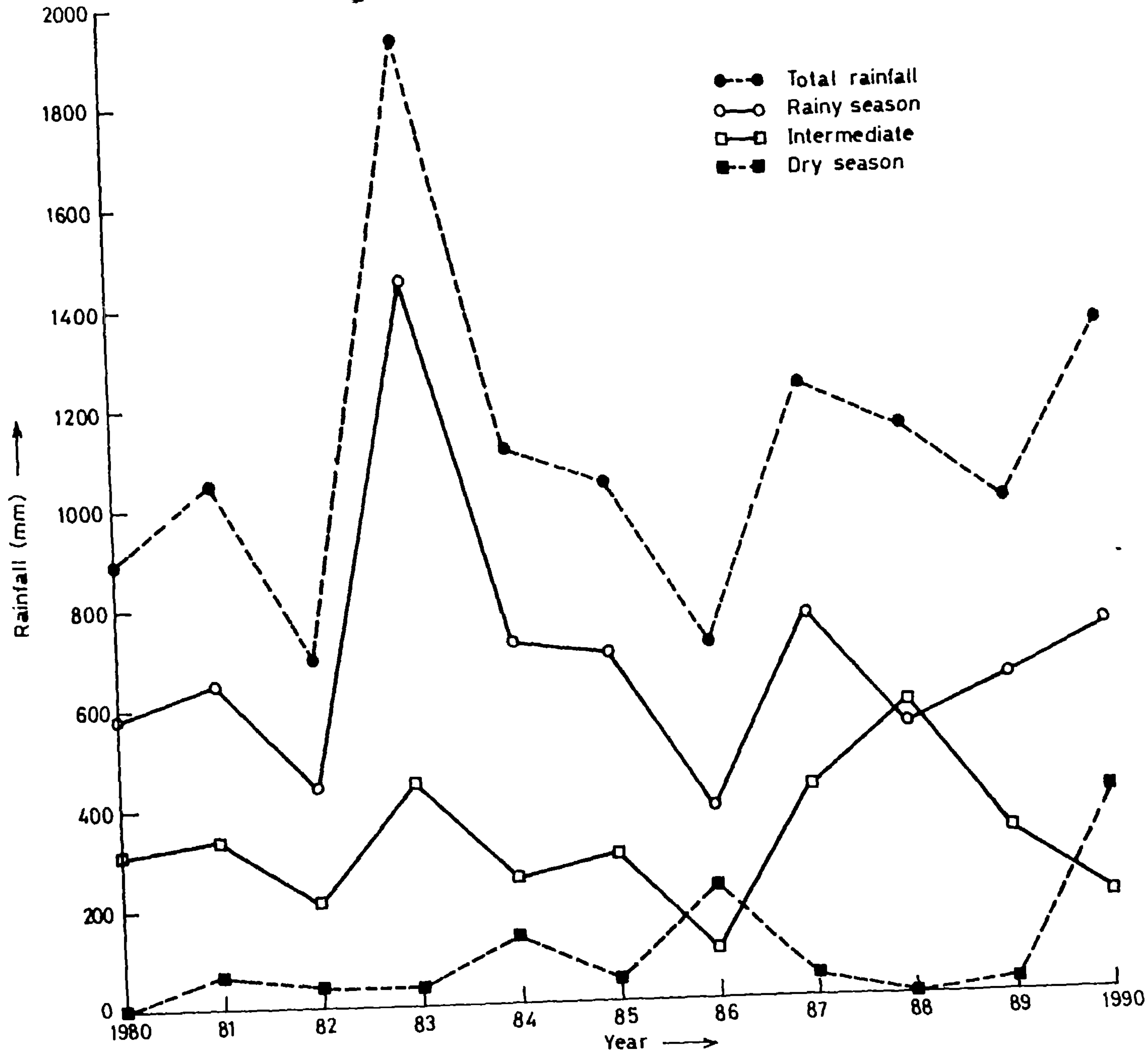
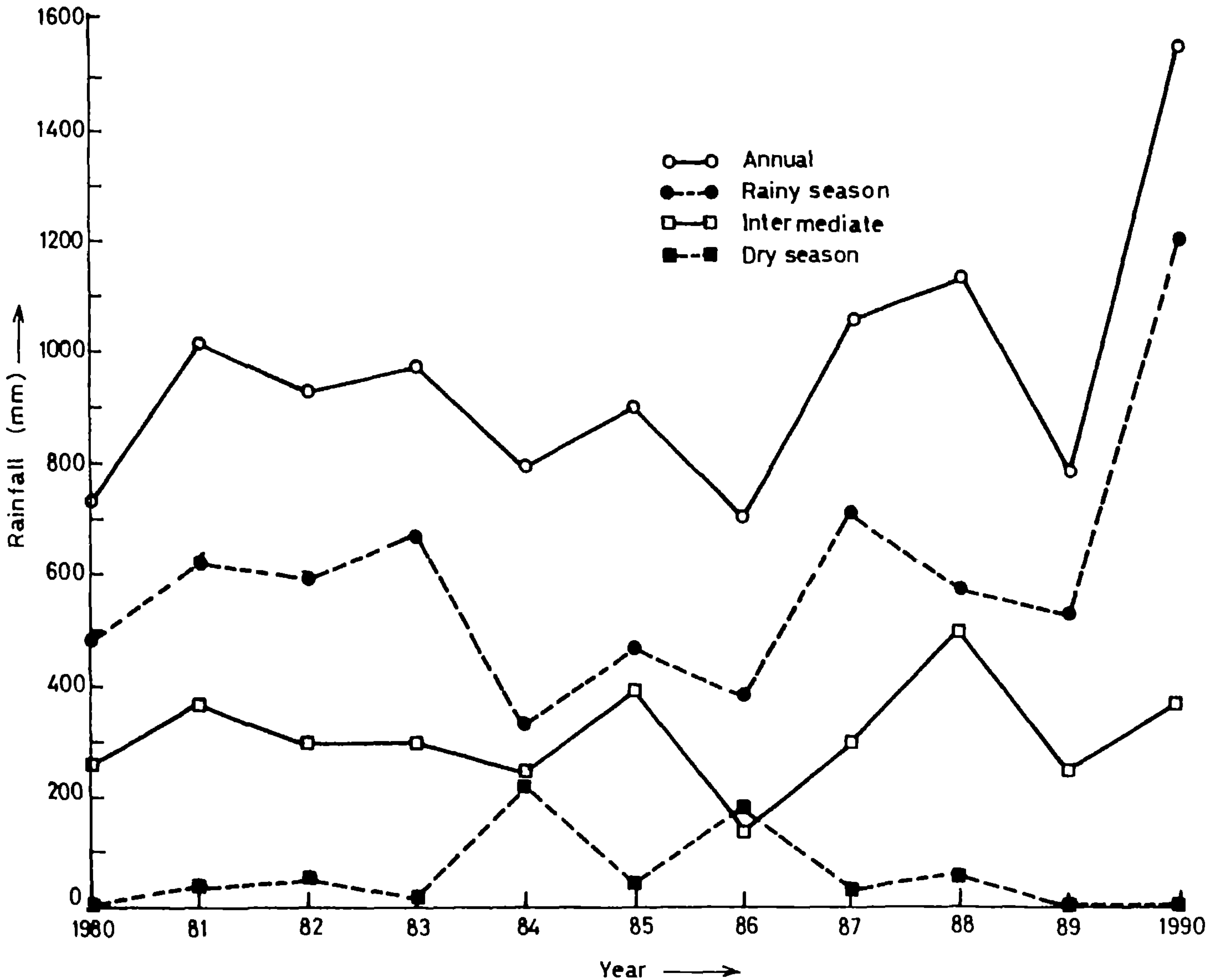


FIG. 4b TOTAL AND SEASONAL RAINFALL OF THIRUVALLUR 1980 - 1990



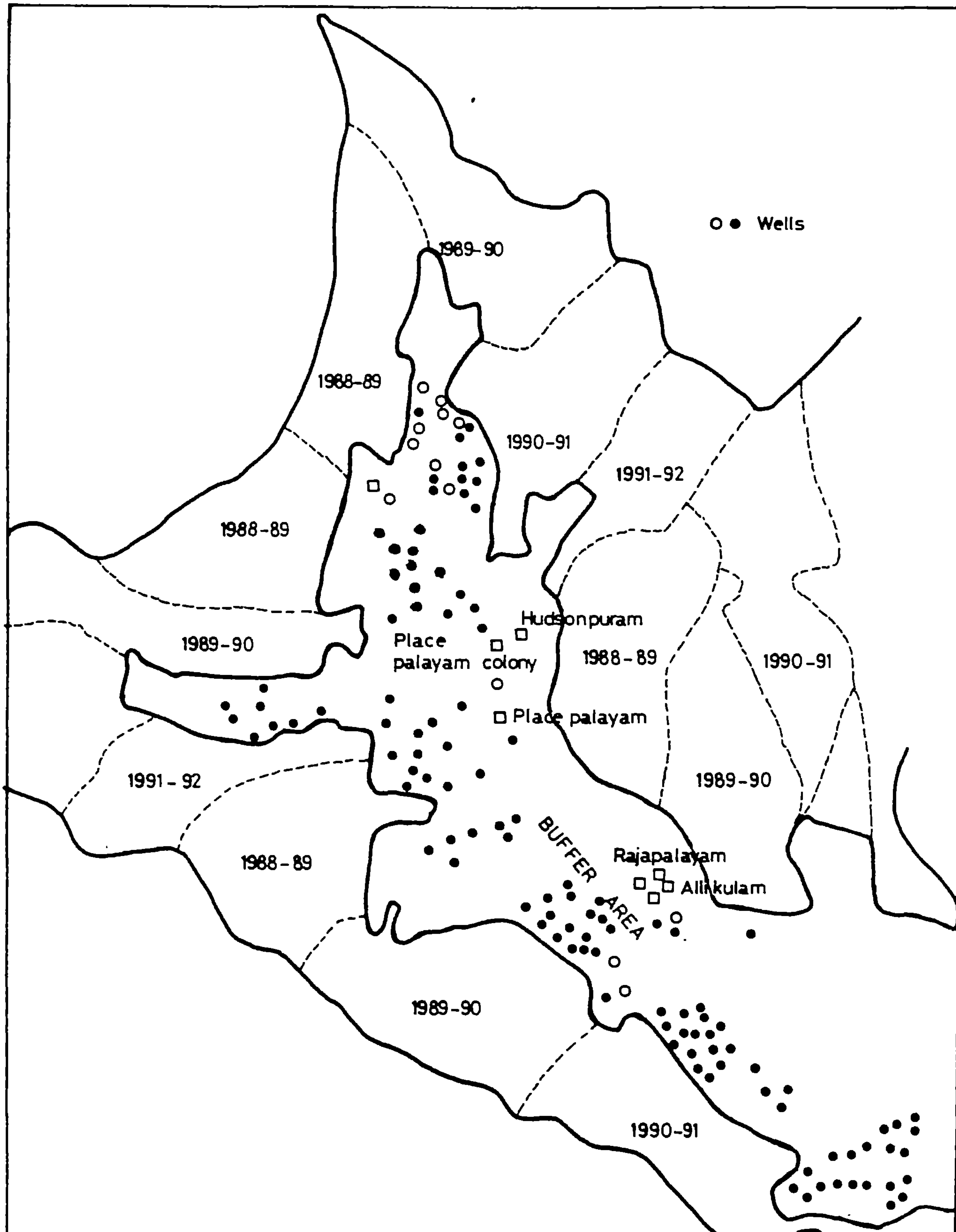


FIG.5 MAP SHOWING LOCATION OF WELLS IN WATERSHED

and carefully designed policy worked out on these matters could be expected since water resources are limited. It would also be logical in view of the declared policy to fix "water rates .. as to convey the scarcity value of the resource to the users and to foster the motivation for economy in water use. ... The efficiency of utilization in all the diverse uses of water should be improved and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives." (GoI, 1986, 10-11).

4.4 Farmer responses to official policies

Since about five years back, bank loans have not been issued for the construction of wells in the area since it is declared as a "black area" by the Government (see below). But wells may be constructed through other loans or own money. Apart from ordinary bank considerations of credit worthiness, the banks are not supposed to give loans to wells that are closer to each other than 150 metres. If we assume that the holdings are square or round in configuration, it means that the bank may finance a well for every 2.25 Ha or 5 to 6 acres. Quite a number of the farmers in the area were thus excluded from bank loans due to the spacing criteria. Given the spacing criteria, an alternative would be to locate a well so that two or more farmers could use the water on a shared basis, or that one farmer having a well in his holding would sell or otherwise distribute water to his or her neighbours. But there are no arrangements of this kind. The Bank is not interested in them and the farmers we spoke with had no intention to share or sell water from his or her well.

But there are always exceptions. The common well meaning a single well being used by many farmers, are often found in Tamil Nadu. Even in the Allikuli basin there are a few wells which are common to more than one farmer. But these wells were constructed long back and the lands to which the water is pumped have subsequently been divided among the brothers who have to share the well water. The procedure is to give one day in turn to each owner and the routine is followed scrupulously. The problem arises when there is a need for maintenance of the well and the pumpsets.

Another example is also of interest. Through his own savings, one farmer had recently constructed a small well (priced 3.000/- as compared to a usual price of 30.000 to 40.000/-). With the help of a simple iron structure erected in a pyramidal shape above the well and with a rope and bucket he could get enough of water to supply his 3 acres of land planted with mango seedlings. From this well, a neighbour was also allowed to use water for his mango seedlings. As far as we could find out, this was the only well of its kind. It represents a water management option which is easy to handle by the farmers and which does not threaten the water resources of the area.

4.5 New directives from Madras

During the last 5 years, the banks have not provided loans to dig wells. The area is part of the Poondi Block which extends over about 11,380 Ha. This Block has been marked as a "black area" by the Groundwater Directorate in Madras. A "Black area" means that the groundwater resources are so heavily used that additional withdrawal is considered harmful. Seen from a local perspective in Allikuli, the designation of it is a "black area" does not make sense. Either it is based on imperfect knowledge about water resources of the area or there must be some other explanation. All available information in the area infer that groundwater resources in this part of the Block are not being depleted. Through visits to a number of wells at the very beginning of the rainy season this year (1991), we could also see that the water table was close to the ground surface. Unanimous answers by the farmers indicated that water resources situation might have improved during the last couple of years. To what extent this is really the case and to what extent it is the result of the IFP will be discussed below.

The changed policy to provide loans can be related to two interpretations. One is that the decision about water extraction and use has been taken for a too large area. Since there are no measurements on water resources in the Allikuli area, the decision is not surprising. Even if it is not justified for the Allikuli watershed, it is probably a correct decision for part of the Block. The Block is obviously not the area which agrees with the principle to manage water "as local as appropriate".

Another interpretation hinges on the fact that ground water mining is a big problem in large parts of Tamil Nadu and that water is extremely scarce for part of the year. Scarcity is experienced very badly not only in the agricultural areas but increasingly so in Madras and other urban centres. The main water supply for household purposes in Madras is the Satyamoorthi Sagar Reservoir at Poondi, some 15 kilometers from Allikuli (Figure 2). This reservoir is currently being extended and 15 TMC (Ten thousand Million Cubic feet) of water from Andhra Pradesh is channeled to it through Telugu Ganga project. A continuous increase in the demand for water in Madras will, of course, push the responsible authorities to do whatever they can to make sure that water resources in the reservoir will not dwindle through excessive withdrawals in the catchment. One of the means to arrest the escalation of withdrawal of water in the catchment is to put the lable "black area". A small part of the Allikuli catchment in the southern end of its RF drains into the Poondi Reservoir (Doraiswamy, 1988, 10 - 11).

Whatever explanation is correct, the decision is obviously not in agreement with the factual water resources situation in the Allikuli area. The example illustrates that decisions taken at a central level, Madras in this case, may be detrimental to local area development and that there is an obvious risk that they are based on false or missing data. The situation is quite ironical since Central and State level interpretations of ground water resources are notoriously ambiguous, though expressed in a confident manner. Recently the Ministry of Water Resources in Delhi revised its estimates of the country's ground water potential from 40 million Ha to 80 million Ha! (Central Gound Water Board, 1987, 2; Vohra, 1990, 24).

Valid data on ground water and soil moisture are hard to come by. It is not realistic to expect that such data should be available for each small watershed in Tamil Nadu and compiled and interpreted in Madras. Actually, it appears more realistic and appropriate that some local organization could monitor water availability and based on that, work out an agreement with a relevant Department (Ground Water, Forestry, Agriculture, Rural Development or whatever would be suitable) concerning what withdrawals would be acceptable. Such an agreement could also form the basis for financial arrangements for wells, for instance. The Departments mentioned should have close contacts with the Banks so that other judgements than ordinary bank considerations of creditworthiness, re-payment potential etc. are appropriately considered, that is, the resource cum environment considerations. The example illustrates that coordination and collaboration between Departments and aid agencies is far from what is needed.

Another possibility for the authorities to manage common water resources is through subsidies and taxes on electricity and diesel. They could also practice what is called "load-shedding", that is, "planned" power cuts. Since the beginning of this year the electricity is, however, free. The farmers pay for electricity supplied to their household connections but not for electricity to the separate connections to the pumpsets. Until last year the rate was related to power of the engine, that is, Rs. 50 /- per horse power per year. The remaining option for the authorities is to regulate supply of electricity and not to install new connections and increase taxes on diesel. In practice, it is only through power cuts and by not giving new connections - waiting time is around 5 years - that demand management to some extent can be executed.

Demand management as distinguished from management of water supply, is called for in a number of reports and policy documents, for instance, in UN (1991). At this stage when the farmers consider that water availability has improved in Allikuli and when they have a positive attitude towards Departments in general, careful thought should be given to the design and implementation of a policy of demand management.

5 CHANGES THROUGH IFP IN ALLIKULI WATERSHED - A POST PROJECT SCENARIO

5.1 Activities

The IFP started in 1988. As described above, the concept of interface forestry involves a broad approach in which reforestation and eco-restoration are basic objectives. This is supposed to be a necessary and appropriate means to uplift the socioeconomic conditions of the communities, especially its poorer sections. Construction of check dams, percolation ponds and other physical soil and water conservation measures is an important component both for eco-restoration and to provide jobs. In the open spaces of the interface area and the asset creating zone (Figure 1) 15 different species have been planted. These species are all selected from the local area and are supposed to be drought resistant and fit the conditions in the area. There are no deliberate attempts to select tree species with low water demands, but the argument is that by selecting the local varieties, the water requirement will be low.

In the buffer zone, some farmers have chosen to plant eucalyptus, which are fast growing but also heavy consumers of water. But most of the seedlings to the farmers are fruit trees. About 12,000 seedlings, mainly of mangos, have been planted in their private lands. In addition, altogether 32 check dams and three percolation ponds have been constructed (Figure 3).

Much concern has been devoted to the protection of the young seedlings and to make a natural re-vegetation possible. A principle of "social fencing" has been promoted. It is part of a social contract where the IFP provides jobs and some other facilities to the members of the community: drinking water, a creche (to stimulate female participation in the works) - which also functions as a premise for adult education and a meeting place for the villagers - threshing floor and some medical assistance. As a result of these facilities and after rounds of information and discussions the farmers have agreed to refrain from abusing the R F. The most important step has been to get rid of the goats browsing the trees and seedlings. According to Project reports, the number of goats has been reduced drastically. Arrangements are also made to provide loans from banks to buy milch animals and to provide training to obtain skills.

5.2 Eco-restoration and water availability

Unfortunately, there are no systematic data to quantify the regeneration of the natural vegetation and since the planted seedlings are only a couple of years old at the most, they are still small. From photographs taken in 1988 and compared to the situation today, it is quite obvious, however, that the natural vegetation has recovered significantly. There are few signs of erosion today and the canopy covers most of the ground area. This, in fact, raises the important issue of the relevance of man-made plantation versus natural regeneration "Repeated experiments [...] have shown that man-made plantations are far too costly, too dilatory and too uncertain of survival to provide the vegetational cover needed by such areas and that the only answer lies in letting the land regenerate itself with whatever vegetation it can sustain" (Vohra, 1990, 9).

The changing landscape characteristics are bound to affect the water balance of the watershed. Check dams, percolation ponds, gully plugging etc. have all arrested the rapid surface flow of water. The increased canopy cover has reduced the aggressiveness of the rains and changed the micro climate. With increasing root systems penetrating the soil and with much fewer goats and other grazing animals, the hardening of the ground surface is reduced. Increased vegetation will augment the organic matter contents of the soil and thus its water holding capacity. Taken together, these changes in the catchment will facilitate an increase of infiltration and prolong the retention period. Increased biomass will, however, also mean that transpiration losses will increase. To what extent the new balance will affect the availability of water in the area positively or negatively is still early to judge. This kind of research /data collection will be carried out in the IFP divisions by installing gauges for water measurements. One such setup is being constructed in Allikuli.

But the important question is not only whether total availability of water has changed but how the changes are distributed to various parts of the watershed and how the change will be affected by the, supposedly, gradual regeneration of vegetation. Moreover, it is the seasonal variation in the availability of ground water and soil moisture that is of paramount interest. Will the precipitation falling over the RF, which covers almost 3/4 of the catchment area, be withheld and "consumed" there by the growing trees and the increasing amount of biomass? If that will turn out to be the case, the water resources in the "buffer zone" are likely to be reduced as compared to today. Or will the regeneration of natural vegetation and trees in the RF stabilize and improve the availability of water also in the buffer zone? Finally, it is of great relevance to monitor the convectional precipitation. With the attempted large scale afforestation in Tamil Nadu, this type of precipitation may change.

There is no doubt that the regeneration of the natural vegetation has been substantial during the last couple of years. Today, this vegetation consists mainly of schrubs whereas the trees still are small. If a large part of the watershed is to become a forest area the water balance is likely to change as compared to the situation today (Figure 6).

5.3 Farmers' perceptions

The views of the farmers in the area are quite unanimous in their conviction of a positive impact of the IFP. They are confident that ground water availability has improved and that a reforestation will not jeopardize the current positive impact. They argue that the flow of water in the stream will be of longer duration as compared to the situation before the IFP. They also believe that precipitation will increase as a result of the increased forest cover. They talk about improved "summer rains" that is, an improvement not only in the monsoon rains.

In another watershed in Tamil Nadu, the farmers in downstream locations have, however, severely objected the construction of check dams and percolation ponds in upstream locations. They fear that these structures will reduce water availability in their part of the catchment (S. Sankaramurthy, Chief Conservator of Forests, SFW, Madras; personal communication). In Allikuli area, however, the farmers have so far never argued that upstream location of check dams or percolation ponds will endanger the water resources situation in downstream areas. Intensive discussions with farmers in various parts of the Allikuli watershed did not reveal any worry whatsoever about possible negative impact of the IFP on water availability.

Scientific evidence or support from other areas in India for the views expressed by the farmers in Allikuli is quite limited. For the Chotanagpur Plateau it was found that the previous frequent afternoon showers during the summer months had been greatly reduced during a period widespread destruction of the forests between 1920 - 1943 (see Agarwal et al., 1987). Recent experience in other areas, for instance, in Raligaon Shidde in the State of Maharashtra, is very encouraging. The rainfall is only about 500 mm, and after implementing soil and water conservation and reforestation measures during the last 6 to 7 years, an increased base flow in the stream up to February is noticed even though the rainy season is over by September. The water table in the wells during the summer is now about 20 feet from the ground surface whereas previously no water was available in the wells even for drinking purposes. These improvements in the environment and water availability have been achieved together with substantial increases in productivity and the well-being of the people (personal communication and field visit of Dr. Sivanappan; "An Experience in Watershed Development", 1989, Anonymous).

In any case, it is likely that increased permanent vegetation, be it regeneration of natural vegetation or aforestation will reduce the genuinely unproductive water losses from the watershed in terms of direct evaporation from bare surfaces and surface run-off halted. There are, however, a number of parameters that need to be monitored before the overall impact of aforestation can be verified: changes in infiltration, tetention periods of soil moisture in a soil profile, surface run-off, transpiration and possible changes in precipitation pattern. Monitoring and interpretation of possible changes in water balance parameters should consider both the impact from the changes in biomass produced in the area and ground cover, and the physical structures in terms of dams, ponds etc. Finally, the results from measurement in a particular watershed will have limited general validity. Hydroclimatic conditions, topography, soils and combinations of vegetational cover vary significantly between different sites and the impact on water balance from changes in one or two of the parameters may also vary.

5.4 Increased cultivation intensity in irrigated lands

As mentioned above, there are no systematic data on changes in water availability in the wells over time neither of the amount of groundwater pumped or of the acreage being cultivated. Calculations can only be made based on oral information provided by the farmers supplemented with field checks and validating checks with people who have insights into the actual land and water use.

The picture which emerges out of such a Rapid Rural Appraisal (RRA) technique is that the farmers are now cultivating the entire command area under the wells during the main season. On average, they have roughly doubled the acreage under cultivation during the intermediate

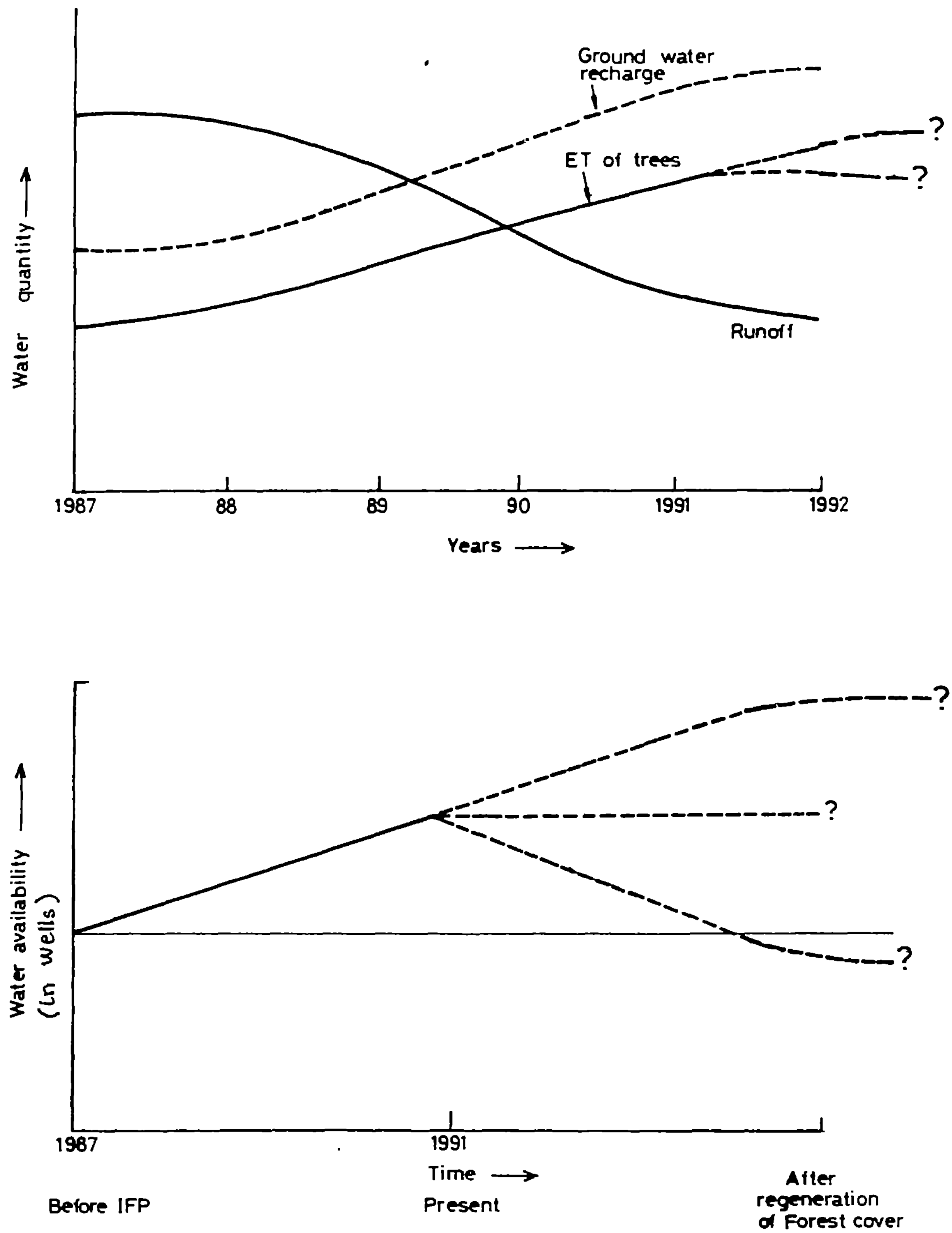


FIG. 6 WATER AVAILABILITY BEFORE AND AFTER I.F PROJECTS

and dry seasons. The majority have not changed the cropping pattern. It was noticed that as a result of increased and more stable water supply throughout the year, one or two farmers have now started to cultivate sugarcane to an extent of 10 to 15 acres. Sugarcane is a 12-month crop which requires about 2,000 mm of water. Neither is irrigation extended to new areas. (This is, however, a matter of definition; well irrigated area is determined on the basis of tax principles and it is this area that is about 350 Ha). The changes and the implications for well water withdrawal are shown in Table 4.

According to the calculations presented in tables 3 and 4, the additional amount of water that has been withdrawn from the wells is about 1,3 million m3, or an increase in ground water utilization of about one third. The estimated increase has been withdrawn from the same number of wells. There is only one ordinary sized and one small new well constructed during the last couple of years. At the same time, the farmers claimed that some of the wells and pumpsets were in need of repair. Contrary to efforts made in other parts of Tamil Nadu, there are no attempts in Allikuli to deepen the wells. The increase of the area under irrigation during the intermediary and dry season is claimed to be the result of improved availability of water in the wells.

The supposed improved availability of water in the wells could be interpreted in various ways. One contributing circumstance might be the comparatively high rainfall in 1990 (see Table 2). But there have been years in the past when rainfall has been comparatively abundant. In spite of this, the farmers and officers working in the area stressed that the wells have frequently dried up during the dry season. The other interpretation is that there has been an improvement in the availability of ground water during a prolonged period of the year. This could be the result of the landscape engineering measures and/or the changes in the vegetational situation as discussed under 5.3.

We may also estimate the extra income that has resulted from the improved water availability. Net income from paddy is about Rs. 6,000/- per Ha, groundnuts about Rs. 10,000 /- per Ha and millet about Rs. 4,000/- per Ha according to the Agricultural officer of the area. The additional income would thus be in the order of Rs. 1.63 million (50 x 6,000 + 105 x 10,000 + 70 x 4,000). On average the 185 farmers having wells would get an additional yearly net income in the order of Rs. 8,600/- . Since the additional amount of well water needed for the intensified cultivation is about 1.3 million m3, the net income generation effect of the additional water is about one rupee per m3.

5.5 Socioeconomic changes

One important component of the "social contract" is that villagers refrain from letting cattle and especially goats browse in the RF through so called "social fencing". "Social fencing" to be effective, requires that the farmers have confidence in the project and that they believe and actually see that there are alternative livelihood opportunities than abusing the R F. At the initiation of the IFP, the farmers were very reluctant to trust that the intention of the project was indeed to improve their lot. They were even reluctant to accept the seedlings offered free of charge to plant in their private lands. They thought that it was a first step in a deliberate attempt to take over their land. The mistrust among the village communities towards officials is deeply rooted and lack of communication channels between them and officials is an obvious feature. The Forest Department has been one of the most detested ones, since the rangers, dressed in uniforms, used to police the RF and harass people.

TABLE 4

HYPOTHETICAL CALCULATIONS OF WATER WITHDRAWAL FROM WELLS FOR AGRICULTURE AND HOUSEHOLD/ANIMAL

After the IFF work completed(1990-91 - 1991-92)

1st Season	Total area of 350 Ha - Paddy 350 x 10,000 x 70/100	=	2.45 mm³
2nd season	Ground nut area 60% - 210 Ha Total water withdrawn = 210 x (650/1000) x 10,000	=	1.37 mm³
3rd season	Millet - 40% - 140 Ha Total water withdrawn 140x(450/1000)x10,000	=	0.63 mm³
	Withdrawal for drinking and for cattle = 4500 x (100/1000)x365	=	0.16 mm³
	Total	=	4.61 mm³
			(or) 4.60 mm³
	Additional water used due to water conservation and harvesting measures = (4.61 - 3.25)	=	1.26 mm³ (or) 1.30 mm³

In the Allikuli IFP some of these features have changed for the better. Four Forest Rangers live in the villages, they are no longer dressed in uniforms and they take part in the daily activities in the area. They supply the seedlings and, most important, they provide jobs. According to official records 70% of the households are employed, most of them for about 200 to 300 days with an income of Rs. 3,000 to 4,000 /- per year. The poverty line varies from area to area and for this area it is about Rs. 3,500/-. The earnings have to a large extent been used for daily living expenses. It is observed that people are better dressed now. Spending has also been done on education of children. Villagers belonging to the scheduled castes have, for instance, hired transport to send 12 children to a convent school some 15 kms away.

The strengthening of contacts with other parts of Tamil Nadu and the promises of an improved resource situation has meant that the value of land has increased quite significantly. But land transactions are very rare and the increase in price is therefore difficult to estimate. It varies obviously between the different land categories (see Table 2). In an extreme case it was argued that a piece of dryland which could now be cultivated with fruit trees and some intercropping in the initial phase, had increased from virtually no value to Rs 30,000 /- per acre. But there is apparently no or little interest to sell land. In the whole area, it was only some 12 acres that had been sold. Outsiders owning or controlling land in Allikuli are rare. One Madras based person had bought about 10 acres before the IFP started and had developed it to a very prosperous mango estate with a big and expensive fence surrounding it.

The reluctance to sell or speculate in land must be seen as positive. Such a behaviour would certainly not be a desirable outcome of the IFP. But there is another side of the coin. Since the farmers do not appreciate the economic value of their land and the opportunities created through the IFP they are also reluctant to intensify and diversify their production to the extent possible. For the landless and marginal farmers it means that not much of employment opportunities are being created by their fellow land owners in the villages. The improvement they have experienced so far, is almost exclusively a result of the direct income from jobs provided by the IFP. They are sceptical as to the possibility that an increased intensity in land use through mango plantations in the dry lands and increased intensity in the use of irrigated land (se below) would create much employment opportunities.

5.6 Administrative structure

There are twentytwo districts in Tamil Nadu. Each district is administered by the District Collector who is responsible for the law and order and for the coordination of development activities in the district. All the technical departments like irrigation, agriculture, forestry, are having officers in each of the districts. Though they are under the technical control of their respective heads of Department stationed at Madras (State Capital), the officers are to collaborate and coordinate the development functions with the Collector who acts as the District Head.

In the Departments of Agriculture and Forest respectively, which are of concern in this report, the administrative setup varies. In each District, there is a joint Director of Agriculture. Below the district level there is a hierarchy of people who are to assist him within the agricultural sector. At the *Taluk* level there is an Assistant Director of Agriculture, at the Block level there is an Agricultural Development Officer and one or two Agricultural Officers to assist him and finally, at the village level Assistant Agricultural Officers are placed. These officers do extension work within the agricultural sector and provide all the farm inputs like seed, fertilizers, etc. They have, however, no activities within the field of water management.

In the forestry sector, there are two subsectors; one Social Forestry Wing and one Territorial Wing. Under the Chief Conservator of Forests (Social Forestry), there are 5 Conservators of Forests and 27 Divisional Forest Officers (DFO), including DFO's for Interface Forestry Divisions. Each Conservator of Forests is in charge of 3 to 6 districts. A DFO is in charge of 1 to 2 districts. However, one DFO is in exclusive charge of the Interface Forestry Programme in the division which by itself is a part of the district. At the Division level the DFO is supported by 5 Range Officers and 20 Foresters apart from Clerks, Draftsmen and other Office Staff. Each year this staff is expected to afforest 750 Ha of degraded Reserve Forest and to improve the productivity of about 100 Ha of agricultural land in the "buffer zone" by doing soil and water conservation work, distributing free seedlings to farmers etc as described above.

The expenditure for the afforestation and soil and water conservation work is as shown in Table 5.

Table 5. Expenditure on afforestation and soil & water conservation work in the Allikuli watershed (Rupees per Ha).

Range	Planting	Soil & water conservation	Total expen-diture
Allikuli	849.14	2743.43	3592.57
Hudson Puram	975.77	2744.95	3720.62
Placepalayam	333.43	4249.18	4503.21
Gangalukandigai	214.87	3842.41	4057.28

The considerable variation in cost between the various ranges is mainly due to the various degree of environmental degradation. The avegare cost for soil and water conservation work in the Allikuli watershed is about 3,400 Rs/Ha. Out of the total expenditure,, the investments made in the "buffer zone" varies between 23.8% to 33.6%.

6 PHASING OUT THE PROJECT - BUT HOW?

6.1 Buffer zone critical for the Reserve Forest

Development projects are not for ever. The critical phase of the project is yet to come. When the support and especially the employment opportunities are withdrawn - which is supposed to be in March 1992 or four years after the project commenced - the landless and the poor will face a tough time. There is an imminent risk that the vacuum created by a rapid withdrawal will have quite a radical effect that will be counterproductive to the long term objective of the IFP. In order to secure a continuous positive development in the area various follow up activities will have to be contemplated.

A regeneration of the RF is primarily important as revenue for the State. Use of RF by the villagers is permitted to a certain degree, but the income and resources which can be tapped from the interface and the asset creating zones will not be enough to cater for the needs of the landless and the poorer sections of the population after the Forestry Department has withdrawn from the area. The main income generating activities for the villagers will have to be found in the buffer zone. And they have to be found now. It is thus the use of land, water and other resources in the "buffer zone" that will have to be in focus in order to reach the objective to improve the RF.

6.2 Entrepreneurs and intrapreneurship badly needed

Institutional and organizational issues have increasingly been stressed to be of significant importance for the design and implementation of development activities. Institutional reforms are called for in attempts to reduce bureaucratic stiffness, to promote inter- and intra-departmental collaboration and to upgrade the competence and efficiency of the work. The discussion on these issues is quite vivid in India since it is widely held that the administration and official structure in India is in great need of some kind of reform.

India is also well-known for having a large number of NGOs, more often called Voluntary Organizations (VOs) in India, among other things in the environmental sector. Great hope, and a lot of support, has been invested in the VO sector. The support is motivated both by the arguments that the official organizations are functioning poorly but also because VOs, by definition, are close to the prople. The VOs have done a lot of impressive work and they deserve all support they need. At the same time it is clear that the quality and the degree of seriousness of the VOs vary, they have no accountability and they do not have the capacity to engange themselves more than in certain areas. In the Allikuli area there is one voluntary health organization. In connection with the IFP, Village Interface Forest Committees were formed in the area, but they are weak and have a semi-official character since the rangers play a great role at present.

Under these circumstances, it is highly relevant to identify and support innovative behaviour through institutional and administrative reforms. It is of paramount importance to recognize that institutions are created by individuals in interaction with other individuals. And they may flourish through commitment, competence and dedicated actions of these individuals.

The individual Forest Ranger, for instance, may achieve substantial results in the project area since he lives in the villages and has access to first-hand, relevant information which is usually not the case in offices in cities. To gain the confidence of the local communities, to be efficient and to find satisfaction in his job, he (it is always a male) should be given a fair degree of freedom. In the absence of viable VOs, it may be most appropriate to create a milieu for individual officers inside the Departments which would contain certain characteristics typical of the VOs, but still maintain the positive aspects of the Formal Organizations, like accountability. Through the Interface Forestry programmes the Forest Department has started a very promising strategy in this regard.

This type of reform is referred to as a creation of *intrapreneurship within formal organizations* as opposed to the idea of entrepreneurs acting in the private sector (Rathin Roy, Extension & Training Officer, FAO, Madras; personal communication).

The success of the project depends not only on officers and institutions. The end result is, of course, to a considerable extent dependent upon the dynamics of the communities. The farmers, the artisans, the traders etc. - as individuals and through collaboration with others - will have to take a lead in village committees or as entrepreneurs to show the way for innovative resource use practices, to start small scale industries in the area, etc. Committed and visionary individuals are needed for the proper functioning of the village Interface Forest Committees and for innovative resource management.

Entrepreneurs, not in a narrow economic sense, but as agents of change and as organizers of activities for the common good, are very badly needed. Indeed, it is not only the poor and disadvanteged sections of the communities that should be supported and stimulated through development projects. Efforts should also be made to identify and stimulate the change agents in the communities. It might well be that it is among the poor and landless that we may find the individuals that are most susceptible to change and development (cf. chapter 3.1 and 3.3 above). A strategy which supports a combination of official intrapreneurship and private entrepreneurs in the sense just described seems highly relevant. Such a combination would be a means to guard against self interest and malpractices in general.

6.3 Crucial management issues for sustainable flow of project benefits

- Strengthening of functions of the village IFP committees. As they are organized and function today they are far too weak to be of significant importance to organize common activities and to promote innovative resource utilization at an "appropriate level". Much more attention should be paid to organize the committees so that social and caste barriers do not jeopardize their functioning. The five committees which are formed in Allikuli are not formed with this problem in mind. It is crucial that the functions of the committees be more clearly identified and how their role should be visavi the village panchayats. It is logical that their key role should be related to the protection of the RF and in the distribution of the rights among the community members to use the RF.

- Incentives must be provided for the farmers to use the available water resources more efficiently and productively. Today, there is no directive or guidance whatsoever for use of scarce water resources. Electricity is free and no extension service in the field of water management is guiding the farmers in crop selection and package of practices for crop production. Training is necessary not only for the farmers but for the extension staff as well. Certainly water is considered good, but not an economic good! It is necessary that the national policy on incentives and disincentives, as drawn up by the Ministry of Water Resources (GoI, 1986), will be translated into a firm programme for implementation within the framework of watershed areas.

Since the farmers at this stage have quite a positive attitude to officials, it seems most appropriate to design and implement the intended national policy measures in Allikuli now.

- To carefully investigate the options for a combination of official vs. private sector activities. The IFP has, among other things, promoted a large scale plantation of mango seedlings. Within a couple of years the produce will be substantial, but there are no processing industries in the area. The situation is the same with regard to other produce in the area. Some kind of agro- or forest-based industries should be viable in the area with respect to raw material and for employment purposes. A strategy to involve suitable industries in the development of the area is warrented.

- It is, indeed, essential to monitor the eco-restoration, eco-protection and eco-production for those parameters that are supposed to be improved, i e regeneration of natural vegetation, tree growth and water availability. Today, there are no hard facts to verify the positive impact that is widely claimed. Although water quality is not considered a problem in this area today, a monitoring of water quality would be desirable.

- A careful look into institutional aspects. Coordination between Departments and between Departments and village institutions is one aspect that has been emphasized on several occasions. In addition, it is relevant to review the division of responsibilities. As discussed above, the most critical task now is related to an improved resource use and new opportunities in the Buffer zone. And although the Forest Department has included that area in its plan of operation, it would certainly make sense that other Departments whose jurisdiction is more closely associated with the "Buffer zone" area, should be more involved than they are today.

As discussed above under 6.2, the Forest Ranger is a key person in the actual implementation of the IFP and to some extent also in the design of some of its components. Their comitment and competence is vital for the success or failure of the programme. It is therefore important that they are stimulated in their jobs through various arrangements by providing training programmes (for instance, in water resources management) and that they may perform their duties with certain degrees of freedom.

The IFP is, however, a multipurpose project. The outcome of the project will depend on changes in many sectors and the Forest Rangers and the Forestry Department would benefit from more frequent contacts with other Departments and agencies, in particular, the Agriculture Departement. One improvement would, for instance, be to facilitate the purchase of services or equipment by the Forest Rangers from other Departments.

A special interest should be given to financial institutions and credit facilities. The Banks do, of course, have a professional interest and possibility to take care of this issue. But as discussed above, it may be appropriate to extend credit judgements to the Departments having a direct responsibility for the resources and the environment.

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UNCED 1992
Freshwater Resources – Nordic Initiative

Local Water Management in Rural Areas and Small Towns

Case Study: Banfora, Burkina Faso

August 1991

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PREAMBLE

The International Drinking Water Supply and Sanitation Decade has come to an end. However, the goals laid down in the Mar del Plata Action Plan have not been fully met, particularly in the developing countries, where the formulation in general terms of actions to be undertaken has been one of the reasons for the poor performance as regards results.

In order to avoid this situation in the future and as part of the preparation of the United Nations Conference on Environment and Development (UNCED) to be held in Rio de Janerio (Brazil) in June 1992 and the Preparatory Conference on Water and the Environment in Dublin in January 1992, the Nordic countries (Denmark, Finland, Norway, and Sweden) have initiated case studies focussing on the great issues of the 1990s such as:

- integrated water resource management
- local water management
- water as an economic benefit
- master plans and action plans

The case study concerns the city of Banfora, a small community with approx. 50.000 inhabitants within its administrative and hydrologic context, the province of Comoé[1].

The water supply system of Banfora and its dependance on supply from a source outside its direct control, makes it a suitable case for illustration and discussion of water resource management. Banfora draws its raw water from the main pipeline supplying a sugar factory. The present water supply facilities were financed by Danida in 1977 and it is managed by the ONEA, which is the authority in charge of the public water supply for urban and semi-urban communities in Burkina Faso.

In order to support the intentions of the Nordic Initiative to formulate more concrete solutions to the problems related to water resource management, the study concludes in the presentation of terms of reference for a pilot project for water resource management in Banfora.

1. The name of the province is Comoé whereas the river is called Komoé.

1. GENERAL CHARACTERISTICS OF THE PROVINCE

1.1 Physiography

The province of Comoé covers 17,672 km^2 in the Soudanien zone of Burkina Faso close to the Ivory Coast border (fig. 1). Favoured by a humid tropical climate and abundant and fertile natural resources, the province is often referred to as the orchard of Burkina Faso. The provincial capital of Banfora is a dynamic town with considerable agricultural, industrial and commercial potential.

The hydrography of the province is totally dominated by the Komoé river the catchment area of which occupies the major part of province. A minor part of the province belongs to the catchment area of the Bougouriba, Leraba and Baoué rivers.

1.1.1 Geology

The Comoé province is situated in the border area between the West African craton towards the south and the Taudenit basin towards the north. The precambrian craton consists mainly of granites, schists and greenstones within the province. The Taudenit basin which extends more than thousand kilometres to the north consists mainly of sandstone and shale/schist.

The sediments within the Comoé province belong to the initial sedimentation phase and consist mainly of coarse grained precambrian - infracambrian sandstones. The granites cover 59 per cent, the schists and greenstones 25% and the sandstones 15% of the area in the province.

The bedrock is covered with a zone of alteration consisting of laterite and sapprolite with the exception of minor mountain areas along the border to Mali and along the escarpment of Banfora. The zone of alteration is about 10-15 m thick in the sandstone area, but may be more than 30 m in the granite and schist areas.

1.1.2 Climate

The Komoé province is situated in the southernmost part of Burkina Faso, which has the highest rainfall in the country. The year can be divided into a rainy season from May to September and a dry season from October to May. More than 80 per cent of the rain falls within the rainy season.

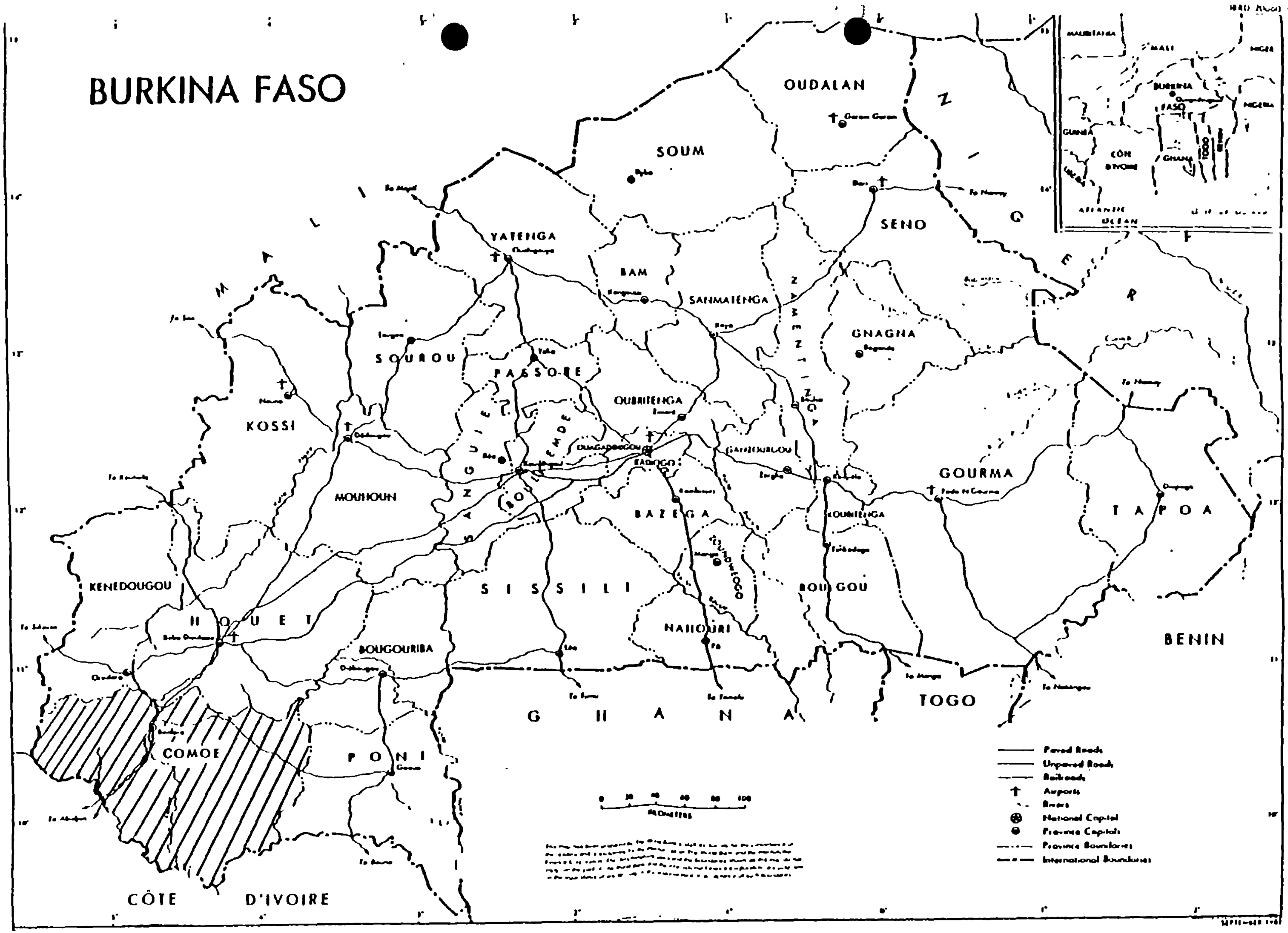


Fig. 1 The Comoé Province

A general decrease in precipitation has been observed in the previous decades. Thus the mean annual rainfall of the Banfora area has fallen from 1179 mm in the period of 1940 - 1964 to 1024 mm in the period of 1964 - 1989. In recent time, the drought periods of 1973 - 1975 and 1983 - 1984 reflect very low rainfalls. In 1983 e.g. the annual rainfall was only 580 mm (see table 1).

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Rainfall	1,027.4	836.5	580.2	866.2	1,310.1	1,093.9	894.7	1,229.8	888.7	1,078.1

Table 1: Variations in Annual Rainfall

The climate in the region is tropical with mean daily temperatures of 23-30°C. In the period from March - May, the maximum dayly temperatures may reach 40-45°C. The potential evaporation in the area is in the order of 2000 mm per year.

1.2 Socio-Economy

In the province of Comoé, more than ten different ethnic groups are represented. Moreover, the province receives a considerable number of Mossi immigrants, the largest ethnic group (50 per cent of the Burkinese population).

According to the extrapolation of the official statistics, the population of the province was 283,757 in 1990, which corresponds to a population density of 16 inhabitants per km^2. There is one large city, Banfora, with a population of approx. 51,000 inhabitants in 1990 and 5 secondary centres with 2,000 to 9,000 inhabitants each. About 71 per cent of the population lives in rural areas (201,000).

The primary economic activities of the province lie within the agricultural sector. Even though stock farming is not widespread, the province is still an area of great importance and has potential as regards pastoral transhumance. In 1990, the province counted 114,000 cattle, 82,000 sheep, and 69,000 goats[2].

The province produces a surplus of cereal (sorghum, maize, millet, and peanuts). Cotton cultivation is also of considerable importance to the province which also has

2. Rapport Technique Annuel Campagne Agricole 1990/91, CRPA, Banfora, April 1991.

a concentration of arboriculture, especially mango. Furthermore, irrigated cultivation is greatly developed in the province. Of special importance is the large sugar cane plantation (3,000 ha) and the rice fields (approx. 40 ha). Maize and tomato are also cultivated on irrigated fields.

Its location between Bobo-Dioulasso and Abidjan makes the town of Banfora accessible at all seasons from the railway and the international road between Burkina Faso and the Ivory Coast. Several industries are located in Banfora, the sugar factory SOSUCO, the Grands Moulins du Burkina, the GMB producing semolina and flour, the SOPAL producing pharmaceutical and combustible alcohol for consumption, combustion, and pharmaceutical use, and the Scieries Goussoub et Coulibaly sawmill.

Banfora is presently a melting pot of various nationalities and ethnic groups. The town is divided into 11 sectors combining 8 former suburbs and villages (ref. Appendix 1). The town has experienced extraordinary demographic development. In 1960, the town population counted 4,500 inhabitants growing to 12,350 in 1975 and 35,000 in 1985. The population has thus tripled in the ten-year period from 1975 to 1985. A comparative analysis of the population in 1975 and 1985 respectively shows:

- A decrease in the size of the households by almost 4 persons.

- Massive immigration of young unmarried people in 1985: 52 per cent male and 48 per cent female

which composition is contrary to the national average in which the women are in the majority.

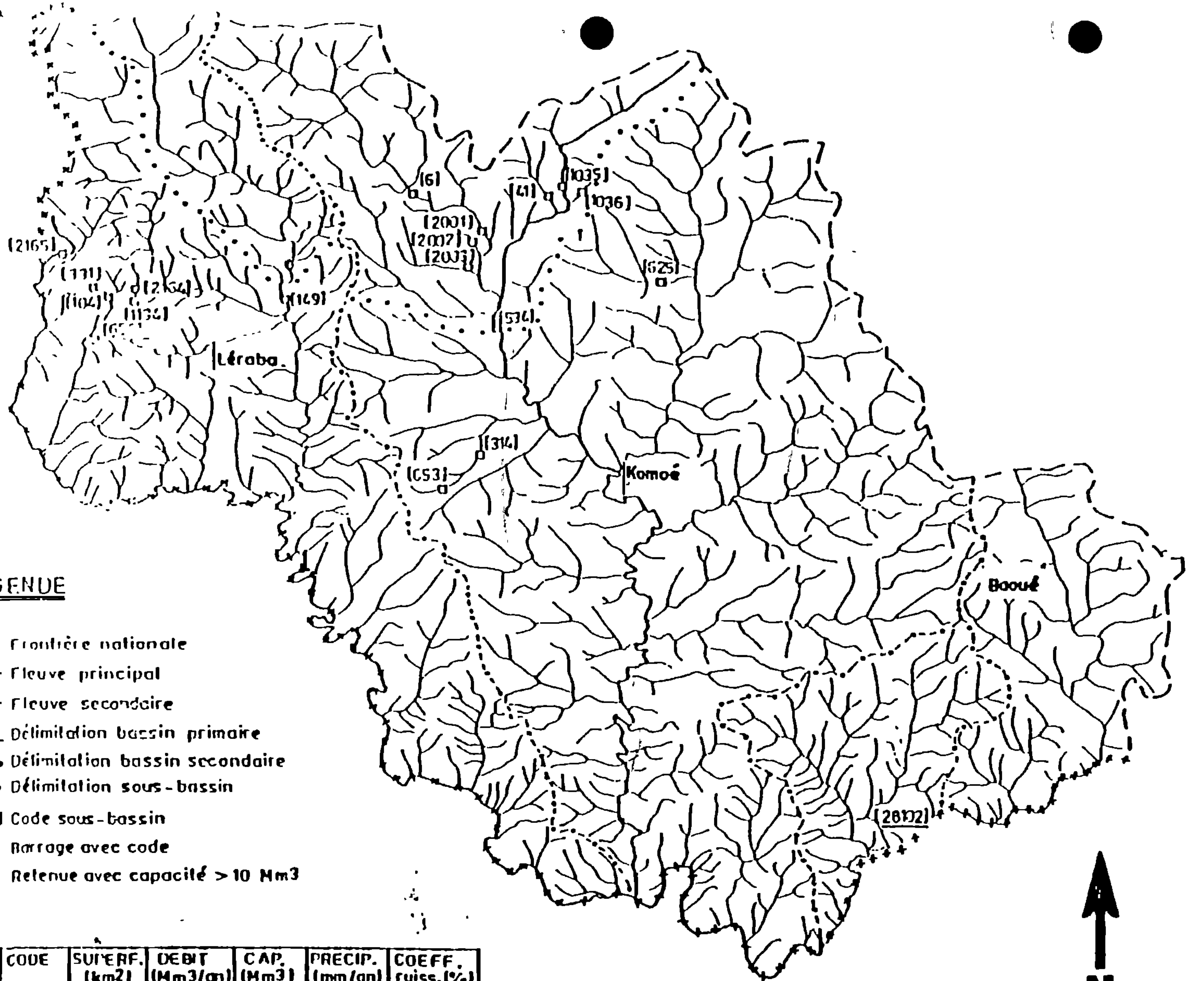
The 1990 population of 51,000 gives an annual population increase since 1985 of 10 per cent.

Several factors contribute to this remarkable increase: the establishment of industries making Banfora a town of great employment possibilities, the moving of inhabitants from the surrounding villages to Banfora, the migration from the Mossi plateau towards West of which Banfora has attracted the majority given its fertile soil and the improved roads and railways.

The religious groups comprise two large categories:

- Muslims, the largest in number covering several sects

- Christians, mainly Catholics with 6 chapels and various other sects.



LEGENDE

- Frontière nationale
- Fleuve principal
- Fleuve secondaire
- Délimitation bassin primaire
- Délimitation bassin secondaire
- Délimitation sous-bassin
- 28100 Code sous-bassin
- (41) Barrage avec code
- Retenue avec capacité > 10 Mm3

BASSIN	CODE	SUPERF. (km2)	DEBIT (Mm3/an)	CAP. (Mm3)	PRECIP. (mm/an)	COEFF. ruiss. (%)
Léraba	28101	4.760	502	52,37	1.060	11,0
Comoé	28100	9.576	644	15,82	1.020	6,6
	28102	1.073	64	0	1.070	5,0
Booué	28103	1.458	77,4	0	1.050	5,0

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Client: Ministère de l'Eau
Projet: Bilan d'Eau
Dessiné: AS
Vu:
Figure numéro: 1
Date: 25-05-91

Fig. 2 Hydrology of the Comoe Province

The majority of the national authorities are represented at a local level in Banfora, whose twin town is the French town of Chauvigny.

2. WATER RESOURCES

2.1 Surface Water

The Comoé province is drained by three rivers (fig. 2). Komoé, the major river within the province has a catchment area of 9,576 km². The Leraba river in the western part of the province has a catchment area of 4,760 km² and the Baoué river to the east has a catchment area of 1,458 km².

The key hydrological data of the province are shown in table fig. 2. The run off data for the four catchment areas indicate very high surface water potential and that the overall surface resources are sufficient to cover the present and future needs. The Komoé river e.g. has a annual mean runoff of 644 x 10^6 m³ corresponding to 1,375 x 10^6 m³/day. However, due to the uneven distribution of rainfall, the flow in the streams and rivers is very irregular and makes storage necessary. Only a few water courses in the province are perennial.

2.1.1 Existing Water Reservoirs

The experience of several dry periods in recent time and important water needs of the region have led to the construction of a number of water reservoirs.

The number of registered reservoirs in the Komoé province is 24. The concentration of reservoirs is low compared to other parts of Burkina especially the region of Ouagadougou. Two large reservoirs exist in the province, the Donua reservoir of 50 x 10^6 m³ and the Moussodougou reservoir of 38 x 10^6 m³. A large part of the total reservoir capacity is present in the Banfora area (table 2). The major part of the water in the Banfora reservoirs is used for irrigation of sugar cane fields.

Reservoir	Water Capacity (m^3)
Lobi	4,172,000
Yannon	4,006,000
Karfiguela	800,000
Bérégadougou	400,000
Lémouroudougou	400,000
Comoé (Moussodougou)	38,000,000
Total	47,778,000.00

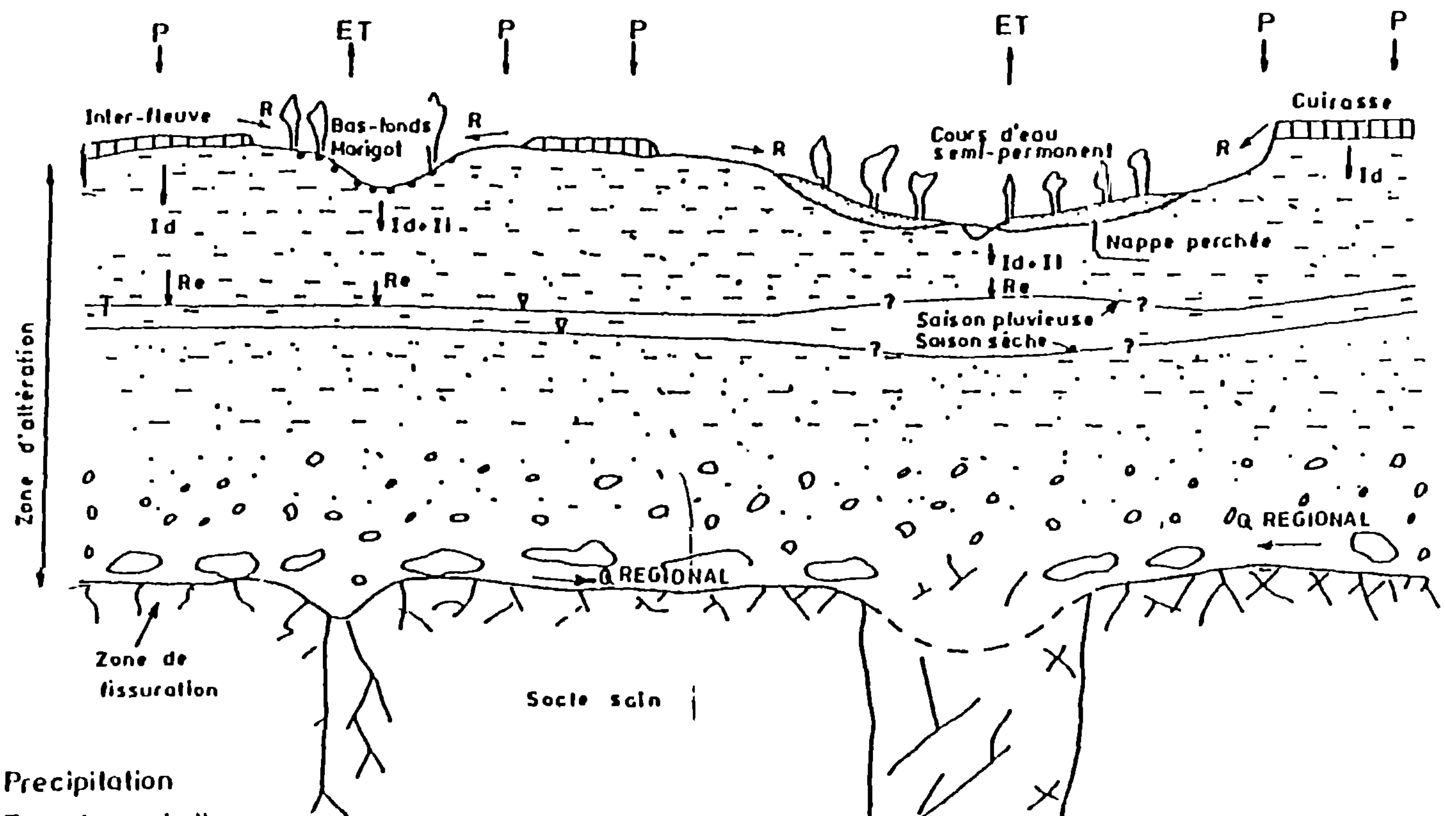
Table 2: Water Reservoirs in the Banfora Area

2.2 Groundwater

Exploitable aquifers exist in the entire Comoé province. Generally, the aquifers are artesian with higher water levels (6-8 m below surface) in the north-western part and lower water levels (down to 17-20 m) in the sout-eastern part. As described in 1.1.1 Geology, the bedrock in the Comoé province consists of granites, greenstones and schist in the southern part and of sandstones in the northern part of the province. These formations constitute the lower primary aquifers, which are fractured with the groundwater movement mainly dependent on secondary permeability. In most places, a zone of alteration has been developed above the bedrock forming the laterite and the sapprolite aquifers. These aquifers consist mainly of clay and sandy clay and have a relatively low water potential, but a high storage capacity. A schematic cross section of the different aquifers is shown in fig. 3.

2.2.1 Granite, greenstone and schist aquifers

The granite, greenstone and the schist aquifers belong to the old core of magmatic and metamorphic rocks. The yields of the wells depend on the presence and of the development of fractures. Generally the fractures are more abundant in the upper part of the formations i.e. in the upper weathered part. The best yielding fractures occur in the upper 30 m of the aquifer. The zone of alteration within these areas is normally 20-50 m thick.



P Precipitation

ET Evapotranspiration

R Ruissellement

Id Infiltration directe

Ii Infiltration indirecte

R Recharge

Regional Ecoulement souterrain regional

Zone de fissuration intensive

Fracture

(Zone de drainage local)

Zone broyée

Fracture majeure

(Zone de drainage regional)

Client: DEP / Ministère de l'Eau

Projet: Bilan d'eau

Titre: PROFIL HYDROGEOLOGIQUE SCHEMATISE

Dessiné: AS

Vu:

Figure numero: 2

Date:

Dessin numero:

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Fig. 3 Schematic Cross Section of Aquifer Types

Thus the major water bearing zones are expected to be at a depth of 20-80 m below surface.

The average yield (see map fig. 4) of boreholes within the areas of granite and greenstone is approximately 4 m^3/h whereas the average yield within the schist area is 3.5 m^3/h. In the granite area, the borehole yilds do not exceed 10 m^3/h whereas boreholes with yields of more than 10 m^3/h occasionally can be located in the areas with greenstone.

2.2.2 Sandstone aquifer

The sandstone aquifer covers the north-western part of the province. The yields of the boreholes depend on the vertical and in particular of the horizontal fractures, which are parallel to the bedding planes. The thickness of the aquifer is not very well known, but boreholes of more than 200 m have not penetrated the sandstone formation. In Sikasso, a town in Mali some 50 km west of the Comoé province, a series of boreholes up to 390 m have been drilled in the same sandstone formation as in the Comoé province. Some of these boreholes yield more than 100 m^3/h. However, the average yield of boreholes in the sandstone of the Comoé province is approximately 5 m^3/h.

2.2.3 Laterite and sapprolite aquifer

The laterite aquifer is the uppermost surface near aquifer which consists of clay and laterite. The laterite aquifer is rarely more than 5 m thick and often dries out in the dry season. The sapprolite aquifer occurs in the zone between the laterite and the bedrock and consists of clay and sand.

The yields of the laterite aquifer is limited but normally sufficient to feed a traditional well. The sapprolite aquifer has higher yield and may sometimes yield just as much as the bedrock aquifer. A combined use of the sapprolite and the bedrock aquifer is often preferable. The sapprolite has a good storage capacity and may often act as storage for the bedrock aquifer.

The thickness of the sapprolite aquifer depends on the thickness of the zone of alteration, which is about 20-50 m in the granite, schist and greenstone area and 10-15 m in the sandstone area.

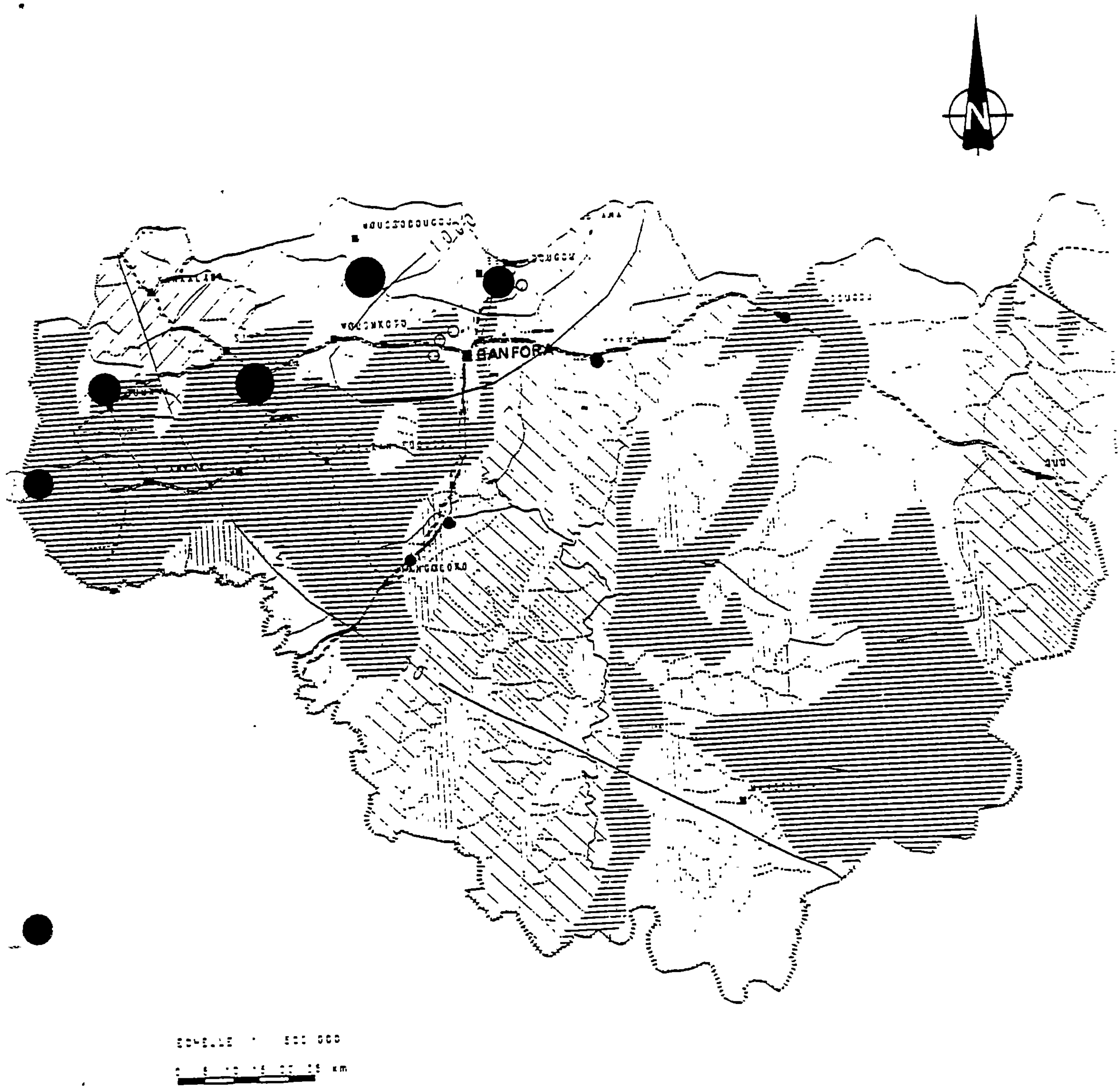

Fig. 4 Water Resources of the Comoé Province (Legende see fig. 5)

CARTE DES RESSOURCES EN EAU
REGION DES HAUTS BASSINS

LEGENDE

FRONTIERE NATIONALE

LIMITE REGIONALE

LIMITE PROVINCIALE

LIMITE DEPARTEMENTALE

ROUTE PRINCIPALE

ROUTE SECONDAIRE

CHEMIN DE FER

FLEUVE PRINCIPAL

FLEUVE SECONDAIRE

FLEUVE TERTIAIRE

CHEF LIEU DE PROVINCE

CHEF LIEU DE DEPARTEMENT

ISOHYETE

RETENUE (CAPACITE INCONNUE)

RETENUE (CAP. 0 - 0.5 Mm3)

RETENUE (CAP. 0.5 - 2.0 Mm3)

RETENUE (CAP. 2.0 - 10.0 Mm3)

RETENUE (CAP SUP. A 10.0 Mm3)

UNITES HYDROGEOLOGIQUES

BF CH GF RF RH SL VD SF

CODES GEOLOGIQUES
(1er symbole)
A = ARGILITES
B = GRANITES SYN-TECTONIQUES ET MIGMATITES
C = CALCAIRES ET DOLOMIES
F = GRES SILICIEUX
G = GRANITES ANTE-BIRRIMIENS
H = SCHISTES ET BRECHES
P = GRANITES POST-TECTONIQUES
Q = QUARTZITES
R = GRES
S = SCHISTES BIRRIMIENS
T = TARKWAIEN
V = ROCHES VERTES

CODES PEDOLOGIQUES
(2me symbole)
A = SOLS FERRUGINEUX TRES CULTIVES, RELIEF FAIBLE, BUTTES CUIRRASSÉS
C = SOLS VERTIQUES ET BRUNS EUTROPHES DEGRADES: COLLINES ET DEPRESSIONS PERIPHERIQUES
D = SOLS VERTIQUES ET BRUNS EUTROPHES COLLINES ET DEPRESSIONS PERIPHERIQUES
E = SOLS FERRUGINEUX DEGRADES RELIEF FAIBLE, BUTTES CUIRRASSES
F = SOLS FERRUGINEUX PEU CULTIVES, RELIEF FAIBLE
H = SOLS HYDROMORPHES PLAINES
L = LITHOSOLS ET SABLES DUNAIRES PLAINES ET CORDONS DUNAIRES
S = SOLS HALOMORPHES ET SABLES DUNAIRES, PLAINES ET CORDONS DUNAIRES
V = SOLS VERTIQUES ET VERTISOLS RELIEF ONDULE

CARACTERISTIQUES DES UNITES HYDROGEOLOGIQUES

UNITE HYDROGEOLOGIQUE	PROFONDEUR MOYENNE FORAGE (m)	POURCENTAGE REUSSITE	DEBIT MOYEN FORAGES POSITIFS (m3/h)	NIVEAU STATIQUE MOYEN (m)	RESERVES TOTALES *	RECHARGE **	POTENTIALITES EXPLOITATION EXTENSIVE ***	POTENTIALITES EXPLOITATION INTENSIVE ***
AF	49	57	2.2	6	5	4	2	3
AL	74	40	7.3	28	5	3	1	3
BA	49	77	6.5	8	4	3	3	4
BE	60	62	3.7	18	3	2	1	2
BEC	54	74	2.6	20	1	2	2	1
BF	49	76	4.5	[illegible]	3	5	3	3
BFC	46	80	2.7	21	1	4	3	1
BSC	51	61	3.5	21	1	1	2	1
BVC	40	84	4.9	9	2	2	3	2
CE	79	83	4.6	47	5	2	2	2
CH	62	90	7.3	14	5	3	3	4
CL	60	67	7.7	22	5	2	1	3
FV	58	80	5.6	25	5	2	2	2
GA	54	75	5.2	12	4	2	2	3
GE	61	66	2.9	20	2	2	1	1
GEC	53	68	2.9	19	1	2	2	1
GF	50	73	3.9	[illegible]	3	5	3	3
GFC	43	68	3.7	17	3	4	2	2
GS	55	51	2.5	14	3	1	1	1
GSC	49	60	3.3	15	1	1	2	1
GV	49	76	4.0	13	2	3	3	2
GVC	42	73	4.1	12	1	2	3	1
HL	46	65	12.4	17	5	2	2	3
PE	58	60	2.3	16	3	2	1	1
PFC	50	71	5.9	12	1	4	2	2
PLC	50	39	2.8	28	1	2	1	1
PSC	49	58	3.5	13	1	1	2	1
RE	67	70	5.7	23	5	2	2	2
RF	61	82	5.1	[illegible]	5	5	2	4
RH	56	88	5.9	[illegible]	5	4	3	4
SA	56	88	4.1	9	4	3	3	3
SC	62	70	3.4	16	4	3	2	2
SCC	47	89	2.7	14	1	2	3	1
SE	65	64	2.9	11	4	2	1	2
SEC	56	78	2.0	17	1	2	2	1
SF	54	76	3.5	14	3	5	2	3
SFC	47	83	10.6	[illegible]	1	4	3	3
SL	56	74	5.1	[illegible]	3	2	2	2
SVC	48	78	3.7	14	1	2	3	1
TC	53	67	2.8	22	2	2	2	1
VC	61	64	3.3	[illegible]	2	3	1	1
VCC	51	86	2.5	[illegible]	1	2	3	1
VD	51	74	4.0	[illegible]	3	5	2	3
QF	--	--	---	--	5	5	-	-

REMARQUES

DANS CETTE REGION SEULES LES UNITES INDIQUEES EN ROUGE Y FIGURENT

* RESERVES TOTALES	CLASSE NO
0 - 100 mm	1
100 - 200 mm	2
200 - 400 mm	3
400 - 900 mm	4
sup. a 900 mm	5

** RECHARGE	CLASSE NO
0 - 5 mm/an	1
5 - 15 mm/an	2
15 - 30 mm/an	3
30 - 50 mm/an	4
sup a 50 mm/an	5

*** POTENTIALITES	CLASSE NO
mauvaises	1
mediocres	2
bonnes	3
tres bonnes	4

Fig. 5 Legend to Water Resources of the Comoé Province

2.2.4 Groundwater resources

Due to abundant rainfall of around 1000 mm per year and a high permeability of the soils, the aquifer recharge is good. According to the water resource map (fig. 4 and 5), the infiltration is more than 50 mm per year, which is good compared to other parts of Burkina Faso.

The groundwater potential is classified as good and very good. It is believed that the sandstone aquifer in the northwestern part of the area has the highest groundwater potential mainly because of the big aquifer thickness and the abundant horizontal fractures.

2.3 Quality of water

The water found in the province of Comoé is, generally, of good quality.

The surface water of the region has still not been threatened by numerous possible sources of pollution. Locally, some industrial wastewater has infected a number of lakes causing increased mortality among of the local population of fish. These cases, however, are still rare, and plans are being prepared to control such spills.

The quality of the groundwater emanating from the aquifers is equally very fine. The groundwater, which is being extracted by means of wells and boreholes, is generally used by the rural population as drinking water and for domestic use. A chemical analysis is always performed before the water is commissioned for general use. With the exception of water with a high content of iron, which gives the water an odd taste, the groundwater is highly appreciated by the population.

2.4 Surface water versus groundwater

From the previous sections it is obvious that the region exhibits a considerable surface water and groundwater potential, which can be utilized for domestic, industrial and agricultural purposes.

The present water supply to Banfora is based on surface water led through a pipeline from a large dammed reservoir, but the town was earlier supplied with water from the underlying sandstone aquifer, which has a high water potential. In the development of the future water supply of Banfora both surface and groundwater should be taken into consideration.

Several dammed reservoirs of various size exist in the region. The reservoirs give excellent opportunities for crop irrigation and may easily be further developed.

The reservoirs are almost entirely used for irrigation purposes. In particular the irrigation of rice fields are common and could be implemented in several river valleys.

The groundwater potential is believed to be sufficient for village and small town drinking water supply all over the region. In the north-western part, in the area of the sandstone aquifer, a groundwater potential for irrigation is present. Development of a groundwater based irrigation system is expensive and difficult in a region like Comoé and should be carefully examined before being implemented.

3. PRESENT WATER UTILIZATION

At present time, the consumers can be divided into three main categories:

- Households: In urban areas, where the ONEA is responsible for the water supply, and in rural areas (handpumps, wells)
- Industries: SOSOCU, SOPAL, GMB
- Agriculture: Including irrigated cultivation

3.1 Rural Water Supply

The rural water supply has mainly been based on traditional wells, utilizing the laterite or the sapprolite aquifer. Surface water is used to some degree in the rainy season, but very rare in the dry season because most streams and rivers dry out. As a considerable part of the traditional wells may also dry out as was the case in the dry season in the drought striken period of 1973 - 1975 and 1983 - 1984, there is an urgent need to improve the drinking water situation. The most obvious solutions would be either by improved technical methods to deepen the traditional wells or to drill boreholes with modern drilling equipment.

Only one modern water supply programme has been implemented in the province of Comoé, viz. the Comoé Rural Water Supply Project financed by the EDF. The project comprised three phases stretching from 1981 to

1990 and a total of 196 wells were made (of which 40 deepened) and 445 boreholes fitted with Vergnet hydraulic foot pumps.

Even though the programme is based on the widely recognized concepts for modern rural water supply, local participation, establishment of operation and maintenance organizations (water committees, a network of repair tradesmen, and a spare-part distribution network), its success has only been partial.

An internal study of the project in 1989 (report dated June 1989) after 5-6 years of operation showed that 83.4 per cent of the facilities installed were operational at the time of the study. The spare part most frequently changed is the rubber cylinder (1.4 per pump on an average). Average annual cost per pump: XOF 20,000.

The repair tradesmen constitute the strong point of the system. The competition permits the consumers to change to another repair unit in case of incompetence and thus keep the fees at an acceptable level.

The distribution of spare parts by an agent is the weak point of the system. In 60 per cent of the cases the needed spare part was not in stock at the agent's store, and in 56 per cent of the cases the time of delivery varied between 1 and 8 months. Some villages prefer traditional wells to boreholes because of the insufficiency of spare parts in stock. The majority of the consumers express a desire for local spare part depot at provincial capital level. The problem seems to be one of import rather than depot. The evaluation in 1985 already raised the question.

87 per cent of the water committees have not changed in composition since their creation. They play a limited role intervening in case of breakdown, keeping the villagers informed and collecting contributions. The meeting frequency is very low. Only the treasurer and the president seem to play a specific role. The funds of the committees are maintained by contributions which vary greatly in size and frequency between the villages. At the time of the survey the 47 per cent of the committees had at their disposal between XOF 10,000 and 60,000, only 12 per cent had more than XOF 60,000 and 22 per cent had no funds at all.

79 per cent of the villagers participating in the survey had access to other sources of water supply, but reserved the water from the well for consumption and cooking, except in the rainy season when surface water covers all needs.

At present (1991), about 60 per cent of the pumps are operational according to the ONPF. 20 per cent of the water points had been abandoned by the population for various reasons mainly because of the existence of alternative sources of water and breakdowns represented only 20 per cent.

In conclusion, the findings of this internal study differ little from the evaluation of other rural water supply programmes in the humid tropical zone. In spite of considerable efforts in the form of motivation, attempts to increase public awareness and organization of consumers, the fact that traditional water sources are readily available most the year limits the consumers' interest and the degree to which the new installations are used.

3.2 Urban Water Supply - Banfora

Until 1977, Banfora was supplied with water from three boreholes. The water was distributed through an unsatisfactory and insufficient distribution network. Starting in 1977, Danida financed the construction of a water supply system based on surface water from an intake of the Komoé river about 20 km west of Banfora. The system comprises:

- gravity distribution main of 315 mm diameter
- treatment plant with a capacity of 100 m^3/h
- 700 m^3 reservoir at ground level
- 80 m^3 water tower
- distribution networks which have by now reached a length of 37.55 km

The water is supplied from a 1,000 mm diameter pipeline serving the SOSUCO sugar factory through a gravity distribution system.

The daily production varies with the seasons between 700 and 1,600 m^3/d.

Water loss in the water supply schemes amounts to approximately 14%.

The development in the consumption from private connections and public standpipes appears from table 3 covering the period from 1983 to 1990.

Year	Private Connections			Public Standpipes			Total	
	Number	Consumption (1,000 m^3)	Increase (%)	Number	Consumption (1,000 m^3)	Increase (%)	Consumption (1,000 m^3)	Increase (%)
1983	772	262.2	-	15	25.9	-	288.10	-
1984	883	262.4	0.1	15	38.3	32.4	300.70	4.2
1985	948	247.0	-6.2	18	37.3	-2.7	284.30	-5.8
1986	1,028	236.5	-4.4	22	31.0	-20.3	267.50	-4.4
1987	1,096	254.9	7.2	29	43.2	28.2	298.10	10.3
1988	1,193	261.0	2.3	38	63.1	46.2	324.10	8.0
1989	1,303	268.0	2.6	38	53.6	-15.0	321.60	-0.7
1990	1,343	235.3	-12.2	44	62.4	16.4	297.70	-7.4

Table 3: Consumption from Private Connections and Public Standpipes, Banfora

The table shows that the volume consumed from private connections has fallen considerably while that from public standpipes has increased slightly.

One of the explanations of the above changes could be that the increasing number of public standpipes gives a larger part of the population in more remote areas access to potable water. The reasons for the fall in the consumption from private connections are unknown.

3.3 Industries

The largest consumer of the region is the sugar factory Société Sucrière de la Comoé (SOSUCO). Apart from the factory's need for water to be used as drinking water and at various stages of the production of sugar, the SOSUCO irrigates 3,685 ha fields of sugar canes.

Presently, the total annual consumption of SOSUCO is 30 mill. m^3, but in order to reach the optimum production the factory needs 40 million m^3/year.

Furthermore, the SOSUCO presently covers the needs for water of the SOPAL (Société de Production d'Alcool) and supplies potable water for its employees out of its own production or by means of wells drilled in the cities. The yields of these wells are unknown.

According to the technical report of the ONEA prepared in 1990, the Grands Maisons et Industries, of which the GMB is the largest consumer, had a consumption of 40,530 m^3 which represents 12 per cent of the total ONEA consumption in Banfora in 1990.

3.4 Agriculture

The rainfall of the region is sufficient in volume and geographical distribution to create favourable conditions for rainy-season farming.

The main types of crop grown are rain-fed food crops such as maize, millet, sorghum and tubers in the highlands and rice in the lowlands.

These crops have been grown traditionally with a low level of financial investment in the production.

The crowing of commercial crops has accounted for almost 10 per cent of the total cultivated area and has been dominated by peanut growing. However, cotton has recently been introduced and is becoming increasingly important as a commercial crop.

In the province, 3 per cent of the total cultivated area is covered with rice representing 16 per cent of the fields cultivated. Thus, rice fields are smaller in size than fields with other crops. The average size of a rice field is 0.12 ha compared to a general average of 0.75 ha. 97 per cent of all rice fields are located in the lowlands and only 3 per cent in the highlands[3].

Rice growing is generally allocated to women, but in some areas it is undertaken by the heads of the families. In the non-developed plains, the rice growers have no modern facilities at their disposal, only the traditional tools. Even the use of fertilizers is limited because of the high costs involved and the uncertainties as to yield due to lack of control over the water supply. Mainly, the traditional varieties of rice are grown.

In 1980, the project Opération Riz Comoé (ORC), financed by the EDF, started development of rice fields. The primary goal of the project is to increase the yield of rice by developing the means of production. The project also aims at reaching some degree of water management by the users and decentralized operation and maintenance of the facilities. The project involves a population of

3. van't Land, G. et Bronswijk, P. 1990

7,400 and operates on the basis of a credit policy towards the producers.

Between 1980 and 1991, 8 fields (or 620 ha) were developed. The concept has been changed several times: some plains were planned to have a central collector main and irrigation canals (Tanion), some were to have a central collector main, only (Moadougou), and in the remaining plains, small embankments were to be built along the contour lines without any collector mains or canals (Kawara). In all cases, it would only be a question of partial control over the water supply. The introduction of these facilities has been accompanied by the formation of "Groupements Rizicoles".

The intervention of the ORC aims at increasing the average yield from 700-1,500 kg/ha to 3,000 kg/ha. In the second phase starting in 1990, the area of intervention is expected to be extended to 850 ha in 10 plains, which also increases the amount of water used.

The pastoral needs are presently rather limited but considerable increase should be anticipated taking into account the extremely favourable conditions of the region for transhumance and the drought which has hit the northern part of Burkina Faso and the neighboring countries.

The livestock is composed as follows:

	Banfora	Province of Comoé
Cattle	14,500	82,000
Goats	19,000	69,000
Donkeys	300	1,000
Pigs	3,500	8,000
Poultry	118,000	580,000

Table 4: Livestock in Banfora and in the Province of Comoé

The remaining agro-pastoral needs concern:

* Farming crops grown in the reservoir surroundings

* Manure pits whose water demand for composting is around 14 m^3/year. An ongoing project aims at equipping each household with a manure pit.

4. WATER RESOURCE MANAGEMENT PROBLEMS IN BANFORA

4.1.1 Water Management in Burkina Faso

In Burkina Faso, mobilization of water resources in order to obtain economic and social development is given top priority, nationally. Thus, the first and second five-year plans (1986-90, 1991-95) reserved 23 and 21 per cent of the anticipated investments, respectively, for the water sector.

A ministerial department, the Ministry of Water, was established with the purpose of defining and implementing the water policies. The structure of the Ministry is the following:

1. Direction des Inventaires Hydrauliques in charge of the management of water resource data.

2. Direction des Etudes et de la Planification (DEP) whose task it is to prepare and implement policies and programmes. Three offices were established as a tool to implement the water policy:

   - Office National des Puits et Forages (ONPF) undertaking the drilling boreholes and wells.

   - Office National des Barrages et Aménagements Hydroagricoles in charge of the establishment and management of dams and irrigations schemes.

   - Office National de l'Eau et de l'Assainissement (ONEA) in charge of the construction and management of the distribution system for potable water and sanitation.

Large-scale projects are generally implemented within the framework of an autonomous organization e.g. the ongoing BAGRE project for the establishment of an important hydro-electric barrage.

4.1.2 National Priorities

At the national level, the Ministry of Water is in charge of the formulation of a national water policy and has laid down the following priorities:

First priority is given to human consumption aiming at a supply of 20 l/d/hab. in rural areas and 38 l/d/hab. in urban areas.

Second priority is given to development of potential soil and water resources to ensure agricultural self-sufficiency. The Ministry considers the SOSUCO to comply with this priority.

Third priority is given to environmental protection.

The two latest plans for economic and social development in Burkina Faso anticipate respectively 23 and 21 per cent of the expected investments in the water sector.

4.2 Water as an Economic Good

In principle, all water utilization in Burkina Faso is regulated by the Authorities.

In the case of small quantities, a sort of simple notification to the water authorities is sufficient. Private consumption from traditional sources in both rural and urban areas (wells, sources, rivers etc.) are free of charge.

4.2.1 Rural water supply

Rural water supply programmes always enforce user contribution for both establishment (only a small part of total costs) and operation and maintenance (total costs to be covered by users).

4.2.2 Urban water supply

For urban water supply, where ONEA is responsible, a national tariff which applies to all water distribution systems is in force:

Quantity (m^3)	Price (XOF)	Additional Charge for Sanitation (XOF)
0 - 10	113	5
11 - 25	120	5
26 - 50	250	20
51 - 100	320	40
> 100	350	50

Table 5: National tariff of Urban Water

The tariff at the public standpipes is 90 + 5 XOF/m^3 whereas the actual price (the resale price) of water in Burkina Faso varies between 150 and 250 XOF/m^3. Water from the autonomous standpipes[4] is invoiced at 46 + 5 XOF/m^3. Raw water costs 186 XOF/m^3.

Surveys of water utilization, family income and willingness to pay in other major towns in Burkina Faso have revealed some interesting features.

In general in urban areas, almost a third of the entire population relies on traditional, free resources for their water supply.

A survey[5] in one city showed that 69% of the families not supplied with house connection gave the high connection costs as reason for not being supplied by ONEA. In fact 60% of these households were willing and able to pay more than XOF 1000/month for water consumption.

In the same survey a breakdown of household expenses showed that:

Food is the most important expense for the family, but expenses for luxury items (beer and cigarettes) and for fire wood are equally important. Expenses for firewood are twice the amount spent for water.

For households provided with water from their own tap, expenses are minor and should not be of any economic burden for the family.

In average families not connected spent 35% more on water that connected households. The tariff imposed for water from ONEA supply systems is applicable nationally and leaves no room for local adjustments to specific conditions. Consequences of the latest increase of 16% (February 1991) have not been studied by ONEA.

4. Autonomous water points each consisting of a borehole, a pump, and taps in one unit. The pumps are connected to the public electricity supply.

5. Avant projet de l'adduction d'eau de la ville de Koudougou, Décembre 1989, ONEA - I. Krüger Consult - COWIconsult

4.2.3 Irrigation

For extraction of large quantities, an authorization should be required and a charge of 2 XOF/m^3 should be payable.

Thus, the SOSUCO consumption which is in the order of 40 million m^3 should include this charge in its budget. Although Burkina Faso considers water as an economic good, the country has never enforced the application of this principle.

Measures are about to be taken in order to implement this concept, especially as concerns the SOSUCO. However, the Brasseries de la Brakina seem to refuse to accept such an arrangement.

4.3 Supply and Demand

In Banfora, water resource management reveals different basic/original characteristics as concerns supply and demand, institutions and the competition between different needs.

Before 1977, Banfora was supplied from insufficient groundwater resources. In 1974, the SOSUCO established its infrastructure among others a water intake at the Komoé river from which the water is lead first an open canal and afterwards through two water mains (1,000 and 1,200 mm) downstream to the sugar factory over a distance of almost 15 km. The difference in level of about 100 m allows the water to be distributed with no use of pumping.

In 1977, Danida financed a water supply system for Banfora taking water from the SOSUCO pipeline.

Progressively with the increasing needs of the factory (presently for 3,865 ha of sugar canes) and other users, the SOSUCO has drawn water from other reservoirs such as surrounding lakes and the three barrages of Yannon, Toussiana and Comoé. The latter which has a reservoir capacity of 38 mill m^3 was financed by the CCCE and put into use on 3 August 1991.

With these reservoir facilities the present as well as the medium term water needs are believed to be covered in years with normal rainfall (table 6) In dry periods, however, resource problems may arise and lead to conflicts between the different users. Therefore, a profound evaluation of the existing surface water resources should be carried out.

	Present needs in 1000 m^3/year	Medium-term needs (in 1000 m^3/year)
SOSUCO	30,000	40,000
Banfora	515	1,000
Karfiguela*	1,000	10,000
Total	31,515	51,000

* = 30 ha presently irrigated, 300 ha planned to be irrigated

Table 6: Water needs of the Banfora area

4.3.2 Water Supply and Demand by the ONEA

Banfora has experienced demographic expansion outside of the ordinary mainly due to the following factors:

- Presence of agro-industrial enterprises
- Extraordinary extension of the sugar factory located 15 km out of town which means that the small suburbs situated between the factory and the town should be considered as an integral part of the town.

If the average national rate of population increase (2.7 per cent) is applied to the known population of Banfora in 1985, the population would reach 51,627 in 1990. This population is served by 1,400 private connections and 27 public standpipes of which 22 were operational in 1991. Thus, 20 per cent of the population has access to water from private connections.

In terms of daily per habita production, the annual production in 1990 of 407,000 m^3 equals 22 l/day/hab. (the national objective for rural areas). However, a number of problems remain:

* Whole quarters are still unserved
* The housing estate for workers and white collars, the SOCUSO and the SOPAL as well as the suburbs are not supplied by the ONEA.
* Few households have access to private connections

* The low average consumption may indicate that the population resorts to other resources which include numerous wells in the court-yards and the surrounding lakes.

The SOSUCO has its own autonomous treatment plant (traditional decantation/chlorination treatment). The plant supplies the SOSUCO factory, the housing estate, and the SOPAL factory). The population of the housing estate is served from public standpipes and private wells in the court yards.

Presently, discussions are going on between the ONEA and the SOSUCO which should lead to a reinforcement of the structure of the ONEA putting them in a position to undertake all drinking water supply.

4.4 Institutional Aspects

The ONEA is the official organization in charge of supplying adequate water for urban and semi-urban areas. The organization has supreme authority over water resources of Burkina Faso and is in charge of the water distribution system in Banfora. The agro-industrial complex of SOSUCO has a mixed economy (private and foreign) and was founded by means technical and financial assistance from France. The factory was founded in Banfora prior to ONEA and its consumption amounts to almost 60 times that of the rest of the town.

Several paradoxes within the institutional set-up can be detected:

1. The ONEA has made an agreement with the SOSUCO for the maintenance of the hydraulic equipment outside of the production site, but this obligation has not been fulfilled.

2. The SOSUCO is to pay a charge for the groundwater it recovers of 2 XOF/m^3, which has never been effected[6].

3. It is difficult to place the responsibility for resource management. The goodwill of the SOSUCO means that the system has functioned favourably for the ONEA, but not for the rice growers.

6. Another case of non-payment is that of the Brasserie Brakina, which is supplied from the natural resource of "Guingette".

In June 1991, there were two cases in which in order to accelerate the filling of the Comoé barrage the factory shut/closed off the water, and by doing so deprived the other users of water.

4.5 Problems to be Solved

The water resource management problems of Banfora comprise the following:

4.5.1 Water Resource Management

A. No responsible water resource management can be said to be effective in Banfora, presently. Neither the ONEA nor the SOSUCO is undertaking any real management.

The lack of water resource management is worsened by the fact that the water resources remain limited (evaluated at 60 million m^3/year) even after the completion of the Comoé dam. Furthermore, the financial agreement concerning the dam is conditioned by the donor upon the creation of a dam management committee comprising the principal users:

* The Regional Water Department
* The ONEA
* The SOSUCO
* The Regional Centre for Agro-pastoral Promotion
* The Karfiguela irrigation scheme

The committee is to be responsible for the allocation of resources and enforcement of decisions.

b) No water master plan exists or is being planned. However, a commission responsible for the preparation of a master plan for agro-pastoral development was established in March 1991.

4.5.2 Qualitative and Quantitative Resource Monitoring

Surface Water

The existing rainfall and hydrometric stations are insufficient and improvements are essential.

Groundwater

No piezometric network exists and no monitoring of the water quality is carried out in spite of the presence of iron in the region.

4.5.3 Maintenance of Raw Water Equipment (dams, channels, mains)

An agreement between the Ministry of Water and SOSUCO, which is just about to be signed, confers the responsibility for the maintenance of the raw water equipment to the SOSUCO against a remuneration. However, it remains to be seen if the SOSUCO possesses the necessary skills, for instance, as concerns the maintenance of dams.

4.5.4 Drinking Water Supply

Service Level

The service level does not correspond to the needs, especially as regards:

* The unserved parts of Banfora
* The SOSUCO and SOPAL factories
* The housing estates
* The villages surrounding the factories

The ONEA estimates a potential of 1,000 private connections.

Private Connections

The recent increase in the price of a house connection from 60,000 to 90,000 XOF as a minimum, limits the access to private connections. An arrangement similar to that of Ouagadougou promoting the installation of connections on lenient terms (XOF 20,000 in down payment and XOF 2,500 per month) would be an appropriate solution, according to ONEA representatives in Banfora.

4.5.5 Community participation

Whereas the village population is fully involved in the design, execution and management of water points, the urban population can only express their demands. The community has very little influence on the ONEA management.

4.5.6 Sanitation

Burkina Faso employs a progressive water tariff system (cfr. 4.2).

However, sanitation activities of the ONEA in Banfora are virtually non-existent. The evacuation of rain water is facilitated by a particularly favourable relief.

5. ENVIRONMENTAL IMPACT

5.1 Introduction

Discussions of environmental problems in Burkina Faso, have, so far, concentrated on identifying environmental problems related to the degradation of natural resources (soil and water) caused by combinations of effects of human activities (e.g. over grazing) and natural factors (e.g. drought).

In Burkina Faso, combined and mutually reinforcing effects of these factors are easily distinguishable, especially north of the 800 mm isohyet.

The country has experienced rapid demographic growth in the Central Mossi Plateau. The traditional agricultural and pastoral practices often exhaust the capacity of the physical environment. The demographic pressure increases the clearing of virgin land and diminishes the fallow periods. These processes, - a harmful development circle - have accelerated with the recurring droughts that further diminish the capacity of the lands.

In the province of Comoé, this degradation is not as visible as in the northern part of the country. However, the extensive migration southward from the central parts of the country could lead to the exhaustion of the natural resources before the year 2010.

5.2 Environmental Problems in Comoé.

In Burkina Faso, the awareness of pollution issues is quite recent and has not, so far, been transformed at the institutional level into adequate organizations and procedures for the monitoring and control of the physical environment.

The Comoé province lies in the relatively densely vegetated part of Burkina Faso. The migration to the province combined with a high growth rate of the original population has increased the pressure on the natural resources.

It is of extreem importance to maintain the ecological balance in a province, which has a key role in supplying the country with agricultural products.

According to the regional environmental department in Banfora, the following specific problems have been identified.

1. Discharge of wastewater from the G.M.B. This problem is now under control.

2. Discharge of wastewater from the SOSUCO factory. This problem remains unsolved. The wastewater is contaminated by oil from the machines. Discharge of the wastewater i.a. from the factory into surrounding lakes has caused increased mortality of fish. Changes in the types of the living fish have also been observed. Monitoring and control of groundwater resources are highly recommendable.

Furthermore, the intensive farming of sugar canes demands large quantities of fertilizer, insecticides and herbicides the effect of which could have a negative impact on the soil and water. Inquiries show no salination but no information is available on groundwater quality. Monitoring and control of groundwater resources is highly recommended.

6. CONCLUDING DISCUSSION

It is obvious that the overall water resources in the Comoé province are sufficient to cover the present and future needs. The problem is the availability, the accessibility of water in sufficient quantity and quality. Only a few rivers are perennial which makes it necessary to store water for example by constructing dams to extend the growing season and irrigate crops such as rice and sugar canes.

The groundwater potential is highest towards north-west where the sandstone aquifer gives good opportunities for irrigation. In the central and southern part of the province the occurrence of the granite and schist aquifers are believed only to give possibilities for hand pumps and village/small town piped water supply.

The main conflict concerning water resources exists between SOSUCO on one side and Banfora Water Supply and the rice growers on the other.

SOSUCO is the dominating user, accounting for 98% of the total amount of water used for piped drinking water supply and large scale irrigation purposes in Banfora. With the construction of the Moussodougou dam, medium term water resources are evaluated as sufficient in normal years.

Problems may arise in the end of the dry season especially in dry years where reservoirs sometimes are nearly empty or simply dry out.

In view of the overwhelming dominance of SOSUCO as well as the potential threats of scarcity, the major problem in Banfora is the management of the water resource.

The donor financing the Moussodougou dam also insisted on the establishment of a committee responsible for allocation of resources.

Representing all water users, the committee must be evaluated as management at the most appropriate level.

However,this committee should not take care of all water resource management problems in the region. Problems concerning irrigation of small rice fields in a village in the northern part of the province have little to do with the management problems of large reservoirs such as the Mossodougou. It is suggested that the small irrigation schemes are managed on village committee level.

Furthermore, rural water supply projects financed by foreign donors (e.g. the programmme financed by EDF) always have an integrated water management component regulating the management problems at village level.

7. SUGGESTED IMPROVEMENTS OF THE MANAGEMENT SYSTEM IN BANFORA

A. Integrated ressource management: Institutional, Scientific and Technical Reinforcement:

1. Creation of a committee to undertake the management of all water resources of the Comoé basin involving all major water consumers.

2. Reinforcement of hydrometric and pluviometric networks.

3. Monitoring and control of resources as regards quality and quantity.

4. Monitoring and control of contamination by factories and the sugar industry.

11. Preparation of a Water Master Plan.

10. Encouragement of reuse of wastewater and use of treacle as fertilizer at SOSUCO.

B. Improvement of Service Level

5. Development of existing ONEA facilities.

6. Reinforcement of the ONEA making the organization capable of meeting all demands for drinking water

7. Special promotion of private house connections

8. Promotion of a sanitation policy

9. Promotion of community participation in water management

Pilot Projet for Water Resource Management
Terms of Reference

The Banfora case study, carried out as part of the Nordic Imitative on Local Water Management in Rural Areas and Small Towns, showed that Banfora's water resources are derived from relatively abundant rainfall (1,000 mm/year), limited groundwater reserves and from the basins of the Komoé river (8,876 km^2).

The intensive utilization of these resources by the SOSUCO, the ONEA and other users is principally based on use of water from the Komoé river thus accentuating their limit.

In spite of the abundance of the resources, there exists competition and risk of shortages and pollution if appropriate measures are not taken.

One of these measures, and the most effective one, would be creation of a resource management committee comprising the principal parties involved (local authorities responsible for water supply, health, agriculture, pastoralism, environment and planning, as well as representatives of communities and users).

The mandate of the committee would be to allocate water resources based on first-hand knowledge of resource availability, including forecasts of future development as well as to monitor resource utilization and make relevant allocation adjustments.

In order to fulfill these obligations, the committee must have at its disposal adequate means enabling it to make the correct decisions. Consequently, the purpose of these terms of reference is to define the mandate and the means necessary for its realization.

1. THE MANDATE

1. Monitoring and control of quantitative and qualitative aspects of the water resource:

   a) Surface Water

   In view of gaps observed, hydrological and pluviometric networks shall be reinforced by creating new observation centres and intensifying measurements.

   Use of telemetric equipment, especially hydrometric, is recommended.

Chemical and bacteriological tests shall be made down stream of SOSUCO and in natural and artificial reservoirs.

Monitoring of the population living next to the Comoé dam will also be necessary considering the existence of dracunculosis in the region.

b) Groundwater

Define, implant and manage an adequate piezometric network.

Take periodic samples from exploited water points for chemical and bacteriological analysis.

c) Publication of Syntheses, Yearbooks, etc.

2. Preparation of Resource Management Plan for the Komoé Basins

All basins shall be considered in respect of competition of users and environmental aspects.

3. Allocation of Resources to Users

On the basis of a accurate knowledge of the resources and according to national priorities, to ensure the allocation of resources at statuary meetings of the management committee and in the presence of all users.

2. THE MEANS

The committee comprising all parties involved shall have at its disposal a technical unit equipped with the composed as follows:

1. Human Resources

Head of unit, hydrologist (national)
Assistant hydrologist
Two technicians (hydrology)
Two technicians (hydrogeology)
One technician (chemistry)

2. Scientific and technical equipment

Hydrometric, pluviometric and piezometric instruments
Personal computers
Equipment for printing and cartography

3. Logistics

Vehicles

3. INSTITUTIONAL ASPECTS

In view of the non-representation in Banfora of certain central authorities, the committee shall be of a national governmental nature. The Government shall formulate the appropriate documentation.

The technical unit shall be supervised by the Direction des Etudes et de la Planification, Ministère de l'Eau.

Appendix 1 - Population of Banfora in 1985

Sector	Population	Males	Females
1	1668	825	843
2	4701	2359	24442
3	5787	2970	2817
4	4426	2279	2147
5	2344	1189	1155
6	5432	3566	1866
7	2265	1184	1081
8	2240	1108	1132
9	1953	905	1048
10	2423	1109	1314
11	3946	1917	2029
TOTAL	37185	13411	17774

UNCED 1992, FRESHWATER RESOURCES
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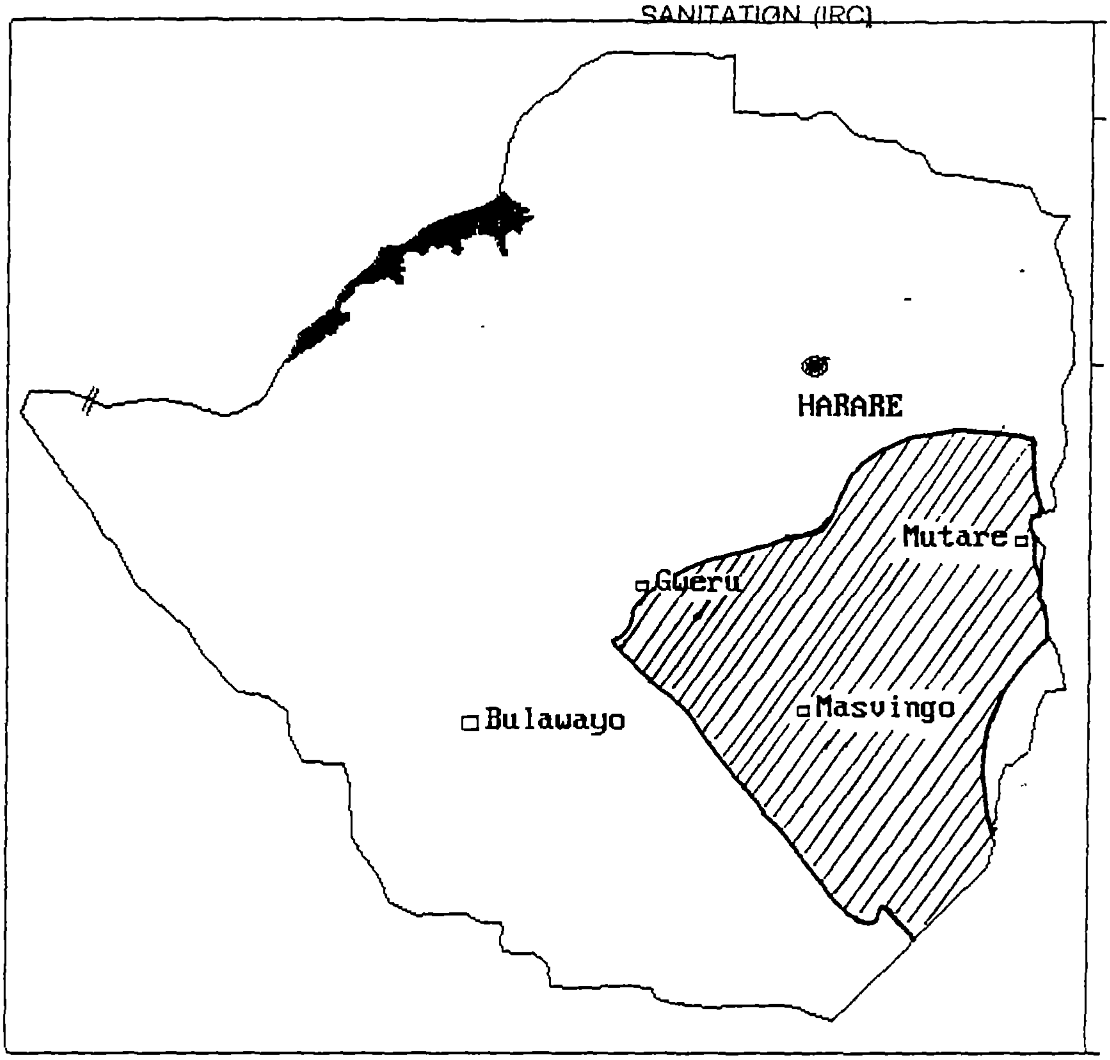
Case Study on Water Management in the Save River Basin, Zimbabwe



Gulbrand Wangen
Det norske Veritas Development A/S

Oslo, November 1991

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LIST OF ABBREVIATIONS

AGRITEX	Agricultural Technical and Extension Services
CFA	Commercial Farming Areas
CLA	Communal Lands Areas
DC	District Council
DDF	District Development Fun
MCCD	Ministry of Community and Cooperative Development
MET	Ministry of Environment and Tourism
MEWRD	Ministry of Energy and Water Resources and Development
MFEPD	Ministry of Finance, Economic Planning and Development
MLGRUD	Ministry of Local Government, Rural and Urban Development
MOH	Ministry of Health
MPA	Ministry of Political Affairs
NGO	Non Governmental Organisations
RA	Resettlement Areas
RB	River Boards
RC	Rural Council
RWA	Regional Water Authority

WATER MANAGEMENT IN THE SAVE RIVER BASIN, ZIMBABWE [1]

1. INTRODUCTION

The overall objective of preparing this case study on Water Management in the Save River Basin in Zimbabwe is to support the preparation of practical and operational guidelines for Local Water Management in Rural Areas and Small Towns during the Informal Consultation on Integrated Water Resources Management in Copenhagen in November 1991 [2].

The case study is prepared based on a Draft terms of reference /1/ and an amendment where the concept Local Water Management has been rephrased to read Integrated Water Resources Management at the lowest appropriate level /2/. Assessment of the lowest appropriate level for water management in Zimbabwe in general and in the Save River Basin in special has to be related to the ongoing process of decentralisation. This process will enable local authorities to take on more of the responsibilities carried out by central government and will have to find ways of strengthening the local authorities autonomy and revenue base. It will of course fall outside the scope of this paper to describe this process in detail. The process has been described in the literature and a framework for analysing the process has been presented in a recent book on Decentralizing for Participatory Planning? /3/. In this book the process is analysed along the following dimensions:

- Types of activities to be transferred
- Types of power and authority to be transferred
- The level to which activities and powers should be transferred
- The government institutions or organisations to which powers and activities should be transferred
- The measures to be used in transferring activities and powers.

The case study on the Save River Basin offers the opportunity to make an assessment of the hierarchy of water management from the local to the basin level . This assessment is used to propose **General Solutions** aiming at the development of operational guidelines for Integrated Water Resources Management at the lowest appropriate level and **Special solutions** which relate to the situation in the River Basin. Proposed **Actions** refer to the situation in the Basin.

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[1] This Case Study has been prepared by Dr. ing Gulbrand Wangen, at the request of the Norwegian Agency for Development Cooperation (NORAD). The findings interpretation and conclusions in this paper are entirely those of the author and should not be attributed to the Government of Zimbabwe or NORAD.

[2] The Nordic countries Denmark, Finland, Norway and Sweden have launched a joint initiative on the freshwater resources issue of the United Nations Conference on the Environment and Development (UNCED) in June 1992. An important step in the preparation of this Conference is the Conference on Water and Environment to be held in Dublin in January 1991. The Nordic countries have offered to assist in this process by hosting an Informal Consultation on Integrated Water Resources Management in Copenhagen in November 1991.

2. PROJECT AREA

2.1 Geographical setting

The Save River Basin is located in Eastern and South Eastern part of Zimbabwe. The basin consists of the Save River Catchment which covers a total area of 43500 km^2 and the Runde River Catchment with a total area of 41000 km^2. The Runde River meets with the Save River some few kilometers from the Mozambique border and these two river systems form part of'an International River Basin which ends in the Mozambique Channel south of Beira in Mozambique. Figure 1 shows a map of the 8 Provinces in Zimbabwe. The Provinces are subdivided into 56 Districts. The Save River Basin covers Manicaland, Mashonaland East, Masvingo, Midlands and a small part of the Matabeleland North Province. The 23 Administrative Districts located in the River Basin are shown on Figure 2.

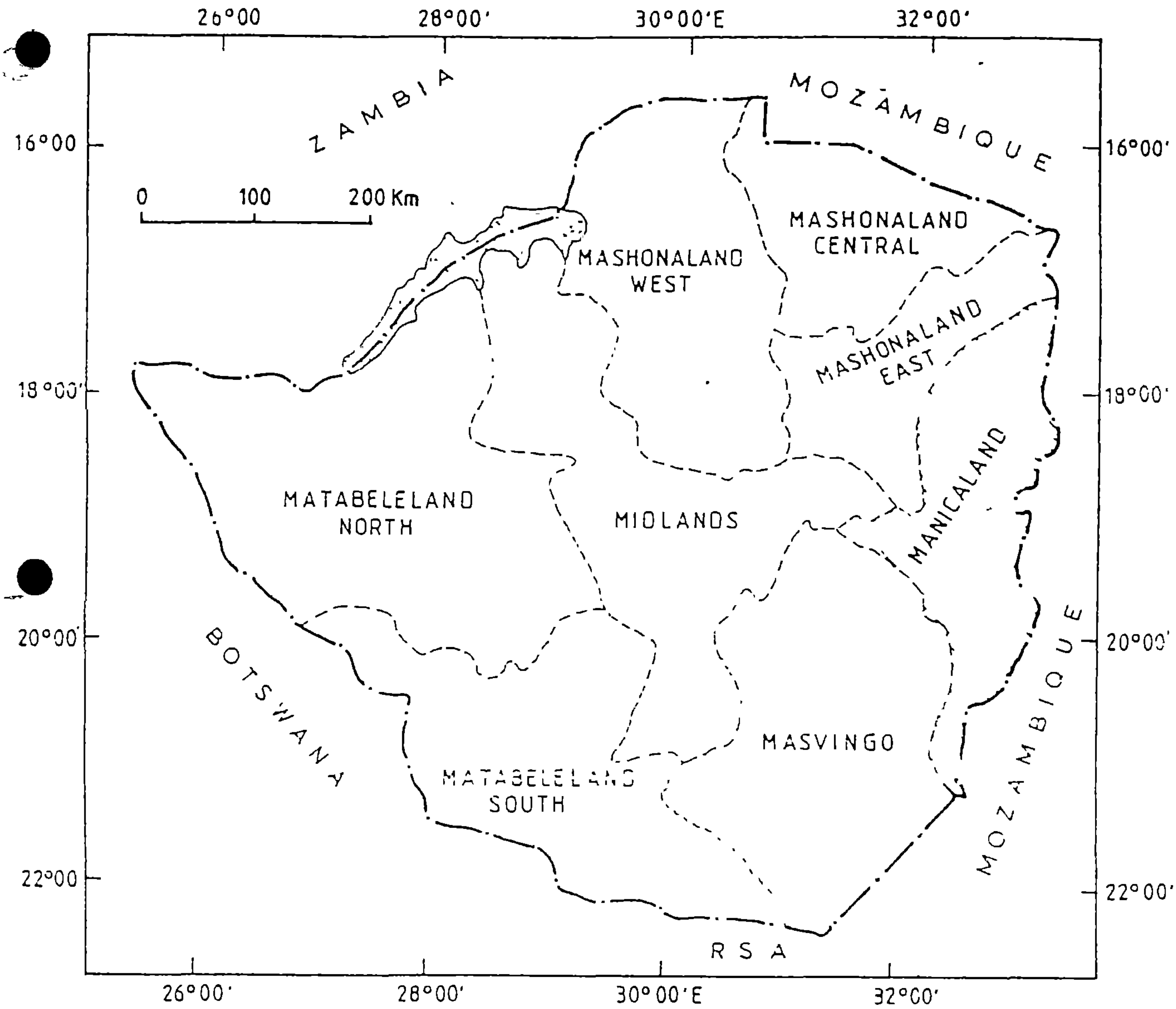


Figure 1. The Provinces in Zimbabwe.

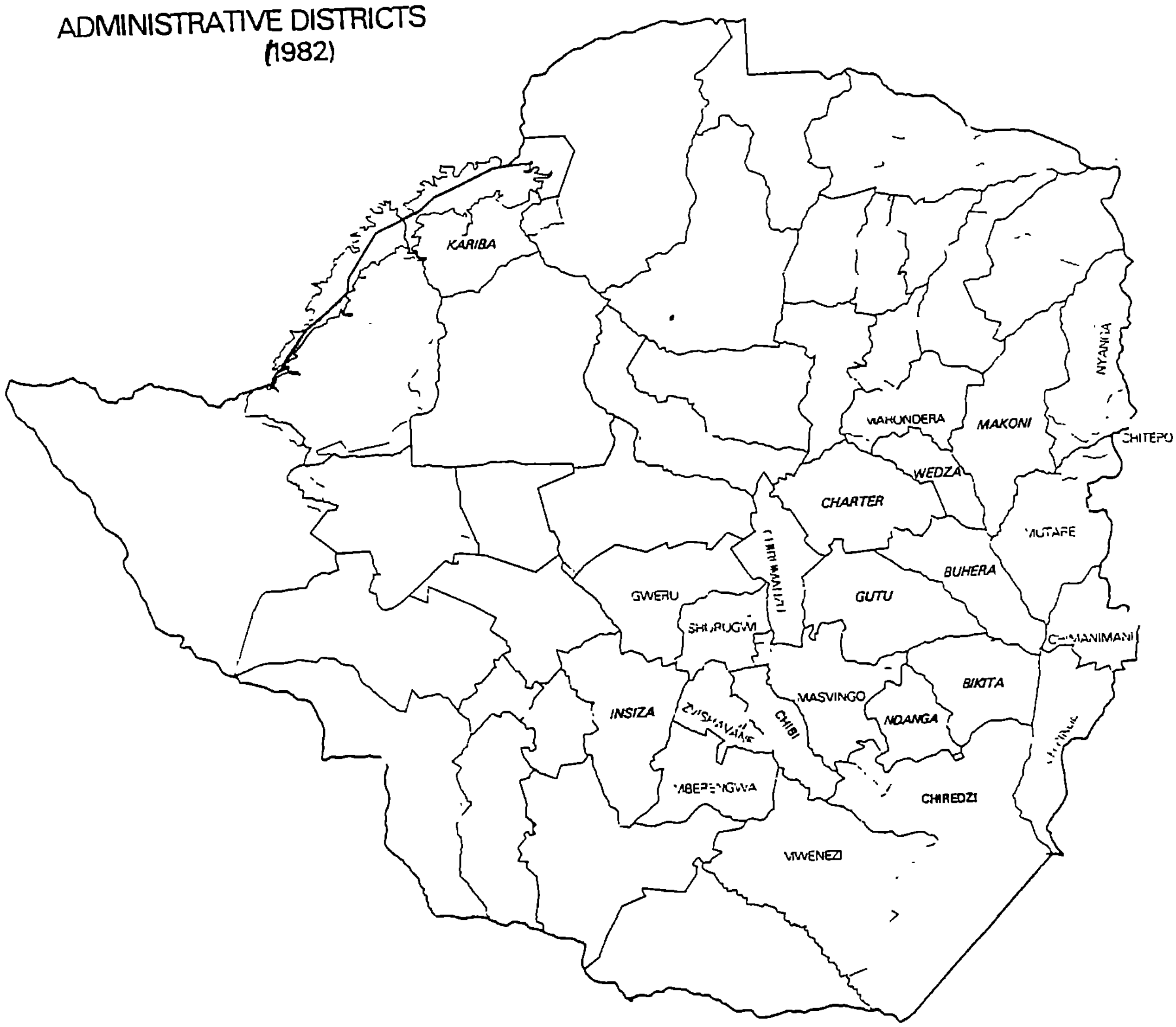


Figure 2. Districts located in the Save River Basin.

2.2 Population

The total population in the Save River Basin is estimated at 2.6 mill. based on the 1982 census. This is equivalent to 34 % of the total rural population in Zimbabwe. Figure 3 shows population data for the different catchments.

Area	Total population (mill.)	Urban population (mill.)	Rural Council population (mill.)	District Council population (mill.)
Save River Basin	2.595	0.145	0.45	2.0
Save River Catchm.	1.545	0.095	0.25	1.20
Runde River Catchm.	1.050	0.050	0.20	0.80

Figure 3. Population data for the Save River Basin

The urban population includes the provincial centres: Masvingo, Gweru, Mutare and Marondera.

The population density varies between Rural and District Council Areas. Rural Councils are established for Commercial Farming Areas (CFA) where the land is privately owned mainly by white farmers, but also by government estates. District Councils are for Communal Land Areas (CLA) where black farmers occupy the land under communal tenure.

The population density in many District Councils (DC) is rather high (more than 60 % of the DCs have a density above 40 per km^2 and the maximum is around 60 per km^2). The figures for Rural Councils vary between 4 and 28. The national average for Zimbabwe was 19.3 km^2 in 1982 as compared to the world average of 33.8 persons per km^2 and the average of Africa which was 16.5. The high population density in many DCs has resulted in a situation where the population exceeds the carrying capacity of the land area. This has resulted in various types of environmental degradation which is further elaborated in chapter 3.4.

The problem of environmental degradation caused by high population density in District Council areas may be reduced in the ongoing land reorganisation where people in CLA are given the option to be resettled on CFA. This process has so far been rather slow. Only 52.000 families out of a target of 160.000 have been resettled on approximately 3 mill. hectares since 1985 /4/. The other solution to this problem is a massive environmental awareness campaign where research projects on farming procedures and natural resource management practices including water management are carried out with the overall objective to develop guidelines for sustainable natural resource management.

2.3 Economic activities

The Save River Basin accounts for 21% of all cultivated land in the Commercial Farming Areas in Zimbabwe.

The catchment provides water to production of strategic crops such as sugar cane for ethanol production to save on fuel imports, cotton, tobacco and soya for generation of foreign exchange and wheat for import substitution. All these products play a vital role in the national economy. Since continued production of these crops is dependent on the availability of irrigation water there is an obvious link between the national economy and a sustainable water management system.

It is government policy to promote irrigation development in order to increase food security in drought prone areas, increase incomes of rural farmers and generate rural employment. In 1984 53 schemes were in operation nationwide in Communal Land Areas /5/. The exact number of schemes in the Save River Basin is not known, but a high proportion them are located in this catchment.

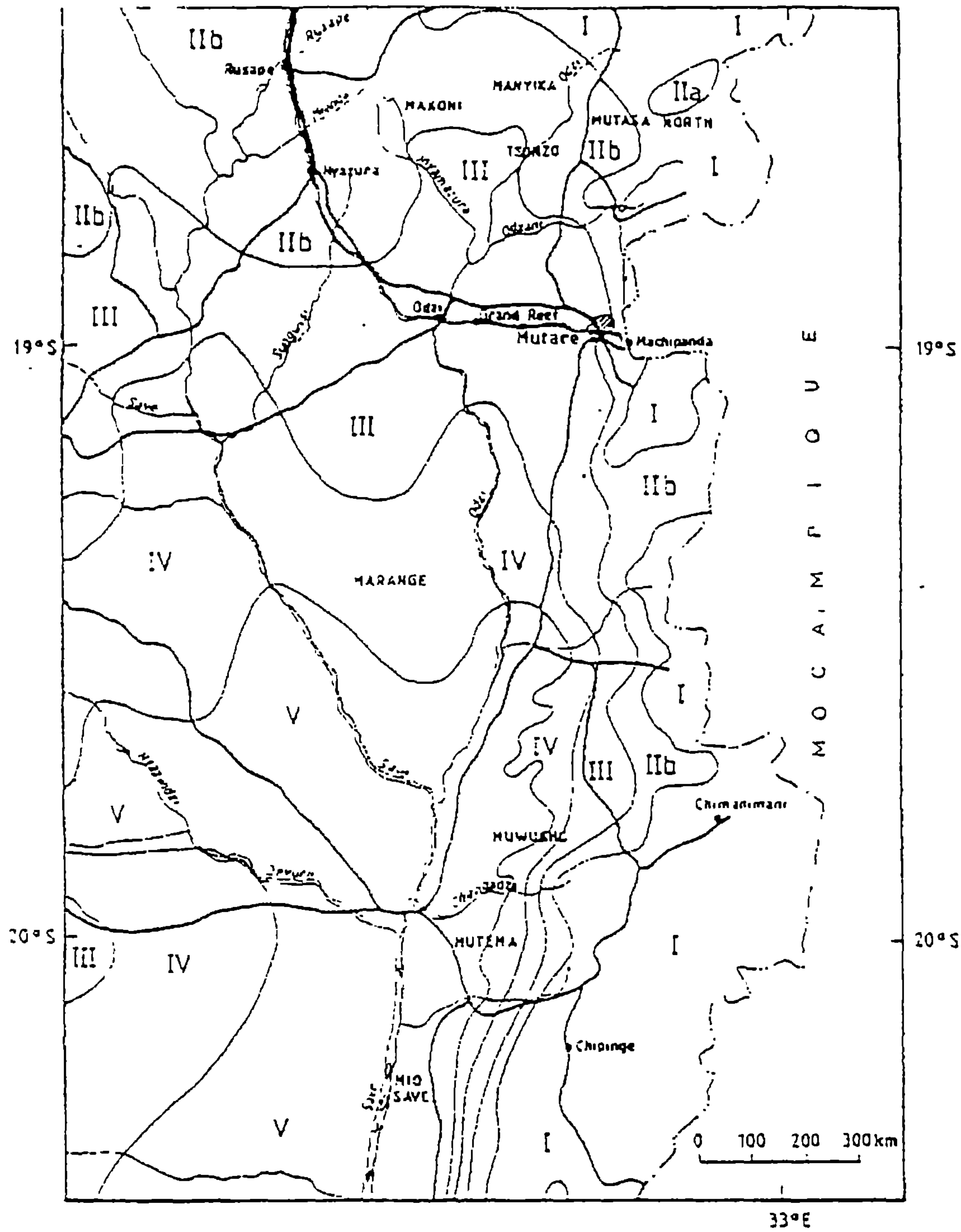
The provincial capital of Masvingo is located in the centre of the River Basin while the three others Marondera(Mashonaland East), Gweru(Midlands) and Mutare(Manicaland) are located in the outskirts of the Basin.

2.4 Hydrology and Natural Regions

The rainfall pattern in the Basin is well documented with a total of 381 rainfall stations in the Save River Catchment and 291 stations in the Runde River Catchment out of which 123 and 104 respectively have a minimum of 30 years of records. For statistical purposes the Save River Catchment is divided into 19 hydrological zones and the Runde River Catchment into 21 zones.

The mean annual rainfall for the Save River Catchment is 648 mm and for the Runde River Catchment 699 mm /6/. The annual rainfall varies from more than 1200 mm in the North and Eastern part of the basin to less than 500 mm in the South. The rainy period is from October to April. Zimbabwe is divided into 5 different Natural Regions based on the rainfall pattern. Although the overall rainfall pattern is as described above there are a lot of variations with a limited area. This is shown on the map of Natural Regions in the mid and upper reaches of the Save River Catchment in Figure 4. This variation indicates that the challenges in local water management will vary within a limited area. Natural Region I should have plenty of water in the rainy season and the challenge will be to store the water for use in dry season. Natural Region V will in some instances, have too little water even in the rainy season and will be dependent on the construction of storage reservoirs in the upper basin to secure perennial delivery of water to cover downstream agriculture water demands.

The map in Figure 4 also indicates that the problems related to environmental degradation will vary even within a limited area due to differences in Natural Regions. As mentioned earlier, it is therefore important that operational guidelines on sustainable natural resource management are adapted to the different problem situations. It has for example in some areas been recommended that a protected zone of 30 meters distance from the river should be defined where gardens are not allowed, in other areas it has been recommended that this zone should be 2000 meters /8/. If the latter zone should be chosen throughout the River Basin this will have significant implications on the agriculture production and again on the supply of food for the people. This example should show the importance of combining results from research projects with the development of operational guidelines for natural resource management.



I. Specialised and diversified farming region.
Annual rainfall > 1000 mm.

II.A Intensive farming region.
Annual rainfall (750-1000) mm. Intensive rain.

II.B Intensive farming sub-region.
Annual rainfall (750-1000) mm.

III Semi-Intensive farming region.
Annual rainfall (650-800) mm.

IV Semi Intensive farming region.
Annual rainfall (450 -650) mm.

V Extensive farming region < 600 mm.

Figure 4. Natural Regions in the mid and upper parts of the Save River Catchment /7/.

3. USE AND DEMAND FOR WATER

3.1 Dam construction.

Only a small fraction, less than 10 % of the rainfall described in chapter 2.4, appears as flow in the river system. The rest being lost to evaporation, evapotranspiration or to replenishment of underground water. The variation in annual run-off is even greater than the variation in rainfall, with means varying from 300 mm in the upper reaches to less than 4 mm per annum in the lower reaches.

Calculations in the Guideline for Development Planning on the availability of water resources in the Save River Basin /9/ show a total mean annual run-off (MAR) of 5954 mill. m^3. The potential yield has been calculated at 3451 mill m^3 and the present use to 1248 mill. which is equivalent to 36 %. It is therefore concluded that there is a potential for construction of new reservoirs in the basin.

The Save River Development Plan presented in 1982 recommended that development planning should aim at securing 80 % of the maximum potential basin yield /10/. The required storage to meet this recommendation was calculated at 6660 mill. m^3. If the plan is implemented the water yield is proposed to be utilised as follows:

1.	Existing water rights	23 %
2.	Increase in primary use	2 %
3.	Reservation 10 % of MAR	9 %
4.	National urban, industrial, and mining	6 %
5.	National agriculture	59 %
	Totalt	100 %

The three first mentioned categories take priority above categories 4 and 5. Considering this proposal, it is obvious that the major trust of development will be in the agriculture sector. Although the need to pass some flow to Mozambique has been mentioned in the Guideline for Development Planning no figure has been given. This is because no consultation has taken place between the two countries on this issue.

Different studies have been carried out to identify possible new dam sites for storage reservoirs. The following new dam sites have been prioritised for construction:

- Osborne Dam (Under construction)
- Chitowe Dam
- Condo Dam

The location of the dams are shown in Figure 5.

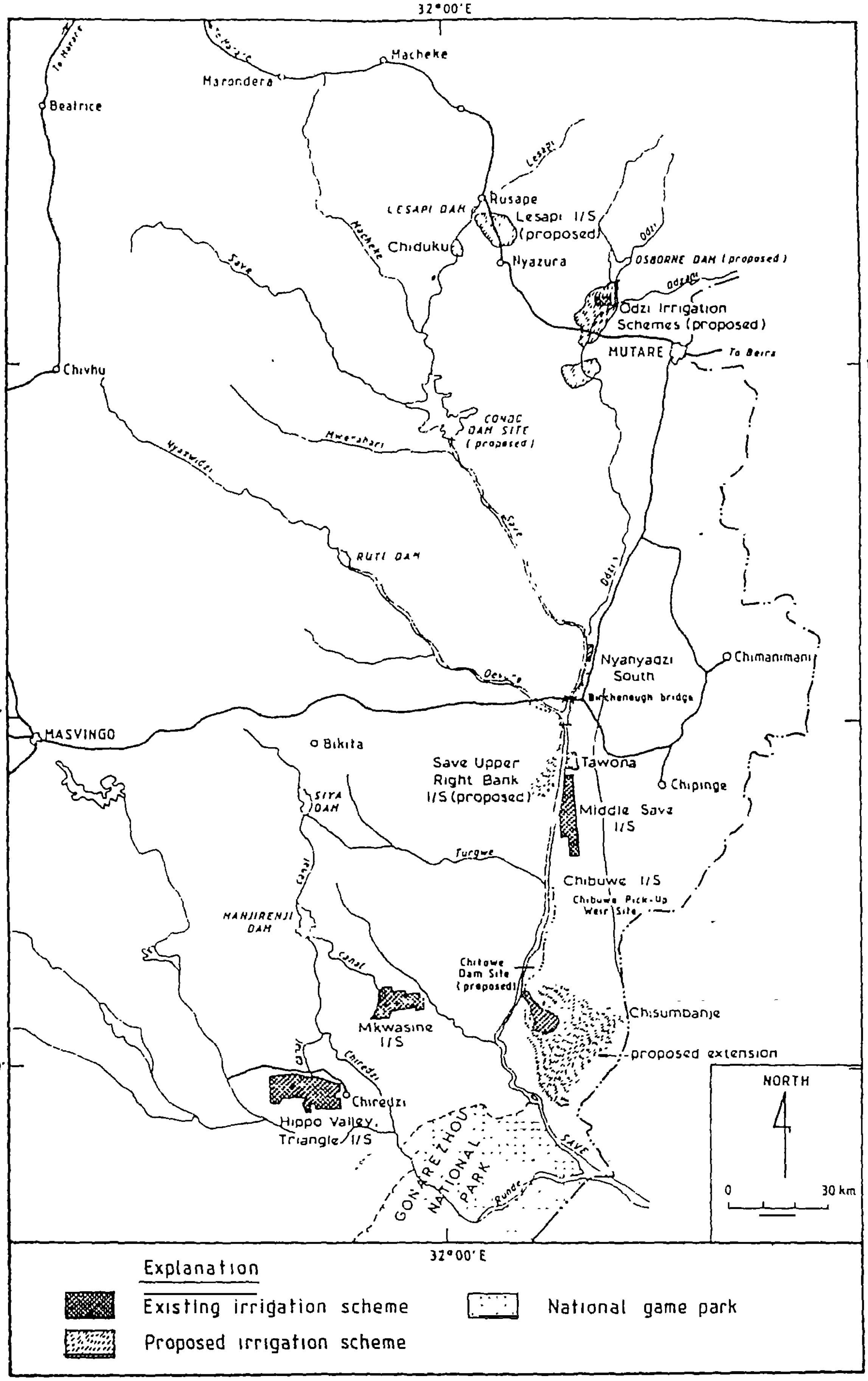


Figure 5. Map of dam sites and irrigation schemes in the Save River Basin /7/.

The Osborne Dam with a capacity of 400 mill. m^3 is under construction and will inundate some 2900 ha of land where more than 50 % of the area is classified as good arable land mainly located in Communal Land Areas (CLA) and Small Scale Commercial Farming Areas (CFA). People living in this area will have to be resettled in the neighboring area. It is a feeling among the people that the resettlement is going to fragment their communities and there has been some opposition against the project /7/.

The availability of a guaranteed supply of water throughout the year is likely to result in more intensive cropping patterns among the resettled people. Emphasis is expected to be placed on staple crops rather than drought tolerant sorghum and millet. A number of small and big irrigation schemes downstream from the reservoir will benefit from construction of the dam.

According to the project documents most of the irrigation water will be allocated to CFA. The following allocation is proposed /7/:

CFA (Large scale)	6236 ha
CLA (Small scale)	1519 ha
Chisumbanje Estate(Full irrigation)	2500 ha
Total Area Full Irrigation	10225 ha

In addition, the area for irrigation of supplementary winter crops is estimated at 6400 ha.

A pilot study on an Environmental Impact Assessment of the Osborne Dam lists important social, ecological, agricultural and economic impacts of the project which would not have been identified if the project had just followed the recommendations specified in the Water Act/7/. It is therefore recommended in the pilot study that legislation on EIA should be prepared, requiring among other things large scale water development projects to undergo EIA at the earliest possible stage in the project planning cycle. Preparation of an EIA will allow affected communities to participate in the planning process and give them the opportunity to make comments to proposal at an early stage.

Soil erosion which ultimately results in siltation of dams is a major problem in the River Basin. The rate of erosion or land depletion is a function of the soil type, the degree of cover and conservation, and the volume and intensity of rainfall. The population density is probably the most important factor and this is clearly demonstrated in the available data on soil loss from CLA and CFA. The average rates of soil loss have been estimated as follows /11/:

Grazing lands	
- CFA	3 tones/ha/year
- CLA	75 tones/ha/year
Cultivated lands	
- CFA	15 tones/ha/year
- CLA	50 tones/ha/year

The data for CLA areas are alarmingly high and it is interesting to note that a study on the sedimentation and yield of small dams concludes that soil erosion is actually far more detrimental as a loss of land resources than as a loss of water resources through reduced storage capacity /12/. The study concludes further that the loss of dam storage due to sedimentation should be taken into account by dam designers. Emphasis should particularly be put on situations where small dams are constructed on large catchments. In such cases it is recommended that the ratio between the dam capacity and the mean annual run-off should never be less than 0.10.

3.2 Water for irrigation

Water for irrigation has traditionally followed the concept of maximising yields per hectare. This approach implicitly presupposes that water is more freely available than irrigable land, and irrigation scheduling is directed at supplying the crops with the full amount of water required at any stage of growth to achieve maximum yield. A change has taken place in this approach. In the present approach water is considered to be a scarce commodity as opposed to land, and planning of irrigation schemes is aiming at achieving maximum crop yield per unit of water rather than per unit of land.

There is a growing demand for irrigation water in the Save River Basin, from fairly small schemes operated in the Communal Land Areas (CLA) and Resettlement Areas (RA) to large schemes operated in Commercial Farming Areas(CFA) and estates at the Middle Save and Chisumbanje. See Figure 5. Development of irrigation schemes in these areas is dependent on a perennial river flow which can only be achieved by construction of new reservoirs.

Data are not available to give a full picture of existing or planned irrigation schemes in the Basin as a whole. This implies that it is difficult to give exact figures for the use and demand for irrigation water. There is, however, a difference in scale between use and demand for irrigation water in CLA and in CFA. In order to show this difference data on irrigation in CLA and RA in Manicaland Province will be presented together with data on irrigation in CFA in Masvingo.

Irrigation in CLA in Manicaland

Irrigation was introduced in Manicaland by missionaries as early as 1908. In the initial period up to 1935 the government provided technical and material assistance to the schemes, but the farmers retained control. As from 1935 the government took over the control of the schemes and introduced restrictive regulations on the operation. In the 1950s and the 1960s an economic viability criterion was introduced in the assessment of new irrigation schemes. This resulted in a reduction of new schemes. The present government policy emphasises the reduction of irrigation subsidies and increased farmer participation in design, financing and management of the scheme /13/.

Manicaland has eleven existing irrigation schemes in CLA and RA. Except for one, they are all located in Natural Region IV and V. The justification for construction and distribution of the schemes has been food security in drought prone areas. Six of the schemes are gravity-fed and five are based on a pumping system. Only one scheme is under sprinkler irrigation. The others are based on surface irrigation.

The total irrigated area is approximately 2500 ha and the average plot size is 0.7 hectare which is a much higher than the plots in Masvingo and Mashonaland Provinces where the average size is less than 0.2 ha. Recent feasibility studies indicate that a plot area of 0.5 ha is the optimum in terms of family labor input /13/. As far as crops are concerned maize is cultivated on 70 % of the area and cotton on 19 % in the summer season. In the winter season it is 70 % sugar beet and 14 % wheat.

The schemes are designed to produce at least two crops per annum and a maximum of three crops per annum for very good farmers. The annual cropping intensity is 179 % which means that not all schemes are cultivated twice a year. Due to low availability of fertilizers and chemicals and various problems related to operation, the productivity on communal irrigation schemes is said to be rather low /13/. A detailed study carried out on the Nyanyadzi scheme, which is the second biggest in Manicaland, concludes that the efficiency of using irrigation water should be improved. This can be done by improved scheme management and better utilisation of the water by the farmers /14/.

As far as new schemes are concerned 11 have been identified in CLA covering a total area of 2303 ha. Some of these schemes can be implemented when the Osborne dam is completed. Others will require investments in new dams and expensive pumping and conveyance systems. A similar number of schemes have been identified in RA covering a total of 572 ha. A third group of schemes are planned to be implemented by NGOs. The number is approximately 20. They are all small in size, in the range of 2 to 30 ha and with a total area of 183 ha.

The potential area for development of new irrigation schemes totals 3000 ha. The development of these schemes is of course dependent on the economic viability of each scheme. Assuming that they are all economically viable, it can be concluded that the demand for water in CLA and RA in Manicaland is double the present use of irrigation water.

Irrigation in CFA in Masvingo and Manicaland
A Regional Water Authority (RWA) has been established to operate and maintain the dams in their area and to sell water to whoever requires it. Water consumers are commercial farmers, estates, private companies and communal farmers located in the lower part of the Basin. The RWA is responsible for operation and maintenance of 5 dams which are shown on Figure 5: Lake Kyle, Bangala Dam, Turgwe-Siya Dam, Manjirenji Dam, and Esquillingwe Weir. The administrative structure of the RWA is shown on Figure 13. The total supply capacity is 1890 mill m^3. In close cooperation with the Ministry of Energy, Water Resources and Development the RWA is also involved in the release of water from Lesapi and Ruti Dam in the upper reaches of the Save River Catchment.

The supply system is divided into 3 branches. The major consumers are shown on Figure 6 and include Triangle Limited, Hippo Valley Estates, Overseas Ranchers, South Eastern Development Company Limited, Chisumbanje Development Company Limited, and Middle Save Development Company Limited. The total irrigated land is estimated at 170.000 ha (exclusive of Triangle Limited) and the total cultivated area is approximately 1.1 mill ha /15/.

The purpose of recording these figures is to indicate the difference in scale between irrigation in CLA and CFA. The irrigation area in CLA in Manicaland is 1-2 % of the irrigation area in CFA in Masvingo and Manicaland. It is therefore easy to conclude that development of new large dam projects is dependent on the economic viability of irrigation projects in CFA. This does not mean that small scale irrigation schemes in CLA will benefit from such projects. Whether development of new irrigation projects in CLA will be conditioned on economic viability or will continue to be subsidised by the Government to improve food production is, however, difficult to say.

3.3 Domestic water supply

Domestic water supply in rural areas is mainly provided from groundwater resources using standard technology of boreholes, blasted wells and shallow wells. The water points are fitted with locally manufactured handpumps. There are approximately 200 piped schemes serving rural areas, rather few are located in the Save River Basin.

The ongoing National Rural Water Supply and Sanitation Programme is aiming at providing people in CLA and RA with safe water from a primary water supply (boreholes and wells) by Year 2000. The target set within the National Programme is to provide the total population with a required amount of safe water within a reasonable walking distance. The target is 100 % coverage which is achieved when the total population in a ward is served with water from a primary water supply (a borehole can serve 250 people, a deep well 150 people and a shallow well 50 people). As far as sanitation is concerned the target is 50% which is equivalent to one ventilated pit latrine for every second household. A decentralised planning framework has been developed based on a concept where provision of water supply and sanitation is integrated with health and hygiene education.

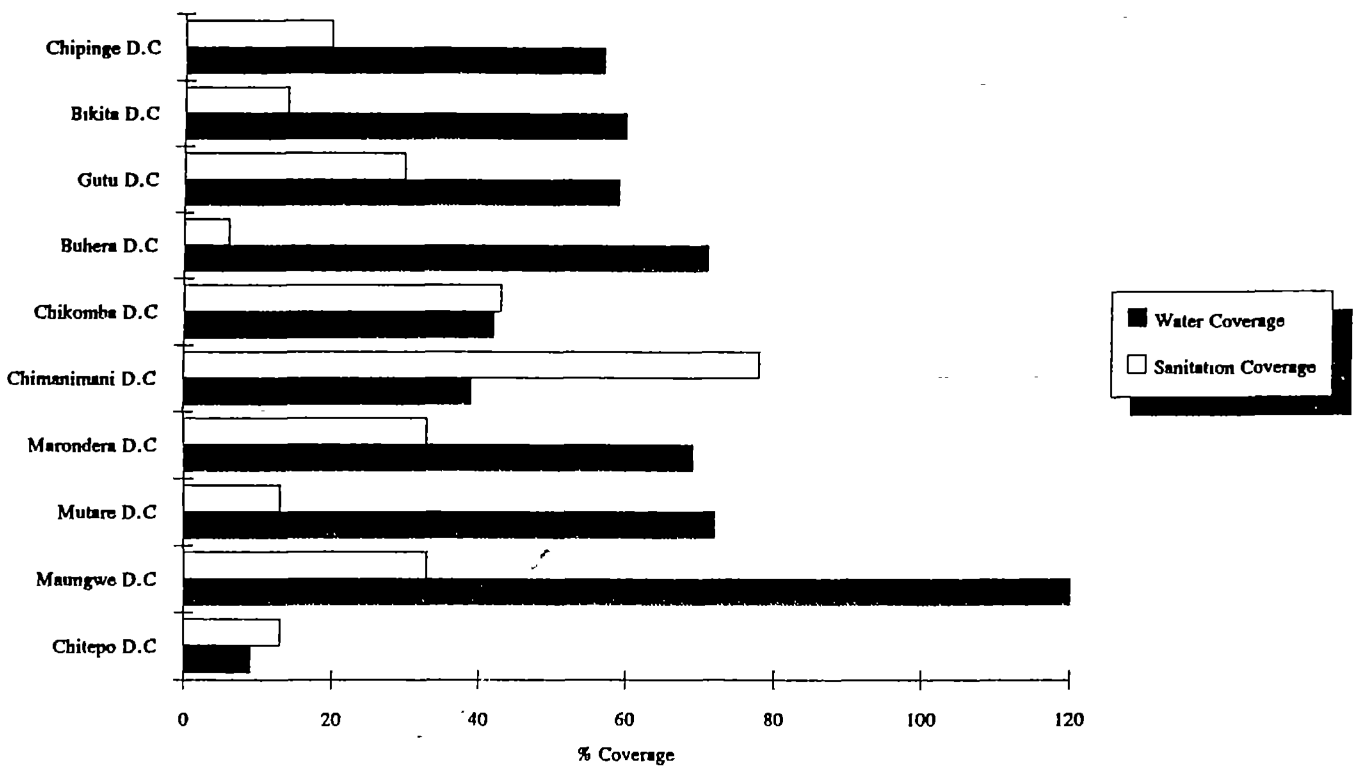


Figure 6. Coverage of water supply and sanitation in the Save River Catchment /16/.

Figure 6 and 7 show the coverage of water supply and sanitation in CLA in the respective river catchments. Integrated Rural Water Supply and Sanitation projects under the national programme are ongoing in 6 districts in the Save Catchment and 5 districts in the Runde Catchment.

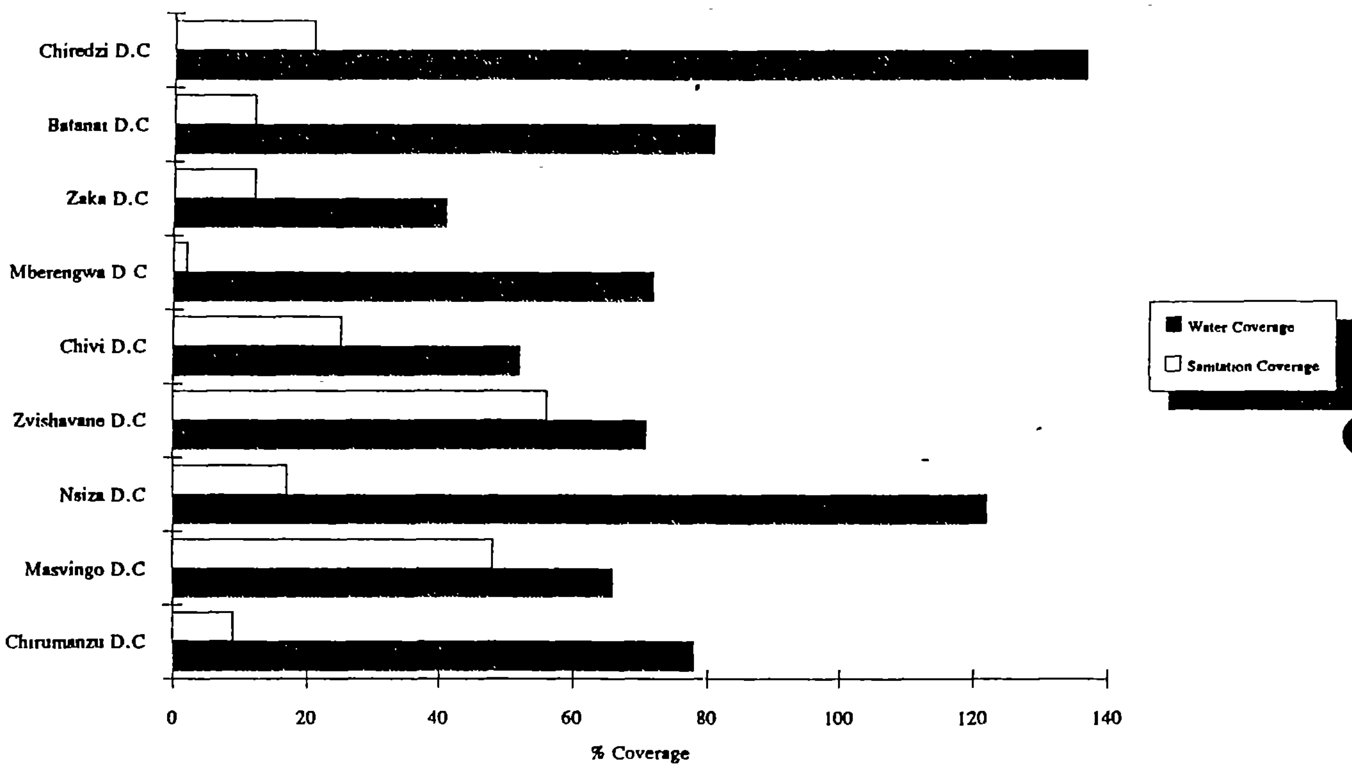


Figure 7. Coverage of water supply and sanitation in the Runde River Catchment /16/.

The construction of new piped schemes have so far been abandoned within the National Programme. This is partly because piped schemes are much more expensive than primary water supplies and because a policy on the recovery of development costs as well as operation and maintenance costs needs to be developed. As long as provision of domestic water supply in rural areas is based on primary water supply technology there should not be any serious conflicts with the other water users.

3.4 Watershed management

The Save River Rehabilitation Action Plan prepared by Department of Natural Resources in the Ministry of Environment and Tourism lists the following problems related to watershed management in CLA /19/:

- High human and livestock population
- Major erosion problems in grazing lands
- Arable land being cultivated without adequate erosion control measures
- Problems of deforestation leading to accelerated erosion
- High prevalence of streambank cultivation
- Land husbandry techniques practiced by the majority of the communal farmers are inadequate
- Many human settlements are poorly planned
- Lack of an integrated resource planning concept.

Although most of these problems result in a badly silted river, it is important to realise that this is only a symptom of the real problem which lies in the imbalance of the relationship between the demand for and the availability of land resources. Furthermore, the land husbandry techniques practiced by the majority of the communal farmers are not in line with conservation strategies aiming at a sustainable development in the CLA.

This is documented in a study carried out in Natural Region III and IV in Buhera District in the upper reaches of the Basin /20/. The study elaborates on the relationship between environmental degradation and the basic needs satisfaction in two different tenure systems. One is in a CLA and the other in a Small Scale Farming Area (SSFA) where black people have been allowed to purchase and own the land individually.

Many differences have been observed with respect to the satisfaction of food and health needs. In the CLA, health and food needs satisfaction is at a very low level; with a high prevalence of undernutrition and diarrhoea among the children. Although the SSFA is just some few kilometres away from the CLA, the households have a much higher degree of needs satisfaction and the food intake in the SSFA is much better than in the CLA.

Despite negligible soil and rainfall differences the production of grain crops in the SSFA has been estimated at over ten times higher than in the CLA. No other variable differs by such an order of magnitude in the two tenure systems. The higher crop production in SSFA is therefore considered to be the major reason for a higher need satisfaction in this area.

Crop production at a household level is dependent on two variables: area planted and yields achieved. The area planted per household is 3 times greater in the SSFA and the average yearly yield is 3.5 times higher than the yield in the CLA. The CLA seems not to be short of land for crop production. The constraint seems to be on the availability of manure, which is linked to the number of draught animals and again the availability of grazing land. Grazing land in CLA would be insufficient even if the grass resources were more carefully managed.

The SSFA farmers have larger herds and hence more manure for soil fertilization. They have also better access to a range of agriculture equipment which helps to increase the productivity.

As far as environmental variables are concerned, the CLA has a more severe degradation of the soil, woodland and grazing resources. Grazing lands are in shorter supply and there are large areas of unproductive, cleared land and the cropland is limited. Environmental degradation is in the form of deforestation, overgrazing, loss of soil fertility, erosion, siltation and changing of hydrological conditions. The effect of environmental degradation on food and health needs satisfactions is shown in Figure 8 .

Environmental trend	Direct and indirect effects
Overgrazing	Low livestock productivity Removal of grass leads to erosion
Deforestation	Lack of wood products
Loss in soil fertility	Decrease in yields Abandonment of land,new land opened often on marginal land Leads to deforestation and erosion
Erosion	Decrease in productive capacity of the soil leads to siltation
Siltation	Effect on long-term viability of irrigation schemes
Hydrological changes	Decrease in surface water supplies Increased downstream erosion

Figure 8. The effects of environmental degradation in CLA /20/.

The Figure 8 shows that environmental degradation has many consequences for needs satisfaction. However, this does not mean that the present low level needs satisfaction result from environmental degradation. The present situation goes back to the division of Zimbabwe along racial lines where the most productive areas were reserved for white farmers and the black farmers were forced to live on less productive areas in CLA. An important explanatory factor to the observed difference between the CLA and the SSFA is the population density which is 29 and 16 per km^2 respectively.

In addition to differences in environmental variables it has been observed that the SSFA has a much better level of service with regard to roads, schools , cattle-dips, markets, credit facilities and extension staff than the CLA.

The conclusion on this subject is that although differences in yield between the two tenure systems are partly related to the availability of the land, including insufficient manure, differences in yields are probably more determined by the infrastructure/services components such as markets, agriculture extension, and availability of fertilizer.

Another conclusion is that the environmental degradation is more serious in the CLA and that the needs satisfaction is at a very low level. If serious actions are not taken the prognosis for a sustainable development of the CLA is not too optimistic.

The study in Buhera District seems to indicate that the concept of watershed management in the Save River Basin has to be considered in a broader scope. There seems to be need for a Natural Resource Management Strategy for the Basin based on the integration of land resources and watershed management. The long term solution to the problem is to reduce the population pressure in CLA and allocate more land for black farmers in CFA. The short term solution will be to strengthen government efforts in further development of CLA with emphasis on infrastructure and access to markets. Another short term solution will be to strengthen the agriculture extension institutions and to improve agriculture husbandry techniques through a massive mobilization campaign among communal farmers. The latter solution is a permanent task which can not be undertaken within the scope of a limited project period. The building of institutions to perform these duties on a permanent basis will therefore be very critical.

The fact that the situation in SSFA is much better than in CLA should be considered positively. The lesson to be learnt is that sustainable development is also possible in CLA if the proposed solutions can be implemented.

3.5 Industrial water

In order to address the shortage of paper in Zimbabwe, only 75 % of the demand is met, a proposal has been tabled where by the Zimbabwe Pulp and Paper Limited to locate a pulp and paper industry downstream of the Osborne Dam. The total investment is estimated at Z$ 540 mill. in 1988.[3] This project has been ranked as the biggest industrial investment ever made in Zimbabwe. Although the return on the investment has in several feasibility studies turned out to be rather modest, the Government has decided to implement the project on the condition that financial resources can be made available from abroad /7/.

The demand for water is estimated at 6 mill m^3 per annum. Implementation of the project is conditional on a minimum flow of 1 m^3/s in the Odzi River downstream the dam. In order to be able to manage unpredictable situations of such as long term drought and break-downs in the biological waste water treatment plant, an alternative effluent system based on irrigation of pasture lands has been recommended. A total land area of 400-600 ha is required for this purpose.

The final decision concerning the production technology has not yet been made. Accurate environmental control costs are therefore not available, but estimates have been made in the order of 6-9 % of the total investment which is equivalent to Z$ 32 to 48 mill.

Construction of a pulp and paper mill will have environmental impacts beyond water effluent problems which are regulated in the Water Act. Other aspects which will have to be considered will be the availability of sufficient supply of wood, the air pollution and noise from the factory, and finally areas for waste disposal. All these aspects have been considered in a pilot EIA-study of this project and the conclusion which is drawn is the need for separate legislation with EIA requirements for certain projects /7/.

[3] 1Z$= 0,555 US$ (Average in 1988)

4. CONFLICTS BETWEEN WATER USE

Existing water rights in the River Basin cover only 22 % of the potential yield available subject to construction of new reservoirs. Even with a 10 % reservation of the yield for unforseen situations there is according to the Water Development Plan a potential of 59 % of the yield for future irrigation water. The constraint seems therefore not to be on the availability of water, but rather on the availability of financial resources and the economic viability of proposed projects to develop the Basin area further.

Potential conflicts between water use in further development of the area can in brief be summarized as follows:

1. Effects of environmental degradation on food and health need satisfaction
Low levels of need satisfaction mainly result from high population density in Communal Land Areas which again is caused by the division of the country along racial lines. It is crucial to find measures which can stop the degradation process caused by overpopulation. If not, will the non-satisfaction of needs leads to further environmental degradation which again will lead to further non-satisfaction of needs, and so on.

2. Allocation of irrigation water to CLA or to CFA
Considering the difference in size, the difference in objectives, and the difference in economic viability between irrigation schemes in the commercial and the communal sector there might be a conflict of interest if the government has to prioritise investments in the two areas. This is because investment in the commercial sector aims at improving the national economy while investment in the communal sector aims at food security and the standard of living for the poor people. In order to achieve the latter aim it might be that the Government will have to subsidise capital costs of new irrigation schemes.

3. Water pollution caused by the Pulp and Paper Mill
A serious drought situation in the Osborne dam area can make it difficult to secure the required minimum flow of water at the location of the proposed pulp and paper mill and break-downs in the waste water treatment plant may result in effluent discharges which can not comply with effluent permits. If any of these situations should occur it will cause a pollution problem which will be in conflict with downstream users.

4. Siltation of dams caused by land degradation
If measures are not taken to reduce land degradation in CLA, this will have serious implications for the economic viability of new dam projects. The proposed new dam sites are in areas where the siltation is higher than in the upper reaches of the Basin where the present dam project is under construction.

5. Allocation of water to Mozambique
The Save River Basin is part of an international river system. There exists no forum between Zimbabwe and Mozambique where utilization of the water resources are discussed. If new water projects should be initiated on the Zimbabwean side without proper consultation with Mozambique, this might cause conflicts.

5. WATER MANAGEMENT SYSTEM

5.1 Political/administrative structure

The 1984 Prime Minister's Directive outlines the nature and powers of the political/administrative structures as shown in Figure 9.

In Communal Land Areas (CLA) the organ for development at village level is the Village Development Committee (VIDCO) which comprises about 100 households and represents a population of about 1000 people. The responsibility of the VIDCOs are:

- identifying and articulating village needs
- coordinating and forwarding village needs and proposals to the Ward Development Committee
- coordinating and cooperating with government extension workers in development projects and planning.
- production of land use plans.

The ward is the second tier of the hierarchy and is represented by a Councillor. The ward is designed to cater for approximately 6 villages. The task is to coordinate the needs expressed by the village and proposed plans and project ideas. The Ward Development Committee (WADCO) is called by the Councillor when required.

The third tier of the administrative structure is the District Council which is a democratically elected authority. The Council is according to the legislation the principal planning and development agency in their jurisdictional zones which is CLA. Each council has its own executive authority for which it has direct control. A District Administrator is the chief executive officer employed by the Ministry of Local Government, Rural and Urban Development. He/she is responsible for the overall planning, development and coordination of inputs from sector ministries. As chairperson of the District Development Committee, composed of all district heads of ministries and departments, he/she is tasked to formulate long- and short-term development plans and to coordinate efforts of ministries, departments and agencies operating in the district.

In Commercial Farming Areas (CFA) there exists a similar structure of the third tier called Rural Council. The Government is, however, in the process of amalgamating Rural and District Councils into Rural/District Councils. The purpose is to create a unified local government system where the inherited dual structure of councils is eliminated. Amalgamation creates immediate problems in terms of defining what needs to be achieved and how existing structures can be incorporated into the new structure. The outcome of this process will also have implications on the recommendations for Water Management in Zimbabwe. The recommendation in this paper is based on the assumption that the Rural and District Councils will be amalgamated in due course.

The political/administrative structure at district level is replicated at the provincial level. The Provincial Council consists of representatives from local authorities and the

Provincial Development Committee (PDC) consists of provincial heads of ministries and departments. Four Subcommittees are established under the PDC: Agriculture and Conservation, Housing and Employment, Infrastructure, and Social Development.

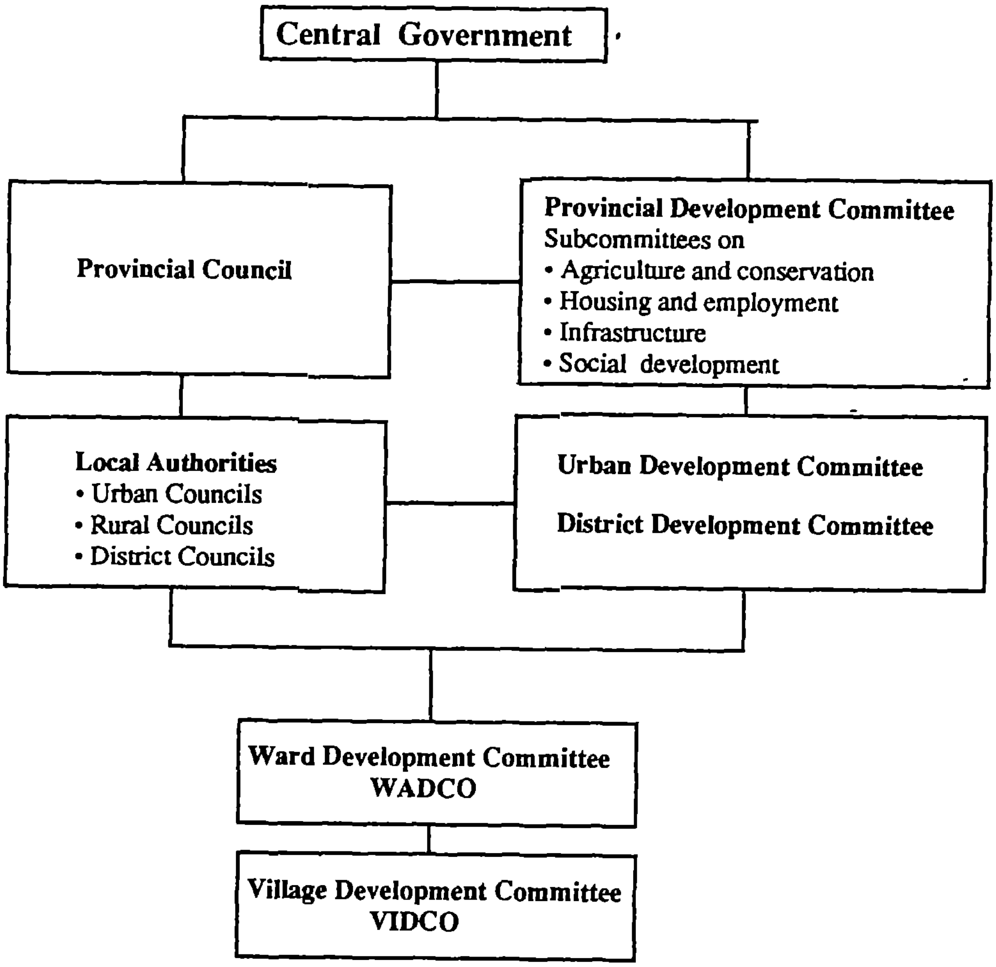


Figure 9. Political/administrative structure /3/.

An observation is that the Development Committees at both district and provincial level are dominated by government staff and that local authority staff have little influence on development priorities presented to the different Councils. The delegation of responsibilities for operation, maintenance and control of completed facilities to rural local authorities is also very limited. Another observation is that non of the permanent subcommittees are explicitly tasked with the long term management of the natural resources. The Ministry of Environment and Tourism is, however, in the process of setting up such a committee under the District Council.

5.2 Institutional responsibilities

In order to present the institutional responsibilities in water management, the various management activities have been divided into the following 7 groups:

- Dam construction
- Irrigation
- Domestic water supply
- Industrial water
- Watershed conservation
- Monitoring of water quality and quantity
- Control of water rights
- Other related issues

In Figure 10 and 11 below the institutional responsibilities are presented with a distinction made between planning and implementation and operational activities.

The Ministry of Energy and Water Resources and Development (MEWRD)

MEWRD is responsible for the overall planning, management and development of the water resources. This agency is also responsible for surveys, data collection and drilling of boreholes. Collection of water quantity data seems to be well organised, but a monitoring system for water quality data is missing. The same applies to data on erosion. As shown in Figure 12 MEWRD is decentralised to 5 provincial offices, but has no representation at the district level. The authority of the MEWRD is outlined in the Water Act which specifies procedures to follow for obtaining water rights and effluent discharge permits.

INSTITUTIONAL RESPONSIBILITIES IN PLANNING AND IMPLEMENTATION OF WATER RESOURCES PROJECTS

ACTIVITIES	MEWRD	RWA	AGRITEX	MLGRUD	DDF	MET	MOH	CCD/MP	RDC	NGOs
Dam Construction	Design and construction of big dams				Design and const. of small dams < 8 m					
Irrigation	Provision of water for irrigation		Planning and implementation of irrigation schemes in CLA	Assist in project identification and planning	Construction of irrigation schemes			Community mobilisation		
Dom. water supply-rural	Borehole drilling		Land use planning	Coordination of project planning and implementation	Borehole drilling and wellsinking		Wellsinking and health and hygiene education	Community mobilisation	Project planning and implementation	Wellsinking and borehole drilling
Dom. water supply-small tow	Construction of piped schemes			Coordination of project planning and implementation				Community mobilisation		
Industrial water	Design and construction of schemes			Coordination of project planning						
Watershed Conservation			Land use planning and measures against land degradations	Assist in project implementation		Programme planning and implementation		Community mobilisation	Project planning and implementation	Assist in project identification and implementation
Other related (Campfire)						Programme planning and implementation		Community mobilisation	Project planning and implementation	Assist in project identification and implementation

Abbreviations

MEWRD	Ministry of Energy and Water Resources and Development
RWA	Regional Water Authority
AGRITEX	Agricultural Technical & Extension Services
MLGRUD	Ministry of Local Government, Rural and Urban Development
DDF	District Development Fund
MET	Ministry of Environment & Tourism
MOH	Ministry of Health
MPA	Ministry of Political Affairs
MCCD	Ministry of Community and Cooperative Development
RDC	Rural/District Councils
NGOs	Non Governmental Organisations
CFA	Commercial Farming Areas
CLA	Communal Land Areas

Figure 10. Institutional responsibilities in planning and implementation of water projects.

INSTITUTIONAL RESPONSIBILITIES IN OPERATION OF WATER FACILITIES AND MONITORING AND CONTROL

ACTIVITIES	MEWRD/RB	RWA	AGRITEX	MLGRUD	DDF	MET	MOH	MCCD/MPA	RDC	NGOs
Dams	Operation and maintenance of big dams	Operation and maintenance of large dams and canals			Operation and maintenance of small dams					
Irrigation schemes		Provision of water for irrigation	Assist in operation of irrigation schemes in CLA							
Dom. water supply - rural				Develop system for recovery of operation and maintenance costs	Operation of primary water supplies		Health and and hygiene education	Community mobilisation		
Dom. water sup. - small tow	Operation of piped schemes Recovery of O&M costs.			Develop system for recovery of operation and maintenance costs	Operation of piped schemes			Community mobilisation	Operation of piped schemes	
Industrial water	Operation of piped schemes									
Watershed Conservation			Assist in watershed conservation			Coordinate watershed conservation programme		Community mobilisation	Implement watershed conservation projects	Assist in watershed conservation
Monitoring - water quantity	Collection of hydrological and hydrogeological data				Colection of hydrogeological data					
Monitoring - water quality	Poor sampling of quality data, water lab. under construction						Collection of some health related water qual. data			
Control of water rights	Controled by head office and delegated to River Boards						Collection of some health related water qual data			

Abbreviations

MEWRD — Ministry of Energy and Water Resources and Development
RWA — Regional Water Authority
AGRITEX — Agricultural Technical & Extension Services
MLGRUD — Ministry of Local Government, Rural and Urban Development
DDF — District Development Fund
MET — Ministry of Environment & Tourism
MOH — Ministry of Health
MPA — Ministry of Political Affairs
MCCD — Ministry of Community and Cooperative Development
RDC — Rural/District Councils
RB — River Boards
NGOs — Non Governmental Organisations
CFA — Commercial Farming Areas
CLA — Communal Land Areas

Figure 11. Institutional responsibilities in operation of water facilities and monitoring and control.

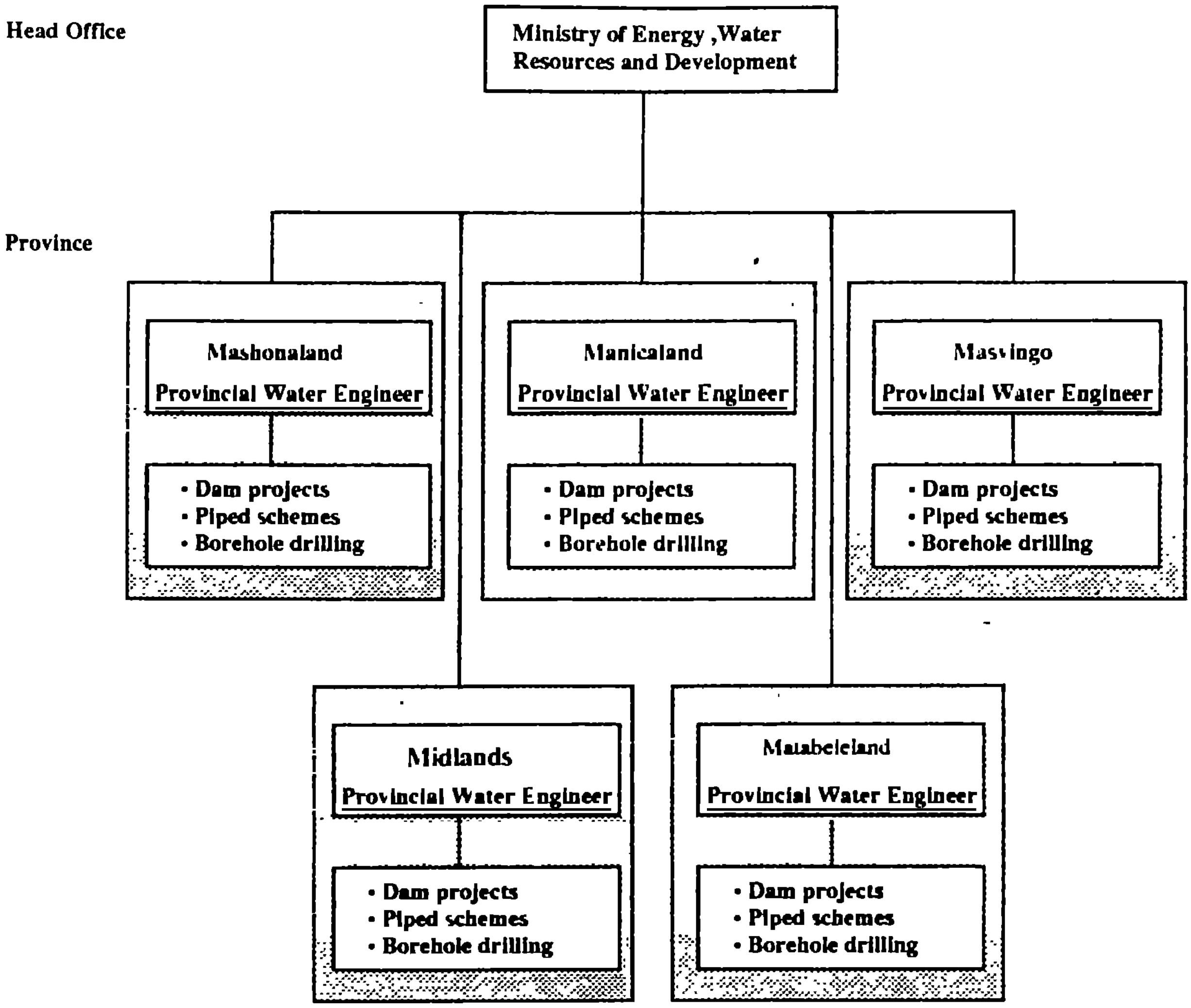


Figure 12. The administrative structure of the MEWRD.

The Water Act /21/ is based on a combination of the "appropriation" doctrine whereby water rights are allocated on a " first come first served" basis and the "riparian" doctrine, in which any riparian owner can enjoy an inherent right to use water for primary purposes, i.e. domestic and stock watering. These inherent rights take preference over other rights except in certain special circumstances such as water requirement for townships, railways and schemes of national importance. For any use other than the primary purposes, specific authority must be obtained from the Water Court.

The Water Act provides that plans should be prepared for development and utilisation of the Zimbabwe's surface water and that there should be public involvement in the planning process. Provisions are also made for the Minster of MEWRD to reserve water for future potential use, when for example the water is approaching the limit of the potential of its catchment area.

Pollution of water is prohibited according to the Water Act. Effluent waste water may not be discharged into any public stream or underground water unless it complies with prescribed quality standards or an exemption permit issued by the MEWRD.

The Regional Water Authority
The Regional Water Authority is a parastatal (government/private agency) under MEWRD with the function to exploit and conserve the water resources of the area with the objective of /22/:

1. Securing their proper use and effective development.
2. Providing, in both short and long term, adequate water supplies on the most economic basis.
3. Ensuring efficient distribution of water supplies in order that the economic development of the area may be promoted, facilitated and expedited in the national interest.

As mentioned in chapter 3.2 the RWA is divided into 3 branches. The administrative structure of the RWA is shown in Figure 13.

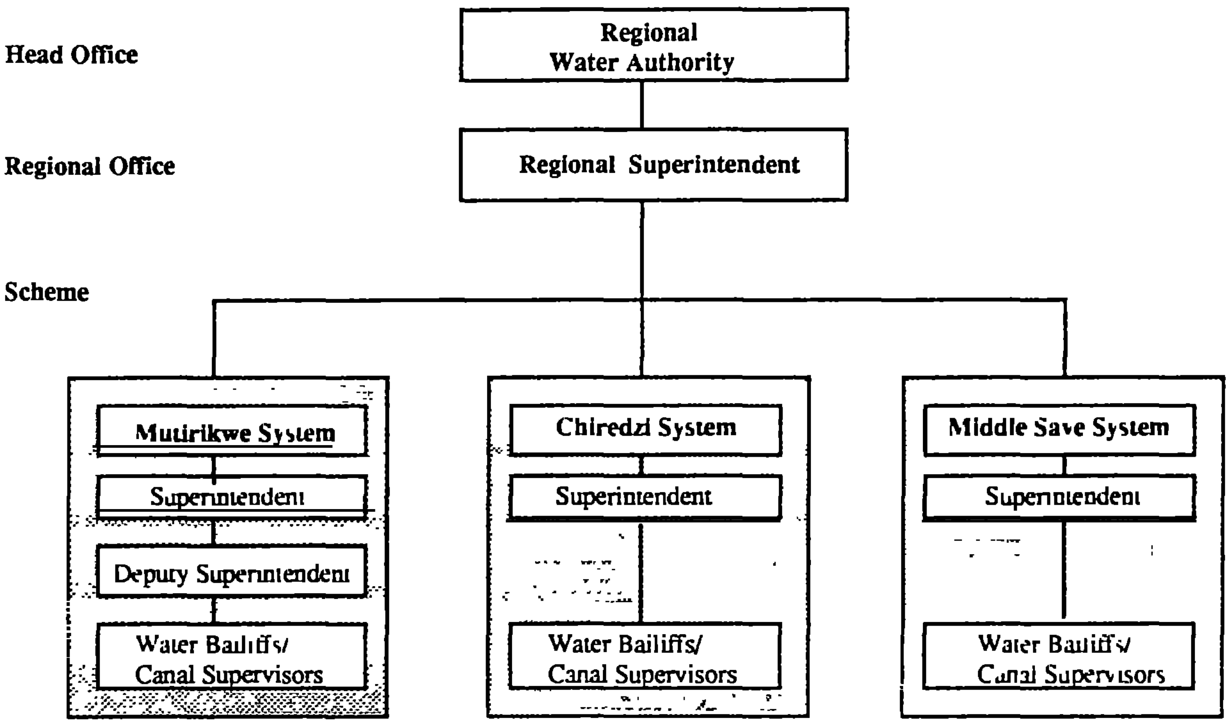


Figure 13. Administrative structure of the RWA.

River Boards (RB)
The MEWRD can according to the Water Act delegate responsibilities to control water rights and monitor instream flows for a specific area to River Boards. There are 5 River Boards in the Save River Basin all established in Commercial

Farming Areas, three are located on the Save Catchment(Ruzarwi, Middle Odzi and Chipinge) and two on the Runde Catchment (Umtebekwe, Hippo Valley). The River Boards get a small annual grant from the government and raise levies from water right holders to finance their activities. The River Boards report to the Secretary for MEWRD.

Agricultural Technical and Extension Services (AGRITEX)
The AGRITEX under the Ministry of Land Agriculture and Rural Resettlement is responsible for providing irrigated water to CLA and RA. AGRITEX is responsible for planning and implementation of schemes, but is also tasked with operation and maintenance responsibilities. The administrative linkage between the Irrigation Management Committee at the scheme level and AGRITEX head office is shown in Figure 14.

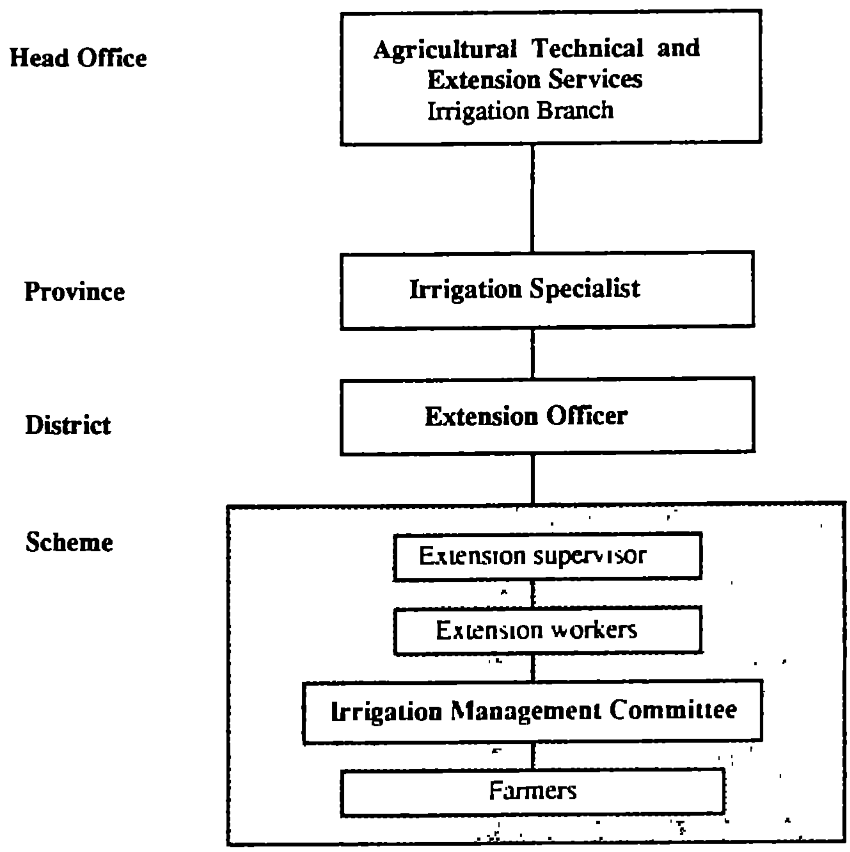


Figure 14. Administrative structure of an irrigation scheme in CLA.

Agricultural and Rural Development Authority (ARDA)
ARDA is a major parastatal under the Ministry of Land, Agriculture and Rural Development responsible for state farming enterprises in agriculture and livestock production. They are also tasked with planning and implementation to improve the standard of living for the rural population. Since ARDA is not playing a major role in the management of water in the Basin the institution is not mentioned in the tables in Figure 10 and 11.

The Ministry of Local Government, Rural and Urban Development (MLGRUD)
MLGRUD is tasked with the overall coordination of planning and implementation of projects which require input from various ministries and agencies. MLGRUD is playing this role in the provision of domestic water supply and sanitation in CLA and RA. As chairperson of the National Action Committee for Rural Water Supply and Sanitation (NAC) MLGRUD is coordinating inputs from 6 various agencies in implementing Integrated Rural Water Supply and Sanitation projects throughout the country. The NAC is replicated at the provincial and district level with informal Water Supply and Sanitation Subcommittees established under the Development Committees.

District Development Fund (DDF)
The DDF is part of MLGRUD and is together with MEWRD responsible for provision of primary water supplies to CLA and RA through its wellsinking and drilling projects implemented under the National Rural Water Supply and Sanitation Programme. The institution is decentralised to the provincial and district level. Responsibilities for project planning and implementation are delegated to the latter level.

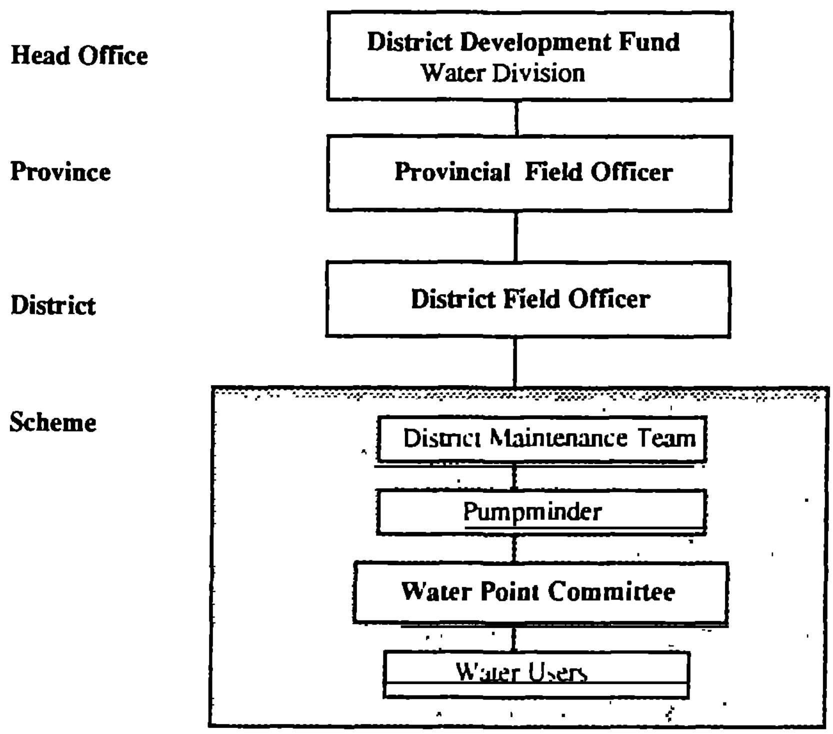


Figure 15. Operation and maintenance system for domestic water supply in CLA.

The DDF has set up a 3-tier system to carry out operation and maintenance duties on primary water supplies. The lowest tier consists of caretaker at the water point level who is responsible for the daily maintenance. At the second tier there is a pumpminder who is responsible for minding pumps within a cycling radius of 10 km. This implies that he/she will be responsible for 15 to 80 water points depending on the type and the density of water points. Both the caretaker and the pumpminder are selected among local community members. The third tier consists of a mobile District Maintenance Team under DDF which is supposed to assist the pumpminders with major repairs which they are not able to do /17/. Figure 15 shows the operation and maintenance system for domestic water supply.

Ministry of Environment and Tourism

The Ministry of Environment and Tourism has at the national level established The Save Catchment Rehabilitation Committee with the mandate to prepare and implement the Save River Rehabilitation Action Plan. A Committee structure under the District Councils is being set up with the aim to implement the Action Plan. Though the content of the various plans will vary from district to distrcit they should address actions within the following areas:

- Conservation and management of the soil and water resources
- Improved production of crops both for food and marketing
- Improved animal husbandry over the catchment.

NGOs and Environment Africa 2000 in particular, are expected to play an important role in implementation of the Plan. Figure 16 shows the administrative structure for implementation of the Plan.

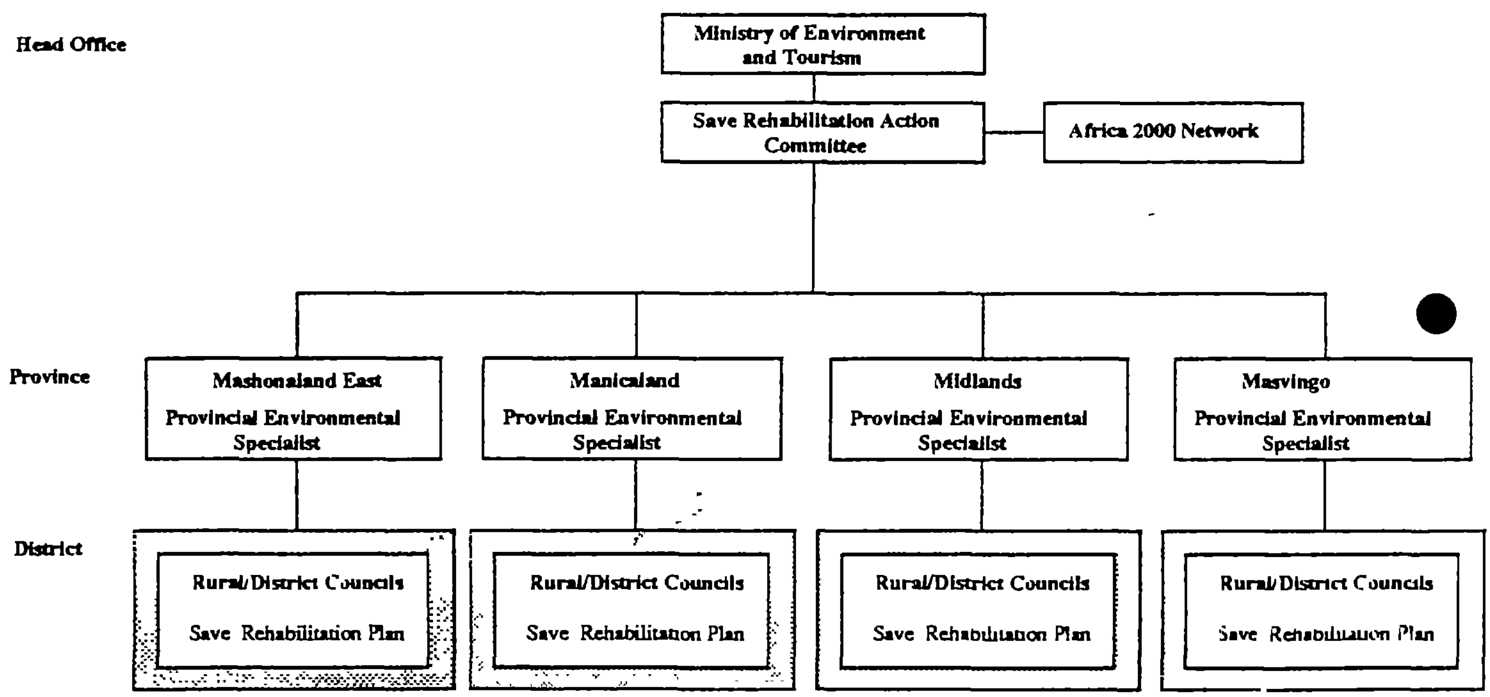


Figure 16. The administrative structure for implementation of the Save Rehabilitation Action Plan

Ministry of Health (MOH)
MOH is responsible for wellsinking activities and for health and hygiene education as part of the provision of domestic water supply for CLA and RA. The Ministry is also responsible for the monitoring of health related water quality parameters.

Ministry of Community and Cooperative Development (MCCD)/ Ministry of Political Affairs (MPA)
The MCCD and the MPA are responsible for community mobilisation in planning and implementation of projects in CLA and RA. The division of responsibilities between the 2 ministries is not clear. The overall picture is, however, that MCCD is responsible for community mobilisation through the WADCO/VIDCO structure and MPA for sensitisation and mobilisation through the Council structure.

Non Governmental Organisations (NGOs)
NGOs are contributing significantly in implementation of domestic water supply projects and in watershed conservation projects. They are also playing an important role in the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE). The Campfire model rely on the ability of rural communities to articulate their own needs, and to take full responsibility for all aspects of wildlife management including collection of revenues for hunt permits /23/. In some communities wildlife management committees have been formed at ward and village level. Two Campfire projects have been established within the boundary of the Save River Basin and a potential for 2 other projects has been identified. The recent development is that several projects have broadened their scope to encompass the full spectrum of management of natural resources. The linkage to the proposed rehabilitation projects in the Save River Basin seems therefore obvious.

5.3 Conclusion
The overall conclusion to be drawn from the review of the water management system is that the responsibility for many activities is shared between various agencies. In the planning and implementation of water projects the situation is as follows:

- The District Councils are playing a minor role in planning and implementation of water projects.
- One agency is responsible for design and construction of big dams(MEWRD). Design and construction of small dams with height less than 8 m are shared between DDF and MEWRD.
- Three agencies (MEWRD, DDF and MOH) are sharing the responsibility for provision of primary water supply in CLA and RA. Two agencies are responsible for borehole drilling.
- Two agencies are sharing the responsibility for implementation of irrigation schemes in CLA (AGRITEX and DDF). In addition comes ARDA which is responsible for management of irrigation water to state farming enterprises.
- Two agencies are sharing the responsibility for community mobilisation (MCCD and MPA).
- An Action Plan for watershed conservation is under implementation, but so far very few actions have been taken.

- The private sector is very little involved in implementation of water projects in CLA.

As far as monitoring of water quality and quantity and operation of water facilities are concerned the situation is as follows:

- Almost non existence of institutions and committees with operation and maintenance responsibilities for water facilities at the District Council level.
- Cost recovery systems for operation and maintenance costs of bulk water supply and irrigation schemes controlled by MEWRD are developed. Similar systems are under preparation for the remaining water service provided by AGRITEX, DDF and Local Authorities, i.e. mainly in CLA and RA.
- Responsibility for operation of irrigation schemes is divided between RWA and AGRITEX. The former is responsible for provision of irrigation water from its dams while the latter is responsible for small scale irrigation.
- Responsibility for operation and maintenance of dams are divided between three agencies (MEWRD, RWA and DDF) depending on the size and the location of the dams.
- Responsibility for operation and maintenance of piped schemes is divided between 3 agencies (MEWRD, DDF, and Local Authorities).
- Monitoring of water quantity parameters is well developed, while monitoring of water quality parameters is poorly developed.
- Control of water rights and monitoring are the responsibility of MEWRD who encourage farmers to set up River Boards to monitor Water Rights in their areas.

6. ECONOMIC AND FINANCIAL ASPECTS OF WATER MANAGEMENT

As in many other developing countries capital for development of water projects is in short supply in Zimbabwe. Another common problem is that the consumers often lack the economic base to afford the cost of new water schemes. It is therefore essential that the scarce water resources are managed properly and that the available funds are used effectively to meet national targets for provision of water to the different sectors.This chapter will focus on pricing policies within the major water use sectors:

6.1 Urban, industrial and mining sector

The present pricing policy is based on individual prices for individual dams. This means that dams, which were built a long time ago when the interest rate was low, now have cheap water, whereas newly constructed and planned dams will have expensive water. Capital costs as well as operation and maintenance costs for dams have escalated tremendously in the past with an estimated inflation rate in dam construction costs between 1978 and 1988 at an average of 15,7 % per year. The MEWRD has addressed this problem in a recent paper where the following policy objectives for bulk water supply to the Urban, Industrial and Mining Sector have been proposed /24/:

The price paid by the consumer should be the same irrespective of their source of supply. This is to ensure that consumers supplied by recently constructed sources do not pay a price several times higher than those supplied by much older sources. This implies that the older sources are subsidising the newer sources across the whole country.

The cost of supplying raw bulk water from existing dams varies between 0,4 cents to 77,8 cents/m^3. Unit prices for new dams are estimated between 13 and 120 cents/m^3. Water for future development is therefore going to be very expensive. In order to address this problem the government policy of recovering annual interest and redemption as well as the operation and maintenance cost of utilising the water sources will be expanded. This is to ensure that the financial feasibility of the system is kept viable in the long run. In stead of introducing an incremental marginal cost of production principle the MEWRD has proposed a national blend price, i.e. an average price of 5,8 cents/m^3 [4]. This policy is accepted by the Ministry of Finance, Economic Planning and Development. The Local Authorities which have enjoyed cheap water over the last years have so far rejected the proposal. The proposal is therefore still to be approved by the Government.

6.2 Water for irrigation

On a national basis large scale commercial farms and estates irrigate 123.000 ha or 82 % of the total irrigated area in Zimbabwe. In many instances these farms have developed their own irrigation facilities using their own funds and/or loans from commercial banks and agricultural finance institutions. These schemes are therefore managed on a commercial basis without any subsidies from the government.

Irrigation schemes developed by the public sector through the MEWRD and the RWA irrigate both Commercial Farming Areas and Communal Lands. In financing these developments government has followed a policy of full cost recovery over 40 years period. RWA projects have been considered in isolation and a water price for the consumer has been calculated based on the predicted water yield of the scheme, the annual amortised cost of the investment and the estimated annual operation and maintenance cost. Water prices have been raised as and when the O & M costs have increased. Irrigation development under these arrangements took place without any direct government subsidies and the cost of the water depended on the age of the scheme and the changing interest rates.

In 1985 charges ranged from 0,2 to 0,8 cents/m^3 for MEWRD and RWA schemes [5]. Due to the escalating costs of storage and distribution works for new schemes, which ranged between 2,1 to 6,6 cents/m^3 in 1985, a new pricing system was introduced in 1986. With reference to Osborne Dam which was mentioned in chapter 5 the same unit cost was estimated at 5,1 cents/m^3 in 1988.

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[4] 1 Z$=0.32 US$ (Average first half year 1991)

[5] 1 Z$=0,62 US$ (Average for 1985)

The new pricing system is based on the average of the costs of old and new schemes. In 1986 these prices were fixed at 1,0 cents/ m^3 for Natural Region III,IV and V areas and 1,2 for Natural Region 1 and 2.

The RWA is still using the old pricing system where the cost is divided by the water yield which is determined by the 10 % yield of the mean annual run-off. The 10 % yield is the yield which has a 10 % probability of non-occurrence. In 1986/87 the costs of the individual schemes ranged from 0,54 to 1,25 cents/m^3 /5/. However, with the escalating costs of new schemes, the average cost of water will soon become very high. If this approach is to be continued the water charges for new schemes may then have to be subsidised.

Communal Land Areas(CLA) cover 3 % of the total irrigated area of 150.600 ha, the remaining area of 15 % comprises public sector estates. Prior to 1980, maintenance fees in CLA were determined by the rate of water circulation in a scheme and these rates varied from Z$ 6,0 to Z$ 70 per ha per annum payable in advance. Around 10 % to 12 % of the annual-running costs of the schemes were recovered. In 1983 these rates were changed to Z$ 145 per ha per annum for schemes with an assured water supply to Z$ 30 per ha for unreliable schemes based on sand abstraction [6]. The irrigation fee of Z$ 145 per ha per annum covered around 19 % of the average O & M costs. The rate of inflation since then has reduced this percentage further. The farmers in CLA have never been expected to repay the capital costs of the schemes. These were regarded as government grants as it was considered that farmers could not afford to contribute to the capital costs. The new direction in government policy is that operation and maintenance of schemes in CLA should be undertaken by the farmers themselves. The government has also set aside a fund to promote irrigation development by farmers in CLA. The fund should be repayable over 10 years at an interest rate of 9,75 % and is meant to cover rehabilitation and in-field costs. The available fund has so far been very little utilised. This is due to many factors, but probably the most important one is the lack of a uniform funding systems for small scale irrigation schemes. The present situation is that government grants and grants from bilateral donors and NGOs are being used in competition with the loan fund mentioned above/5/.

As long as this situation remains uncoordinated it is difficult to see how farmers would apply for loans to pay for in-field costs of the schemes and accordingly take on operation and maintenance responsibilities.

6.3 Domestic water supply

The expectation of the rural people through the 1980s and following the liberation war have been that the government will provide domestic water supply at no cash cost to the beneficiaries. With the government in the role of a provider as opposed to the role of a promoter of self-initiated projects, the result might be that the people believe that the

[6] 1 Z$=0,98 US$ (Average for 1983)

facilities are owned by the government or by the NGOs when they are providing funds for water supplies. If the responsibility for operation and maintenance remain with the providers this will have a serious implication on the long term sustainability of the water facilities.

According to DDF's estimates the maintenance cost of a borehole is Z$ 250 (1991 prices)/17/. A borehole can according to the design criteria prepared for the NRWSSP serve 250 people. This should imply that the O&M cost for a water point is approximately 1 Z$ per person per year. A policy paper prepared by the National Action Committee for Rural Water Supply and Sanitation recommend that O&M costs of primary water supplies should gradually be borne by the consumers in CLA and RA /18/. Whether this recommendation is politically acceptable is difficult to say.

6.4 Effluent charges

Effluent waste water can not be discharged unless it complies with prescribed water quality standards set according to the Water Act. The Act has options for imposing severe penalties on offenders who do not comply with the standards. An effluent charge system has not been introduced in Zimbabwe and is not mentioned as a pollution abatement alternative in the Water Act.

6.5 Conclusion.

Charging for water use is essential not only for inducing conservation and protection of the water resources, but also for creating a responsibility for the functioning of these water systems. Introduction of a blend price for bulk water supply and irrigation schemes implies that old sources are subsidising newer sources across the country. In CLA provision of irrigation schemes and primary water supplies have so far been heavily subsidised by the Government. The proposed new policy is that at least operation and maintenance costs of water services provided in these areas should be borne by the users.

Charging for water services is different from costing of water development projects. A prerequisite for sustainable development of a scarce and vulnerable water resource is that its full economic cost including capital, labour and opportunity cost, reflecting the value of the water use in its most valuable alternative use, should be identified and acknowledged. In most cases the opportunity cost for provision of primary water supplies and irrigation in CLA is negligible, but in urban areas the value can be high and should therefore be calculated.

7. SOCIO - CULTURAL ASPECTS OF WATER MANAGEMENT

7.1 Traditions related to water as a common resource

There is a strong belief in the Shona tradition that natural springs should be left open and not captured by concrete construction and fencing. This is particularly important for the ancestors when they come back in the area. Protection of springs is a recommended technology within the National Rural Water Supply and Sanitation Programme (NRWSSP) and if not handled properly this technology can cause conflicts. The conflict may be within the community and can easily become a generational conflict. The old generation will normally try to preserve the spring, while it is in the interest of the young generation to get a new and better source of water. This conflict may also turn into a conflict between the community and the authorities , if they feel that their spring and the associated values, are being threatened.

As far as sinking of wells and new boreholes are concerned lack of information in the pre-siting exercise can cause problems. If real community participation takes place and the people are given time to go through the rituals they consider suitable in order to inform the ancestors about the plans for new water points, this will normally not create any problems /25/.

Another important local tradition is preservation of water. This is of course a sensible response to the experience of an unstable and insufficient supply of water which has been the situation in rural areas for many years. In this respect it is important to keep in mind that collection of water from a traditional water point was not considered to be a private matter. As long as water is a scarce resource, the amount used by any individual is seen as having a direct bearing on the amount available for others. It is only when water is plentiful that a decision on how much water to draw is purely a question of personal preference. The problem is then to decide when there is plenty of water and when there is limitation. A water use study carried out in the Maungwe District in the Save River Catchment showed that there was a slightly increase in water use just after completion of new water points. The water use per person in a family was between 5 and 8 litres and few used more than 12 liters. It has, however, been estimated that a person should use about 20-25 litres every day in order to achieve a health effect /25/.

The overall objective of the NRWSSP is to improve the health and the standard of living for people in rural areas. Achievement of the health objective is linked to the success of the health and hygiene education which should motivate people to use more water. The study referred to in Maungwe District shows that the achievement of the health objectives is not likely to happen unless people are motivated to use more water.

7.2 Willingness to pay for water

Two studies on willingness to pay have been undertaken in Zimbabwe, both of which conclude that the level of willingness to pay for water is at the level appropriate only to contributing to maintenance costs of primary water supply provision in CLA and not to capital costs. A 1985 study which considered ability and willingness to pay found that willingness to pay was higher among more wealthy families, among women and for individual water sources rather than communal. The study concluded that an annual payment of Z$ 1 (1985 prices) would be affordable and forthcoming from most rural households. About a third of rural households could afford to pay Z$3 per year/26/.

A 1988 study which was undertaken in a wet (Natural Region II) and a dry area (Natural Region III-IV, Buhera District in the Save River Catchment) found willingness to pay to be positively correlated with income, the number of labour days contributed to project construction, education, inhabitants in the dry area and total quantity of water collected and women expressed higher willingness to pay than men /27/. While this study confirms the conclusions of the prior study and gives a mean annual willingness to pay varying between Z$ 1,54 and Z$ 3,17 (1988 prices), the real significance to be put on these studies are questionable. Methodological problems remain in the studies and actual willingness to pay will also be affected by changes in government's policy framework in the sector.

8. POSSIBLE SOLUTIONS

The case study on the Save River Basin offers the opportunity to make an assessment of water management in the River Basin as a whole. In order to structure the presentation of solutions to the conflicts between water users and the problems identified in the water management system the solutions are presented under three different headings which summarise the challenges in Water Management in the Basin.

1. Planning and implementation of water projects.(Development).
2. Operation of water facilities, monitoring and control.(Management).
3. International cooperation in water management.

The same structure is visualised in Figure 17. The Figure illustrates the appropriate level for Integrated Water Resources Management in the River Basin with the emphasis on the level of government or organisations different activities and powers should be transferred to.

It should be emphasised that since Independence development of water projects in Zimbabwe have followed a top-down approach with the central Government in a dominating position. A change in policy is taking place towards decentralisation of both planning and implementation responsibilities to Local Authorities. This process will require a lot of support, particularly on institution building. The most appropriate level for Integrated Water Resources Management in rural Zimbabwe seems therefore to be the Rural/District Council. In those areas where there are major conflicts between water users, strengthening of existing and creation of new River Boards should be considered.

Solutions are divided into two groups. **General Solutions (GEN)** aiming at the UNCED process of preparing operational guidelines for Integrated Water Resources Management and **Specific Solutions (SPES)** to conflicts and problems identified in the River Basin. Proposed **Actions** are limited to the situation in Zimbabwe.

WATER MANAGEMENT IN THE SAVE RIVER BASIN

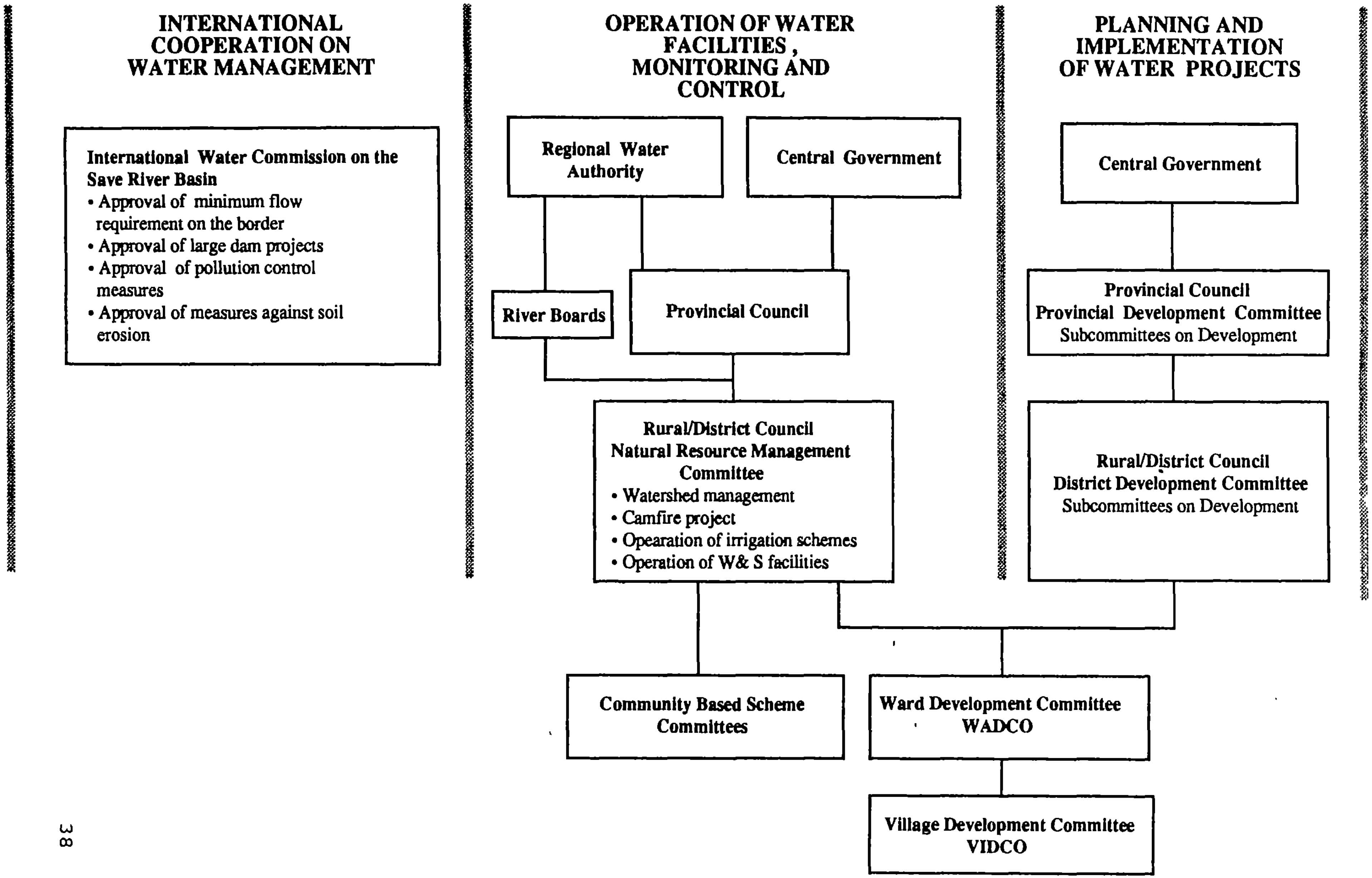

Figure 17. Proposed division of responsibilities in Water Management in the Save River Basin

It might be that linkages between conflicts and problems identified in the River Basin and the proposed **General Solutions** have been presented to brief. The focus of the paper has, however, been kept in line with the major purpose which is to contribute to the preparation of operational guideline in the UNCED process in general and in the Informal Consultation in Copenhagen in particular the focus has been kept.

1. PLANNING AND IMPLEMENTATION OF WATER PROJECTS - DEVELOPMENT

The planning and implementation of water projects should follow the ordinary development planning system in the country. In Zimbabwe this will imply that the Rural and District Development Committees establish their priorities based on proposals from the VIDCO/WADCO structure and submit their recommendations to the Rural/District Council. Provincial priorities are set by the Provincial Development Committee and recommendations are submitted to the Provincial Council for approval. Development of new water projects should be included in both the district and the provincial 5 Years and Annual Development Plans. Planning and implementation of national water projects may differ from the suggested procedure. In such cases the central government level will have to play a more leading role.

There seems to be a need to strengthen the linkage between water project planning in various sector ministries and the overall development planning system under the Ministry of Local Government, Rural and Urban Development. Decentralisation of planning responsibilities to Local Authorities could be seen as an instrument to promote cross-sectorial integration among the various ministries. If the authority to manage water problems is delegated to the level were the problems arise the better is the chance to solve the problems. The following solutions are therefore proposed:

1.1. SINGLE AGENCY APPROACH TO WATER RESOURCES PLANNING

GEN 1.1. One ministry should be responsible for the assessment of the water resources (both quality and quantity) and the overall planning and development of these resources. The Ministry should be in control of legislation which covers water rights as well as pollution control measures. The Ministry should also prepare planning guidelines to be used by Local Authorities in prioritisation and preparation of water development projects.

SPES 1.1. In Zimbabwe the Ministry of Energy, Water Resources and Development has this responsibility. The Ministry should continue to supervise water project development by other ministries through the established system for issuing water rights and effluent permits. Planning guidelines should be prepared to assist Rural/District Councils in preparing proposal for water development projects.

1.2. IMPROVED LINKAGE BETWEEN WATER RESOURCES PLANNING AND DEVELOPMENT PLANNING

GEN 1.2. It is important to link development of water project to the overall development planning in rural and urban areas. A strong linkage should be established between the lead agency on water resources planning and the agency in charge of development planning.

SPES 1.2. In Zimbabwe this implies that the linkage between Ministry of Local Government, Rural and Urban Development as the coordinating ministry for development planning and the Ministry of Energy, Water Resources and Development will have to be strengthened in the planning of water projects.

1.3. CLEAR DISTINCTION BETWEEN GOVERNMENT/LOCAL AUTHORITIES RESPONSIBILITY FOR PLANNING/DESIGN AND CONSTRUCTION OF WATER PROJECTS AND THE RESPONSIBILITY OF THE PRIVATE SECTOR.

GEN 1.3 In order to increase the efficiency in planning/design and construction of water projects a clear distinction should be made between the responsibility of the Government, the Local Authorities and the private sector. When appropriate planning/design of water projects should be carried out by the private sector leaving the Government and the Local Authorities in a supervisory position. Construction of water project should either be left to parastatals (half governmental and half private organisations) specialised in the field or to the private sector.

SPES 1.3 In Zimbabwe this implies that there is a need to review the role of the Government/Local Authorities and the private sector in planning/design and construction of domestic water supply projects (borehole drilling, well sinking and piped schemes), small and large dams, and irrigation schemes.

1.4. INTRODUCTION OF COSTING PRINCIPLES FOR WATER DEVELOPMENT PROJECTS

GEN 1.4. The incremental marginal cost principle which reflects the cost of producing the unit quantity of water by construction of the next proposed scheme should be considered as a mean to tackle the escalating development costs of domestic water supply and irrigation schemes. This principle will have to fit with the government policy of subsidising capital costs of development of primary water supplies and small scale irrigation schemes in underdeveloped areas.

SPES 1.4. In Zimbabwe this will imply that the principle for costing of water development projects should be reviewed and adapted to the Government policies on cost on recovery of at least operation and maintenance costs of primary water supplies and irrigation schemes.

1.5. REQUIREMENT FOR LEGISLATION ON ENVIRONMENTAL IMPACT ASSESSMENT OF WATER PROJECTS

GEN 1.5. Construction of large dam projects and industrial projects will require a legislation specifying requirements for Environmental Impact Assessment (EIA). This will facilitate environmental impact assessment of different plan alternatives and will also improve public participation in the decision making process.

2. OPERATION OF WATER FACILITIES, MONITORING AND CONTROL - MANAGEMENT

The case study shows a need to make a clear distinction between planning and implementation responsibilities and responsibilities for operation and maintenance of water facilities, monitoring, and control of water rights and effluent discharge permits. The organisational set up at district level seems to be geared towards project planning and to some degree implementation of these projects. Very little emphasis seems to be placed on organisations for operational responsibilities and management of natural resources. The study seems to indicate that the concept Integrated Water Resources Management should entail management of both water and land resources. As far as district level institutions are concerned it seems to be a need for establishing a Committee under the Rural/District Council with the overall responsibility for natural resources management.

At central level the Regional Water Authority has been authorized operation and maintenance responsibilities of dams and canals. Though the mandate of the Regional Water Authority is wider, the present responsibility does not allow the RWA to take on the overall operational responsibility of water facilities and monitoring and control functions in the River Basin.

In addition to the RWA, 5 River Boards have been set up in CFA to control water rights and monitor instream flow requirements in specific areas. The following solutions are proposed under this subject:

2.1. MANAGEMENT OF WATER AND LAND RESOURCES MUST BE INTEGRATED.

GEN 2.1 The management of water resources and land resources must be integrated. This implies that watershed conservation will have to be integrated with agricultural husbandry techniques and guidelines for land use planning. The scope is therefore more on Natural Resources Management. At district level there is need to establish a government agency as well as a Committee with Natural Resource Management responsibilities. Management of resources is a continuing activity which can not be put into a short term project concept. Institution building at district level to take on these responsibilities will therefore be critical.

SPES 2.1 In Zimbabwe this will imply that the coordinating role of Ministry of Environment and Tourism must be strengthened and that a Natural Resources Management Committee be set up under the Rural/District Council. This Committee should have an equivalent status to the District Development Committee tasked with development projects. Activities which should fall under this Committee would be Watershed Conservation, the Campfire Project, operation of irrigation schemes, and land use planning. Responsibilities for operation and maintenance of primary water supply could either fall under this Committee or under a general Committee on operation and maintenance of infrastructure. The Ministry of Land, Agriculture and Rural Resettlement and NGOs will have to play an important role in these Committees.

ACTION 2.1. A study should be carried out in order to prepare a proposal on how to establish a system of Natural Resource Management Committees in all Rural/District Councils of Zimbabwe.The study should focus on measures to strengthen the role of MET in setting up the system. As far as the Save River Basin is concerned efforts should be made to concretisice actions within the framework of the River Rehabilitation Plan.

2.2. OPERATIONAL, MONITORING, AND CONTROL RESPONSIBILITIES MUST BE DEFINED

GEN 2.2. In a River Basin of the size such as Save there is need for an organisation to take on the overall operational responsibilities of water facilities and to monitor water quality and quantity. The organisation should operate on a catchment basis which implies that the responsibility will not be limited by administrative structure such as Provinces and Districts. When appropriate control of water rights and effluent discharge permits and monitoring of instream flow requirements should be delegated to River Catchment Boards which should report to the RWA. The Boards should operate within a defined area and the creation of new Boards should be determined by the conflicts among user interests in the area. Whether development responsibilities should be delegated to the same organisation will have to be assessed separately.

SPES 2.2. Since a Regional Water Authority (RWA) is already in existence in the River Basin following responsibilities are proposed delegated to the RWA:

i. Operation and maintenance of dams owned by the government in the Basin.
ii. Continue operation of irrigation schemes in Commercial Farming Areas and give technical advice and support to schemes constructed in Communal Land Areas.
iii. Release of water from dams based on approved regulation rules.
iv. Monitoring of water quality and water quantity parameters. The latter should focus on data needed for planning of release of water from reservoirs in the Basin. Monitoring of siltation should also be included.

Whether the RWA also should be made responsible for development of new water projects will have to be considered in more detail.

It is proposed that the existing River Boards in the Save River Basin should be strengthened and report to the RWA instead of MEWRD. Establishment of new River Boards should be encouraged in areas with major conflicts.

ACTION 2.2. A study should be carried out to assess the need for institutional development and required equipment to put RWA in a position to carry out the proposed extended duties and to assess whether it would be appropriate to delegate development responsibilities to the RWA. An amendment to the Regional Water Authority Act should be considered to allow River Boards to report to the RWA.

3. INTERNATIONAL COOPERATION ON WATER MANAGEMENT

The Save River Basin is an international river system located in Zimbabwe and Mozambique. The availability of water on a perennial basis is of great interest for Mozambique. Continued construction of reservoirs in Zimbabwe for irrigation water will of course have an impact on the availability of water in Mozambique. Variation in the availability of water from year to year and lack of proper control systems and losses in moving water from the dams to the abstraction points will make it difficult to guarantee a minimum instream flow on the border to Mozambique. The following solutions are proposed for management of the joint resource between the two neighboring countries.

3.1 INTERNATIONAL COOPERATION IN MANAGEMENT OF RIVER BASINS

GEN 3.1. In international river systems of the size such as the Save River Basin a formalised cooperation on management of water resources is required.

SPES 3.1. In the Save Basin it is therefore proposed to set up a Water Commission between Zimbabwe and Mozambique to address issues of mutual interest in management of the available water resources.

ACTION 3.1. To prepare an assessment of the need for establishing a Water Commission between Mozambique and Zimbabwe on the management of The Save River Basin. If necessary, prepare a Terms of Reference for the Committee.

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Case Study on Local Water Management in the Ismani Rural Area, Tanzania

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1 Introduction

1.1 Operationalization of local water resource management

Local water management must integrate two distinct elements: on the one hand, the principle of water as a vital physical cycle, on the continued flow of which all life depends; on the other hand, the need to involve the whole wide variety of social user interests in the management of water resources.

In order to operationalize this integration of the two elements, they may be viewed as two *hierarchies*:

- a physical hierarchy of water resources: from the smallest point water source, via streams, catchments and river basins, to the overall water balance;

- and a social hierarchy: from the farmer's selection of crops to exploit the rain on her field or her decisions concerning the use of water stored in the house, via distribution of stream water for irrigation, the operation of a village water supply, district level land use plans and forestry regulations, and regional water rights, to nationally important industrial development.

They are hierarchies, in the sense that not only does what happens at the top of the hierarchy have repercussions further down, but in principle, it is a mutual dependency, so that the higher levels are also influenced by events further down, which again may spread to other lower levels via the top in the hierarchy.

In practice, however, it is obvious that farmers' use of a local spring in a village in Ismani for household purposes and irrigation of vegetable gardens has negligible effect on the Rufiji River Basin, not to speak of the Tanzanian national water balance. It is equally clear that whatever regulation the Tanzanian national government might want to impose on farmers' local irrigation systems or on commercial charcoal burning depleting catchment areas of trees, it simply does not have the means to enforce them. Tribal rules on use of water may similarly differ from one area to the next - and may or may not influence each other significantly.

To be effective - and democratic,for that matter - integrated water management should therefore be located at those interphases of the physical and social hierarchies where management decisions involve those social groups, institutions etc. which have a direct interest in them, in such a way that:

- their common interest in managing the source is greater than their competing interests; and

- management decisions do not have strong repercussions in other parts of the social or physical hierarchies.

This means the establishment of a "water management hierarchy", where management takes place at many different levels, but always as locally as possible in the hierarchy. Only when certain aspects cannot be managed locally - for socio-economic or physical reasons should recourse be made to higher authorities. In such cases, the higher authority may impose regulations on the managing agency or management itself may be removed. It is clear, furthermore, that such a hierarchy should never be static, as both the social and the physical situation may change.

In establishing and adjusting a water management hierarchy, existing social and physical hierarchies, which are never congruent, have to be adapted to each other. Sometimes an existing social institution, such as e.g. the Iringa District Council, may be better placed to regulate the use of the many separate water resources within its boundaries, while in other cases, a river basin water board is created to manage this particular level in the physical water hierarchy.

The purpose of the Ismani case study is to discuss the concrete problems in the establishment of such a "management hierarchy". It will have to look at how different and possibly conflicting social and economic demands can be reconciled by involving communities or the public in management at different social levels. At the same time, this societal management hierarchy must at least to some extent be adapted to match the environmental hierarchy of sub-catchments, catchment areas, river basins etc.

Furthermore, at each level appropriate management measures must be identified which are likely to be both affordable, to function and to have the intended effect. Typically, such measures will be either regulatory, e.g. through legislation, or creating economic incentives or disincentives, e.g. through levies. An important means to consider for ensuring the efficiency of such measures is their enforcement by direct beneficiaries of efficient enforcement.

While regulative measures have so far been most common, water frequently being regarded as a free good, like air, the case study will in particular analyse the potential economic measures as a tool for local water management.

1.2 The Ismani area

Ismani is the common name for the area stretching northeast from the hills bordering Iringa town, approximately bounded by the Iringa-Dar es Salaam and the Iringa-Dodoma roads to the south and west and by mountain ranges separating it from Ruaha flood valley to the north and Image area to the east. It does not have well-defined boundaries, however, and since it has been chosen as a case study because of the presence of the Ismani water scheme being rehabilitated under the Danida Water Project, we define the Ismani area for the purposes of this report as synonymous with the villages served by the water scheme, once rehabilitation is finalized (see map 1).

The Ismani area is located in Iringa District in the northeastern part of Iringa Region, Tanzania. It lies between 7^0 16' and 7^0 49' southern latitude, and between 35^0 44' and 36^0 7' eastern longitude. It is located within the approximately 2100 km^2 catchment area of the Mbunga River being a tributary to the Great Ruaha River and is thus part of the larger Rufiji Basin (map 1).

The Ismani water scheme is a piped gravity scheme with a supply area - the Ismani area -of approximately 1800 km^2 and comprising 21 villages with a 1988-population of 31,100 and a design population (year 2006) of 53,500 (estimated in 1985). The Ismani area is crescent shaped with the long axis in the NNE-SSW direction. It has a maximum length of approximately 70 km and an average width of 25 km (map 4).

The Ismani water scheme utilizes as its main water source the Mgera River, a small stream flowing perennially in its upper reaches. Additionally, it also has an intake in the Kigasi River - another small perennially flowing stream within the Mbunga catchment.

2 Physical description of the area

2.1 Topography, soils, drainage and vegetation

The Mbunga catchment is bounded to the southeast and east by fairly high mountain ranges with altitudes only exceptionally being below 1600 m and mostly being in the interval 1700 - 2300 m above sea level. The hill ranges bounding the Mbunga catchment to the southwest,west and north only exceptionally exceed 1700 m and generally are in the altitude interval 1350 - 1500 m.

The interior of the Mbunga catchment is generally sloping from south towards north-northeast. It is characterized by gently undulating plains with scattered minor *inselbergs*. Centrally in the southern part of the catchment the Hambingetu Inselberg rises imposingly sharp to an altitude of 1935 m - i.e. 555 m above the surroundings being in an altitude of approximately 1380 m. There is very little flat land except in and around the *mbugas* of which the Ilambilole Mbuga is by far the largest - although not the only one (see map 2).

The Ilambilole Mbuga is an approximately 40-50 km^2 seasonally swampy area centrally located just south of the Hambingetu Inselberg in the southern part of the Mbunga catchment, in approximately 1370 m altitude. During the rainy season it is liable to flooding due to runoff from the surrounding higher terrain and mainly due to inflow from the Mgera River while at the same time it is draining to the north by surface runoff through the Msembera River - a seasonal flowing tributary to the Mbunga River. Evapotranspiration and subsurface seepage take place all the year around and thus contribute continuously to the depletion of water from the Ilambilole Mbuga. There are strong indications that a substantial subsurface seepage takes place from the Ilambilole Mbuga towards northwest, discharging perennially into the Kigasi River and that way supplementing the Mbunga River. Thus part of the Kigasi River is located in a 3-4 ha evergreen swampy area covered with papyrus and weeds and located in an altitude of approximately 1310 m. The Ilambilole Mbuga consists of black cotton soil and is intensively used for cattle grazing during the dry season due to its plentiful grass vegetation.

The soils of the Mbunga catchment fall in the ferralitic/ferruginous tropical soil type. Rock outcrops are common on the steeper slopes with mostly shallow stony sand loams and sandy clay loams in the lowest laying areas. The soil cover varies, but besides the mbugas, most is suitable and utilized for cultivation. The drainage pattern leads to freely drained loamy soils except in the lower mbuga lands with water logged clays. The soils are low in phosphorus and nitrogen and therefore moderately fertile.

The Ismani area presents an advanced degree of deforestation due to land clearings, cultivation and fuel-wood cutting for urban consumption and tobacco curing. Most of the natural vegetation has been destroyed so that to day only scattered *acacia* and *miombo* trees punctuates large areas of cleared land.

The Mgera sub-catchment is located in the southernmost part of the Mbunga catchment and the intake of the Ismani water scheme is located in the altitude of 1620 m. The highest point along the topographical divide of the 50 km^2 catchment area upstream the intake is 2385 m and along a substantial part of the divide the altitudes are higher than 2100 m. Thus the catchment is characterized by a strong relief and very steep slopes. Except for some settlement in the valleys a few kilometres upstream of the intake the catchment is only sparsely populated. Presumably the catchment has originally been totally covered by miombo forest. However, substantial tree-felling for the purpose of supplying fuel-wood/charcoal for Iringa town as well as some cultivation has resulted in a rapid depletion of the natural acacia and miombo forest. Approximately 20 km^2 of the highest southeastern part of the Mgera catchment belong to the gazetted Kising'a-Lugalo Forest Reserve covering in total 140 km^2 (see map 3).

The Kigasi sub-catchment is located centrally in the southern part of the Mbunga Catchment. The intake of the Ismani water scheme is located just south of the Kigasi Hill in a small perennially flowing tributary to the Mbunga River. The altitude of the intake is approximately 1310 m. The catchment area upstream of the intake is approximately 100 km^2 - but highly indeterminate as it includes part of the Ilambilole Mbuga.

2.2 Geology

Geomorphologically, most of the inhabited part of the Ismani area belongs to the so-called African Erosional Surface whereas most of the sparsely populated and high altitude areas belongs to the older Gondwana and Post-Gondwana Erosion Surfaces. The extreme northwestern part of the area is located in the Ruaha Valley Escarpment separating the African Surface from the Rift Valley floor.

The African Surface is underlain chiefly by Basement Complex rocks like gneisses, quartzites and granites resulting in a blanketing in-situ weathered overburden on the parent rocks that are quite similar independent of the mineral composition of the parent rock. During the weathering process some of the minerals of the parent rock, mainly quartz, persist, while others are completely destroyed and form clay minerals. The result is that a permeable and porous rock replaces the original fresh rock and a potential aquifer is developed in the lower part of the weathered zone, known as the saprolite. The degree of mechanical and chemical weathering - and thus the thickness of the saprolite - is a function of the geology, climate and in particular the time of weathering for the considered locality and will have a critical control over the water bearing characteristics of the saprolite. For the part of the Ismani area on the African Surface the thickness of the saprolite is generally found to be 30-60 m. The saprolite offers the most reliable and persistent aquifer horizon across the African Surface.

The chemical quality of the ground water on the African Surface is generally found to be acceptable with the iron, manganese and fluoride content below the maximum permissible. This situation may be reversed in areas influenced by Neogene tectonic activity like the Ruaha Valley Escarpment. Here, ground water is often found to be locally polluted by juvenile water, high in salt content, and issuing from fractures and fissure zones.

On the Gondwana and Post-Gondwana Land Surfaces, the most common rocks are granites and gneisses, but shales and schists do occur. Because of the pronounced topographical relief, the saprolite is thin or non-existing on the slopes, and rock frequently outcrops. Some faulting has taken place in the southern part of the area, i.e. particularly in the Mgera catchment. The potential for development of ground water on these land surfaces by means of wells is only marginal.

2.3 Climate, including rainfall and evapotranspiration

The climate of the northeastern part of Iringa Region and thus of the Mbunga catchment is determined by its location close to the equator and the Indian Ocean.

Located between 7^0 and 8^0 southern latitude the area experiences two passages of the so-called Inter-Tropical Convergence Zone (ITCZ): one from north to south around November and another one from south to north around March, both passages lacking about 1-2 month after the corresponding instant for maximum solar insolation. The resulting atmospheric circulation pattern in combination with the vicinity of the warm Indian Ocean gives rise to large seasonal changes, thus creating considerable seasonality in rainfall, temperatures and evapotranspiration. Two distinct periods characterise the climate of the considered area.

From November to April, the northeast monsoon (Kaskazi) prevails partly bringing warm, moist air from the Indian Ocean and producing high temperatures and considerable rainfall because of lifting due to the convergence of air masses as well as topographical effects. There is a tendency to a bimodal pattern with less rainfall in February when the ITCZ is at its most southern position near the Tropic of Capricorn as well as to lower temperatures in January.

From June to October, the southeast monsoon (Kusi) prevails bringing mainly dry, cold air from South Africa and resulting in a pronounced dry and cold season in this period. Thus the total rainfall during June to September in most years is negligible.

For the potential evapotranspiration - which represents an upper limit for the rate of water loss from a vegetated surface to the atmosphere - this results in a seasonal variation with maximum values during September to November and minimum values during February to March or May to July, depending on whether we consider the low altitude northern parts or the high altitude southern parts of the area, respectively.

The mean annual rainfall varies more or less uniformly from about 500 mm/year in the northern part of the Mbunga catchment to 750 mm/year in the southern part, i.e. within the Mgera catchment (see map 2). There are however substantial variations in the annual rainfall from year to year. Thus the Nduli Airport has a mean annual rainfall of about 650 mm/year and a 10 year annual minimum rainfall of 440 mm/year.

The mean annual potential evapotranspiration varies from about 2000 mm/year in the northern part of the area to about 1400 mm/year in the southern part.

Due to lack of adequate water in the soil for the plants during the dry season the actual evapotranspiration is always less than the potential rate. The mean annual actual evapotranspiration may be estimated to vary from about 400 mm/year in the northern part of the area to about 550 mm/year in the southern part of the area.

The seasonal variation of the actual evapotranspiration in the Mbunga catchment follows closely the timing of the water availability in the nature. Thus, the actual evapotranspiration is a maximum during January - April where rainfall is abundant and approaches zero by the end of the dry season, i.e. in October - November.

Temperatures are lowest during June, July and August, and reach a maximum in November before the onset of rains. They range from a mean daily minimum of 11.4°C in July to a maximum of 28.6°C in November.

3 Socio-economic development

3.1 Pre-villagization (- 1974) population, settlement and agricultural development

Until the late 1940s, Ismani was sparsely populated by shifting cultivators growing millet and maize mostly for their own consumption. Despite the presence of the Dodoma-Iringa road, then the only link with the coast, the population had remained small, largely due to the lack of water for domestic use. The wild animals abounding in the miambo woodlands were also a nuisance, both for people and crops.

Within 20 years, Ismani was populated by immigrants, the forest and wild animals had disappeared, and it became known as the granary of Tanzania, producing about 20% of all officially marketed maize in the country.[1]

It was government incentives for large-scale commercial maize production, as well as growing markets, that brought the first immigrants to Ismani, where plenty of virgin land was available. They were people with money earned elsewhere to invest in large-scale clearing, hiring labour and, not least, bringing tankers with water from Iringa Town, some 20-50 km away, to support the labourers.

Soon, less wealthy settlers followed, including many of the initial labourers who took advantage of the nascent infrastructure created by the first settlers - and their sale of water.

Agriculture in Ismani has ever since been characterized by commercial monocropping of maize, supplemented with subsistence production of beans, sunflower and vegetables, and of course bamboo for both local consumption and sale of bamboo wine.

Most farmers cultivated their fields with ox-plough or tractor, owned or hired.

As new water supplies became available, first by construction of earth dams, later piped water, cattle herders were also attracted to the area, particularly by the good dry season grazing on the Ilambilole Mbuga, and towards Ruaha River in the North.

3.2 Post-villagization (1974 -)

In 1967, the Ismani population had reached some 35,000 people (with large seasonal differences).

With the type of agriculture practised, which some observers have called soil mining, yields had already begun to decline, when the government in the early 1970s

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[1] Feldman, Rayah. Ismani: Agricultural change and the politics of Ujamaa. University of East Anglia. August 1983, p.62.

introduced its new villagization policy. Whichever of the two factors might have been most prominent, together they had the effect of:

- forcing the large farmers out of Ismani;
- changing the settlement pattern into one of concentrated villages;
- intensifying land use in the vicinity of the villages;
- intensifying logging in the vicinity of the villages;
- declining agricultural output and economic degradation of the area;
- decreasing population between 1967 and 1978 and only 1.5% annual increase from 1978 to 1988.

As part of the villagization policy, the government followed up with efforts to promote the use of modern techniques, such as improved seeds, fertilizers and insecticides, though with less success in Ismani than elsewhere in the region, probably because of the less suitable rainfall regime.

Increasing population and commercialization have also given valley bottom cultivation an increasingly prominent place in the agricultural system in the region. Here up to three crops per year of tomatoes, onions, cabbage and other vegetables, beans and green maize are harvested, often for sale to the urban centres. A system of small canals are used for irrigation/drainage (depending on season). Compared to other parts of the region, Ismani has relatively limited possibilities for valley bottom cultivation. As map 2 shows, there are, however, important pockets in the south in Mbigiri, Kitumbuka, Irole and Mawala villages and in the north in Mkungugu and Nyakawangala villages.

Growing pressure on the grazing areas of (semi)nomadic Maasai and allied pastoralist groups has finally resulted in increasing seasonal visits by such people and their herds, especially in the northern part of Ismani.

3.3 Soil and water conservation

Growing awareness of the risks of soil erosion and degradation has led to initiation of two new development projects in the area in the late 1980s:

- One project run by the Irish NGO Concern promotes i.a. tree planting, contour bunding and use of manure in Ismani Division;

- the Danida-supported HIMA soil and water conservation project, which has as one of its objectives to protect water source catchment areas, is operative in Mazombe Division, where the intake catchment for the Ismani water supply is located. This project is integrated in Iringa District administration.

3.4 Politico-administrative structure

With the largely immigrant and ethnically mixed population of Ismani hardly anything remains in terms of traditional social institutions. Even those structures developed during the colonial and immediate post-colonial periods have more or less disappeared in the wake of villagization which established not only the new settlement and cultivation patterns, but also the present politico-administrative structure.

Tanzania is - still - a one party state, and at the local levels it is difficult to distinguish between party and government as the same units are both party and administrative units, and the same people often represent both party and government. (Which may mean, however, that although there are signs of an imminent transformation into a multiparty system and therefore the disappearance of the state party, the same units and people may to a large extent remain - as government!)

The most important local institution in the politico-administrative hierarchy is the village. All non-urban areas are divided into villages, normally with a fairly nucleated settlement of some 1-4000 people. Since villagization it has not been uncommon, however, for families to divide their residence between a house in the village nucleus and a house on their old shamba.

The village has a village government, with powers divided between an elected chairman; an appointed secretary (both paid); a village council divided into functional standing committees; and a political committee. The power balance varies from village to village. Land distribution; running of economic projects; regulations concerning environment, water, hygiene etc.; revenue collection; imposition of fines; etc. are all within the jurisdiction of the village government.

The villages are subdivided into ten-house-cells, varying in size from 5-25 households, with an elected ten-cell-leader whose main task is to act as communication link between village government and villagers - and thus make sure that village decisions are implemented by villagers. Sometimes the village council supplemented with the ten-cell-leaders is a powerful organ in the village.

The Ismani water scheme covers 21 villages (when rehabilitation and extension is finalized) which are all within the catchment area of the Mbunga River (table 1). Another 5 or 6 villages are at the margins of the catchment without being served by the water scheme.

From the village to the national level, the politico-administrative structure comprises wards, divisions, districts and regions. 5-15 villages comprise a ward and 3-5 wards a division. Each have a ward or divisional secretary. They are very powerful persons, since they represent at the same time both party, local government (District Council) and central government, and are responsible for the implementation of their decisions at the local level. All such matters are discussed in Ward Development Committees, consisting of all government staff (agriculture, forestry, health, community development, and village chairmen and secretaries in the ward and in divisional development committees with divisional government staff and representatives from the wards. Furthermore, the committees formulate annual development plans which are then brought forward to the next level in the hierarchy.

The Ismani area from north to south includes all of Malengamakali Ward and parts of Kihorogota and Nduli Wards in Ismani Division and parts of Irole Ward in Mazombe Division. Mbunga catchment includes the same areas, but also part of Image Ward in Mazombe Division and a small part falls within the boundary of Iringa township.

Only at district level is there a more clear distinction between local government: the District Council, its chairman and District Executive Director; central government represented by District Commissioner; and the Party (CCM) with its party committee and chairman. The District Councils consist of directly elected representatives from each ward, who are also on the local development committees, and often exert much influence in the system.

Most central government ministries at district level and below are under the District Council and their budgets - except for personnel matters and salaries. District Councils promulgate by-laws concerning a wide range of matters, including environmental protection and protection of water sources.

Finally, the regions have Regional Commissioners and non-decentralized ministerial staff representing the central government, and regional Party chairmen and committees managing party matters.

Table 1
Population by village, Ismani Water Scheme - Population Census 1988
(Source: Population Census, Regional Profile, Iringa. Bureau of Statistics, Dar es Salaam 1990)

Village	Population	Ward
Mbigiri	3376	Irole
Mawala	646	Irole
Subtotal (extension)	*4022*	
Kitumbuka	2424	Irole
Irole	1792	Irole
Ilambilole	2087	Nduli
Igingilanyi	1893	Nduli
Kising'a	1231	Nduli
Mkungugu	1375	Nduli
Ndolela	1618	Kihorogata
Mikongwi	922	Kihorogota
Ismani	1429	Kihorogota
Kihorogota	1187	Kihorogota
Ngano	857	Kihorogota
Nyang'oro	2345	Kihorogota
Igula	1177	Kihorogota
Mangawe	1640	Kihorogota
Subtotal (old scheme)	*21977*	
Iguluba	803	Malengamakali
Usolanga	1398	Malengamakali
Makadupa	548	Malengamakali
Mkulula	1396	Malengamakali
Nyakavangala	934	Malengamakali
Subtotal (extension)	*5079*	
Total	**31078**	

Estimated growth 1978-88:	Actual	1.5% p.a.
	WMP	1.0% p.a.
Apr. household size: 4.8-4.9	Households: 6,500	

3.5 Non-local institutions

Apart from the villages and pastoralists, there are a few non-local institutions in the area:

- When Zambia boycotted South Rhodesia, an oil pipeline was built from Dar es Salaam with one of its pumping stations at Mbigiri village and a police station to protect the line and pumping station;

- At Irole since the thirties, there has been a large Catholic mission, which now includes a dispensary and a college for nursery attendants;

- Ismani Tarafani and Usolanga have smaller mission stations and health centres;

- In Kising'a Uyole Agricultural Centre has established an experimental substation;

- Concern's large tree nursery is located in Mkungugu.

4 Water Resources Assessment

4.1 Surface water

4.1.1 Water quantity

There are no continuous stream-flow measurements within the Mbunga River catchment on basis of which to evaluate the available surface water resources. However - on behalf of the Danida financed Iringa Region Water Project - low flow measurements have been undertaken by the regional hydrologist at the intake sites in the Mgera and Kigasi Rivers since 1984.

In the low lands - say below 1500 m altitude in the southern and 1100 m in the northern part of the Mbunga catchment - the only presently known perennially flowing rivers are the Mgera and the Kigasi Rivers. There may however be possibilities for identifying additionally one or two perennially flowing streams in the northeastern part of the catchment - one being upstream the Ibaka Mbuga east of Nyakavangala.

Based on the figures for mean annual rainfall and actual evapotranspiration given in the previous section on climate we may roughly assume the mean annual net-rainfall (i.e. rainfall minus actual evapotranspiration) to vary from about 100 mm/year in the northern part of the area to about 200 mm/year in the southern part.

Because of the seasonal variations of the rainfall and the actual evapotranspiration (see section on climate) it can be concluded that maximum net-rainfall will occur during January to April whereas negative values approaching zero will occur during May to October - November (physically this means that part of the actual evapotranspiration is satisfied by depletion of soil water from the root zone). The seasonal variation of the net-rainfall means that the rivers in the area may be expected to start rising in November - December, experience a maximum flow in March - April and have their recession period from May to October - November. Most of the seasonal rivers may be expected to run dry during June - July.

Taking the average annual net-rainfall for the 2100 km^2 large Mbunga catchment to be 150 mm/year, enables us to calculate the total average run-off - whether as surface run-off or as ground water run-off - to be about 315 million m^3/year or expressed in another way *863,000 m^3/day*. It should be emphasized that this figure constitutes an *absolute upper limit* for the water resources that can be developed within the Mbunga catchment. In addition, it should be stressed that due to the above mentioned strong seasonality in the availability of the net-rainfall - and thus the stream flow - it would require the establishment of economically unrealistic storage facilities in order to develop a substantial part of these water resources.

Without storage facilities to store surplus water from the wet season to the dry it is only possible by the end of the dry season to take advantage of the amount naturally flowing in the streams.

Neither of the two intakes for the existing Ismani water scheme - i.e. Mgera and Kigasi -involve seasonal storage.

Taking the average net-rainfall for the 50 km^2 Mgera catchment to be 200 mm/year the absolute upper limit for the surface water resources in terms of stream flow is found to be about 27,400 m^3/day. Based on seven years (1984-90) of low flow measurements at the intake site, an average annual low flow of 88 litre/sec equivalent of 7,600 m^3/day as well as a 10-years annual low flow of 62 l/s has been found. Thus, under average conditions, apparently at most 1/4 of the total available surface water resources can be developed from the Mgera intake or downstream by direct intake without storage. The unused flow ends up in the low laying areas between Irole and Mawala, or eventually in the Ilambilole Mbuga from where most of the water evapotranspirate and the rest drains out either as stream flow through the Msembera River or as ground water seepage mainly through the Kigasi River.

Based on seven years (1984-90) of low flow measurements at the intake site in the Kigasi River, an annual low flow of 5.0 l/s equivalent of 430 m^3/day as well as a 10-years annual low flow of 3.5 l/s has been found. This is part of the aforementioned ground water seepage out of the Ilambilole Mbuga.

Presently, the Ismani water scheme may be assumed to divert in total about 15-1700 m^3/day equivalent to 17-20 l/s from the Mgera and Kigasi River intakes - of which about 14-16 l/s are taken from the Mgera intake and 3-4 l/s from the Kigasi intake.

The available direct observations of the low flows at the Mgera and Kigasi intake sites give no indication of any trends in the low flow characteristics of these rivers, induced e.g. by deforestation or other possible land use changes inside the catchment.

There are three old, still functioning 10-30,000 m^3 water ponds within the south-western part of the area established by means of earth dams (see figure 1). They are most probably constructed in the 1960's and at least the one near Nyang'oro has recently been desilted and equipped with a spillway. The ponds are mostly utilized for watering of livestock but also to some extent for domestic purposes in particular during periods of malfunctioning of the Ismani water scheme. They normally run dry by the end of the dry period.

An approximately 10-20,000 m^3 natural depression in the northwestern part of the Ilambilole Mbuga just south of Ilambilole village has been artificially deepened with the assistance of the Irish NGO Concern. It was still holding water in August 1991.

Due to favourable topographical conditions as well as the clayish soils, there is a potential for an additional number of water ponds within most of the Mbunga catchment. Thus, Concern has recently (1988-91) established a number of smaller water ponds in the area by utilizing local, manual labour. However, due to their shallow depth and the excessive evaporation losses these ponds do not hold water long into the dry period.

Rainwater harvesting from roofs is practised in connection with a few individual houses, institutions and missions within the area. There are no rock catchments in the area.

4.1.2 Water quality

Based on the testing of numerous samples, the physical and chemical quality of water from the Mgera and Kigasi intakes are found to be acceptable for domestic purposes according to Tanzanian and WHO standards. Water from the Kigasi intake is found to be slightly salty, corresponding to much higher values for total alkalinity and hardness as compared to water from the Mgera intake. This is fully explainable by the ground water origin of the Kigasi water.

The bacteriological quality of the water from both intakes is found to fall below established standards with too high faecal coliform countings, although the Kigasi water seems slightly better than the Mgera water.

This is a well known situation for many rural water supplies in East Africa. Although the intake may be placed relatively far upstream in the catchment area - as is the case for the Mgera intake - there will still often be some human settlements and livestock activities further upstream that contribute to some bacteriological pollution of the intake water.

Obviously from a pure water supply point of view it is unacceptable that say 30.000 people - present population of Ismani area - receive bacteriologically polluted water due to activities of say 300 people living upstream the intake - like in the Mgera intake catchment area. Thus, from that point of view it seems perfectly reasonable to aim at a solution where the whole intake catchment area is protected from human and livestock activities.

However, all experience - also for the Mgera intake catchment area (see section 6.5) - shows that in practice it is extremely difficult to achieve such an effective protection. There may be strong socio-economic, cultural and political reasons for this. Thus, effective protection implies that land resources in the hills - often particularly valuable due to better rainfall than in the downstream areas - will have to be more or less written off for ever while in addition alternative settlements for the displaced people will have to be found in the downstream areas.

The economic, social and political costs of effective catchment protection has often in practice proved to be higher than the locally felt benefits of receiving bacteriologically safe intake water in stead of slightly polluted. One of the reasons for this situation is that the locally felt benefits of slight improvements in the bacteriological water quality very often seems much less than the benefits ascribed to safe water by water specialists. In this connection it should be carefully kept in mind that many water use studies have proven that much pollution of household water in rural areas in Africa takes place in the time between the water collection at the communal water point and the use in the home.

The question of the bacteriological water quality in rural water supplies - and in particular piped supplies - in Africa is a very complicated and controversial one. From a pure technical point of view it is unacceptable to distribute water below established quality standards. In practice, however it is impossible to find enough naturally unpolluted sources or to rely on the sustainability of treatment facilities. As a consequence the distributed water in many cases in practice falls short of established quality standards - particularly as far as the bacteriological standard is concerned.

As for the Ismani water scheme, the most appropriate way of tackling the controversial water quality issue (see section 6.5) might be - with the assistance of community development workers - to try achieving the best possible cooperation with the people settled within the Mgera and Kigasi intake catchment areas aiming at an environmentally and socially balanced and sustainable utilization of the water, land and forest resources within these areas. Thereby it may be possible in the short term to improve the water quality - although probably not to ensure that it will be within established standards. In the longer term it is foreseen that the only way of ensuring bacteriologically safe water is by means of well functioning treatment facilities. Presently, it is impossible to give any indication of when the social and socio-economic development in the Ismani area will require and make possible sustainable operation and maintenance of such treatment facilities.

4.2 Ground water

There are a number of perennial springs originating within the higher parts of the catchment. According to the Iringa Water Master Plan (CCKK,1982) this is particularly so in the northeastern hill range - but they are also found in the eastern, southern and northern mountain ranges as well as in the Hambingetu Inselberg and in the hill range running in parallel with the Iringa - DSM road just north of Mbigiri. A few of these springs have been measured to have only negligible low flows. Others in the northern part of the area along the Mbunga River Valley are of juvenile origin and saline. There are no information available on the yields of the springs in the mountain ranges bounding the Mbunga catchment to the east and northeast.

During their visit to the Ismani area the authors were informed about the recent development of two springs in the lowland near Irole in an altitude of approximately 1460 m. Since 1974 these springs were only very low yielding. Then suddenly in May 1990 they started increasing their flow. To day the flows have stabilized itself on approximately 10 l/s and 3 l/s, respectively. They are utilized locally for irrigating areas of approximately 6 ha and 2 ha, respectively.

There are also a number of small springs in the lowland south of the Kigasi Hill near Mkungugu - all of them presumably originating from the ground water seepage out of the Ilambilole Mbuga. Some of these springs are utilized for minor irrigation.

According to the Iringa WMP (CCKK,1982) there is a quite good potential for the development of shallow ground water within the area. Thus, it is stated that perennial ground water of an acceptable quality is generally occurring within the saprolite anywhere on the African Surface covering most of the Ismani area. It was estimated that 80% of the villages can be served by nearby wells equipped with hand pumps.

However, more recent experience shows that although ground water is available north of a line connecting Izazi and Usolanga it is of doubtful quality due to high salinity. South of the Izazi - Usolanga line there is a potential for deep ground water of acceptable quality - although there is still a risk for saline water in isolated areas. Development of this ground water potential requires, however, mechanical drilling presumably to an average depth of 60 m and associated lifting heights close to 50 m. This is the main reason together with the doubtful water quality why otherwise plentiful ground water resources in the area are presently utilized only insignificantly.

Concern has on trial basis established a sand dam near Mkulula in a minor tributary to the Mbunga River. The preliminary results are not very promising.

During the dry season, traditional digging of holes in the bed of the major sand rivers like the Mbunga River takes place at a substantial scale. Thus, presently all water for human and livestock consumption during the dry season in Mkulula takes place from numerous 2-3 m deep temporary holes, dug in the sand bed of the Mbunga River.

5 Water usage and demands

The main users of water within the Mbunga catchment are households, institutions (schools, nurseries, health centres, administrative centres and offices, police stations, missions), livestock, forestry nurseries and irrigation. Additionally there is also some use of water for cooling and cleaning purposes in connection with the pumping station for the TAZAMA oil pipeline crossing through the area along the Iringa-DSM Road.

Whereas the other uses by nature are consumptive - that also goes for household water under rural conditions without piped sewage systems - it should be noted that water utilized in the TAZAMA pumping station basically is a non-consumptive use except for minor evaporation losses that might take place depending on the specific technical cooling arrangements.

Households. Based on the official 1988 Population Census figures the population within the supply area in 1988 is found to be 31,078. Similarly, based on official census figures the observed annual increase in population in the period 1978-88 amounts to 1.5%. Experience from rural water use studies undertaken as part of the Implementation of Water Master Plans for Iringa, Ruvuma and Mbeya Regions shows that the per capita consumption during the dry season is about 23 l/cap/day. Thus, the present dry season use of household water is a about 750 m^3/day. Similarly, the year 2006 dry season demand for household water may be estimated to 930 m^3/day based on the present per capita consumption and increase in population. Presently most of the water is provided from the Ismani water scheme while a minor part is taken from small springs, water ponds and traditional water sources like dug holes in the dry river beds.

Institutions. On the basis of presently available information it is not possible to make any accurate calculations of neither the present water use nor the future demand. However, based on experience from other similar rural settings in East Africa the total institutional water demands may be estimated roughly on the basis of the population figures. Thus, it is often found that the institutions necessary for the normal functioning (i.e. excluding missions and police station) of a rural community require water in the amount of 5-10 l/cap/day in addition to the household demand. Accepting 7 l/cap/day as a mean figure and assuming a water demand of 30 m^3/day for each of the Irole, Usolanga and Ismani-Tarafani missions and 50 m^3/day for the police station at Mbigiri we arrive at a present institutional water use of 370 m^3/day and a 2006 institutional water demand of 430 m^3/day. Presently most of the water is provided from the Ismani water scheme.

Livestock. Based on the official 1984 Livestock Census it may be estimated that there are in round figures 43,000 local cattle and 30,000 sheep and goats within the supply area. Taking the specific water demands to be 25 l/day per local cattle and 5 l/day per sheep or goat we arrive at a present water demand for livestock of 1230 m^3/day. With the present lack of knowledge about e.g. the carrying capacity of the area taking into consideration environmental degradation it is difficult to foresee the development in the number of livestock and thus the resulting future water demand for livestock. Presently the water is provided partly from the Ismani water scheme and partly from water ponds, small springs, streams, rivers and traditional water sources like dug holes in the dry river beds.

Forestry nurseries. The NGO Concern is presently involved in an integrated development programme supposed to cover the whole Ismani Division - constituting more than 70% of the Ismani area - and involving a forestry and tree-planting component. The Danida supported Iringa Soil and Water Conservation Project is not foreseen to have forestry activities within the Mbunga catchment in the nearby future. Presently Concern runs a forest nursery near Mkungugu. Based on the present production rate of seedlings it is roughly assumed that the water demand in the dry season is about 50 m^3/day. The necessary water is taken from the Kigasi River downstream of the Kigasi intake for the Ismani water scheme. Concern is planning establishing another nursery with a similar capacity near Nyang'oro taking the needed 50 m^3/day irrigation water from a nearby spring at Kibonyi.

Irrigation. All the year around irrigation - primarily for growing of vegetables - takes place at several locations within the Mbunga catchment. Most intensively it is undertaken at Mbigiri - in the Mgera River valley along the Iringa-DSM road - where approximately 90 ha of land are under irrigation utilizing water from the Mgera River downstream the intake of the Ismani water scheme. Further downstream, the Mgera valley - near Mawala - additionally 6-10 ha are irrigated by the Mgera River. Near Irole 8-10 ha are irrigated utilizing water from the recently developed two springs in the area. Irrigation is also known to take place in the lowland south of Kigasi Hill near Mkungugu, at the artificially deepened depression near Ilambilole and in the Ibaka River valley east of Nyakavangala. Thus, presently in total approximately 120 ha of land may be assumed to be under irrigation within the Mbunga catchment. Taking the mean annual rainfall and the potential evapotranspiration to be about 700 mm/year and 1500 mm/year, respectively we can calculate the average annual irrigation demand to be approximately 960,000 m^3/year equivalent to 2600 m^3/day. It has however to be noted that the water demand for the irrigation of all the 120 ha during the dry season is substantially higher, say about 10,500 m^3/day.

TAZAMA Pumping Station. The main water use is for different cleaning purposes. In addition water is also utilized for cooling of engines and for domestic use in staff houses. According to provided information the daily water use amounts to approximately 15-20 m^3/day. However, as mentioned above most of these uses are basically non-consumptive. After use the heavily oil-polluted waste water is returned untreated to the Mgera River through an open ditch and thereby contributing seriously to its pollution. Approximately 4-500 m^3 of water are at all times kept in an open ground tank as a fire fighting reserve.

Table 2 summarizes the present and future water usage and demands within the Ismani area, while their location within the area is shown in maps 2 and 3.

Table 2
Water usage and demands by water use category

Water Use Category	Water Usage and Demands	
	Present m^3/day	Future m^3/day
Households	750	930
Institutions	370	430
Livestock	1230	?
Forestry nurseries	50-100	?
Irrigation	2600-10,500	?
TAZAMA Pumping Station	20	?

Comparing the above listed figures for water usage and demands with the available water resources - as described in section 4 on Water Resources Assessment - it is clearly seen that based only on average figures the Mbunga catchment is very well endowed with water now and in the future. Thus, the present maximum water usage of 13,000 m^3/day - including all uses - only amounts to less than 2% of the total average run-off of 863,000 m^3/day from the Mbunga catchment. Therefore, there seems to be no constraining physical limitations - as far as water resources are concerned - for future development within the Ismani area.

A closer comparison, however, between the water usage and demand figures on one side and the available water resources on the other side also shows that the present rather intensive irrigation utilization of the low flows in the rivers within the area - like e.g. the Mgera River - give very little room for further expansion applying the present technology, mainly consisting in diverting water directly from the rivers or springs into the irrigation canals without any seasonal storage.

Furthermore, in practice the costs involved in developing a significantly larger part of these water resources, than already done to day, will set strict limitations for such a development - simply because the potential main users within the area i.e. domestic, livestock and irrigation most probably to a large extent will be unable to bear these costs.

Thus, even though there might be reasonably good topographical and hydrological potentials for establishing large surface water reservoirs by the construction of dams in the mountains enclosing the Ismani area, the involved costs might prove prohibitively high to enable economically sound use of the water for any foreseeable future activities within the Ismani area.

Similarly, even though there might be a reasonably good hydrogeological potential for developing significant ground water resources by means of deep boreholes equipped with mechanical pumps, the capital and recurrent costs involved in doing so will be relatively high as compared with the costs of to days development technologies.

To which extent water harvesting technologies like roof catchments, rock catchments, subsurface and sand dams as well as water ponds established by small earth dams may prove economically viable in the area, it is difficult to say - but definitely several of these options are hydrologically and technically feasible.

In order to utilize the more easily developed water resources most efficient and cost effective, it could be considered whether any particular water sources should be allocated for any specific water use, say e.g. domestic water from the upstream parts of rivers and springs as well as ground water, livestock water from the more easily polluted water ponds and irrigation from the downstream parts of rivers. Thus, in most cases e.g. it is totally uneconomic - except for a benefitting individual - to utilize piped water for any kind of irrigation.

6 Water resource management

Water resource management, as described in the introduction, takes place in a hierarchy of social organizations maintaining different water sources, and extracting and distributing the resources to different users for different purposes.

The lowest level of water management is within the individual household deciding on water collection and use for household purposes and the exploitation of rain - or irrigation water for crops in its fields.

Beyond the household level, probably the most important management task, requiring social organization, is to level out conflicting interests in relation to the maintenance, extraction and distribution of the water sources.

Such conflicting interests may be between individual users, but also between upstream and downstream users, and between different water use sectors, and they may concern different types of sources.

6.1 The water supply scheme

6.1.1 Problems of resource management

Most present conflicting interests and thus water management problems in Ismani relate directly to the existence of the water supply scheme.

When the water scheme was first constructed in the late 1960s, little use was made of the water in the Mgera River besides household use by the people living upstream along the river, before it disappeared in the Ilambilole Mbuga. Shortly after villagization took place, resulting in a scheme coverage of 14 of the Ismani villages (indicated with an E on map 4). However, even in villages covered, large parts of the population lived far from existing water posts, while some posts were abandoned because nobody was living within reach of them. The same was the case with the small number of cattle troughs. So there were people establishing lucrative businesses ferrying water by donkey cart to unserved villages, while in other parts deliberate damage was inflicted on the system in order to obtain water. Maintenance deteriorated as government abilities disappeared with the economic crisis and nobody else felt any responsibility.

By 1980-82, when the Iringa WMP was made, the situation in terms of people lacking water because of bad coverage and breakages had become so grave that rehabilitation of the scheme was given high priority, and was started in 1984-85.

During rehabilitation, it is also planned to increase coverage within all villages, and to extend the system to 21 villages, including the 5 indicated to the northeast on the map and 2 bordering the old scheme to the southeast.

During pre-design investigations, it was found that problems in the water scheme were caused by the following management problems in the supply area:

- lack of maintenance;
- use or leakages in 'upstream' villages would reduce supply to those further down stream;
- over-use and breakdowns at cattle troughs and deliberate breakages in order to get enough water for the increasing cattle population;
- pipe breakage by hunters in order to attract wild animals;
- households with individual connections could use the water for irrigation;
- non-scheme villages being served by ox or donkey cart.

Later, an additional demand has been created by the new soil and water conservation projects:

- watering tree nurseries and new tree plantings.

Investigations also showed that not only did the scheme itself need rehabilitation; there was also an intake capacity problem, caused by development that had taken place after the construction of the scheme.

In the 1970s, the Dar es Salaam-Lusaka oil pipe was constructed and the road tarred, whereby three new water uses were introduced:

- A pumping station for the pipeline was located with an intake for cooling water for the engines above the Ismani GWS intake.

- Police barracks for pipeline and pumping station guards also pumped their water from the same location.

- All along the road, which gave easy access to the canning factory in Iringa and the Dar es Salaam market, population increased and people started growing irrigated tomatoes along streams, including Mgera River, especially where it passes Mbigiri village along the road just upstream of the Ismani GWS intake.

6.1.2 Water tap management

During physical rehabilitation of the water scheme a new management system has also been introduced at tap, village and scheme levels.

It is clearly visible that this has been highly successful at tap level: All taps seen during the field work for this study seemed to functioning, with only one running unclosed. Aprons and surrounding areas were clean, and all taps had fences to keep animals out.

The system is based on very simple neighbourhood organizations: The users elect one or two tap attendants, often women living nearby, who look after the tap. If something is wrong they call the village scheme attendants to repair or replace the tap. If replacement is needed, money is collected among the users to pay for it. Tap attendants also call on the users to maintain cleanliness, the fence etc. For this they may work through the ten cell leaders in the area, or they may have a system of taking turns, indicated e.g. with a bottle circulating between the households (the women!) at given intervals.

6.1.3 Village level management

The most important level of local management of maintenance *and* use of the water source (the scheme) is, however, the village.

The Danida/Ministry of Water rehabilitation project to this end introduced two major changes, one technical, one social. The water supply system was reconstructed, so that all taps and cattle troughs are connected to a distribution system supplied from a village tank, meaning that the amount of water which taps and troughs in a village can extract from the system is limited by the design capacity of the village tank(s). Villagers thus have an immediate interest in regulating water use in the village.

At the same time village ownership and responsibility for operation and maintenance of the village scheme has been introduced and a Village Water Committee (VWC) established to manage this responsibility.

The VWC is supposed to supervise maintenance done by the trained village scheme attendants, and to maintain a village water fund to cover allowances to village scheme attendants and payment for required spare parts. It is also the task of the VWC to regulate water use in the village.

In both respects, the VWCs have so far been heavily supported by the water project in terms of training, follow-up, attendance at meetings, contacts with village governments, setting regulations etc.

Especially the village level maintenance seems to function, since no important faults were reported to be recurring in distribution systems. This is, however, in spite of the fact that scheme attendants are often not paid for months, and still mainly based on the stock of spares given to villages at handover.

Apart from VWC efforts to avoid direct waste, other regulations of water use have been imposed by the water project, to be *implemented* by VWCs:

- The use of water from the scheme for irrigation is prohibited;

- Private house connections, apart from those existing before rehabilitation, are not allowed.

Both regulations are explained by the limited capacity of the system, and the first is clearly seen as reasonable and a help for the VWC as widespread water use for irrigation clearly *would* strain the system beyond capacity. As design capacity allows for 20 years population growth there is, on the other hand, presently a surplus capacity, which many people feel would not be endangered by allowing house-connections against cost coverage and extra contribution to the village water fund. Consequently the water project has had to intervene in some cases to uphold the rule.

Ilambilole and Mawala villages had invented another way of boosting the water fund: By licensing commercial water-mongers from neighbouring Uhambingeto and Vitono villages to collect water on ass-carts against a fee. Mawala has, however, discontinued the practice after they began experiencing capacity problems.

The VWC is a directly elected subcommittee under one of the standing committees in the village government. Since it is not formally part of the village government there has, however, been a lot of ambiguity over its status. On the one hand the VWC can thus formally only introduce village by-laws to regulate water use or contributing to operation and maintenance through the village government, and there is competition between the two over handling of water funds. On the other hand, the VWC can command a lot of support from the water project.

6.1.4 Water scheme management

The ambiguous status of the VWC is even more marked at group scheme level, for the Group Scheme Committee. This is an institution established exclusively in Danida/Ministry of Water projects covering several villages. It has two members from each village in the scheme, but apparently it is only the so-called "core group" of chairman, secretary and 4 other elected members that meet 2-4 times a year. When the core group meets, members are often supplemented by Ward and Divisional Secretaries as well as District Council members from the wards. This helps to give the meetings some of the status which is otherwise lacking because the committee is entirely outside the formal government system.

The committee meets to discuss general scheme matters. But as it has no formal authority, the only joint action it has so far undertaken is to collect money from scheme villages to top up the payment of the scheme attendants in Mbigiri village for their work on maintaining the intake. Even in the collection of these money it had to enlist the help of Ward and Divisional Secretaries.

When discussing the problem of people living in the intake catchment area (see below), the committee refrained from taking any decisions, apart from appointing representatives to meet with Mbigiri village government and request it to take action!

The main function of the committee, therefore, seems to be to present grievances over scheme problems, e.g. complaints over frequent breakages of old asbestos mainlines, and requests for help to the Danida/Ministry of Water project personnel. For the members this is clearly a highly relevant function, realising that in reality all important decisions concerning water management in the scheme as a whole seems to be taken at project level, by project personnel or in the Regional Steering Committee set up for the project. This includes e.g. the above mentioned regulations on irrigation and house connections and decisions on institutional connections, on extension of scheme to other villages, on cattle troughs, on location of intakes, on village tanks etc.

On some of these questions not all members have common interests, as demonstrated by repeated requests from non-village representatives to extend the scheme to more villages - which is clearly not in the interest of those presently included, both for technical and organizational reasons. This is not, however, the case with the proposed extension to Lugalo village, as it is obviously a scheme management problem that the main transmission line passes through part of the village, while villagers have to pass over the line to collect water from Mgera River, far below the intake. The technical problem is that because of the altitude, it would not be possible to bring water all the way up to the main settlement area.

6.2 Water for cattle

Before rehabilitation of the scheme cattle owners were regarded as a major threat to its sustainability, being accused of deliberately breaking pipes to get water for their cattle.

One solution proposed was to rehabilitate and possibly increase the number of earth dams, to provide a supplementary source of water for cattle in the dry season. Some of the largest cattle herders in the area, the Maasai, expressed willingness to contribute to this solution. However, since it was not within the terms of reference of the water project to provide water to cattle, further investigations into this possibility did not materialize - and no other solution to the problem of water for cattle was suggested, apart from forcibly removing the pastoralists as proposed by the District Water Engineer.

Now that the scheme has been put into working order and an operation and maintenance system is established at tap, trough and village levels, the problem is vastly reduced as cattle owners in the present scheme area seem content with using the cattle troughs supplemented with seasonal sources.

For several reasons, the water project is considering not to supply cattle troughs in the scheme extension to the five northern villages, which have the highest cattle population in the area. Such a decision is of course highly sensitive, and requires very careful consideration of potential management <u>and</u> development of alternative water sources for cattle.

Presently, cattle herds are divided in the dry season, the larger parts of the large herds being grazed and watered away from Ismani, while those remaining get water from holes dug in the dry river bed, where the water table is some 2-10 feet below the surface. Such holes are dug and maintained by groups of people, and nobody can be denied the right to dig water holes. The work involved, and the time it takes to water cattle this way, put limits to dry season herd size, which is also beneficial for plant cover. One reason for not providing cattle troughs is to protect plant cover by not inviting all cattle to remain also in the dry season.

The problem of course is, whether this can be avoided anyway, once the water is actually there, in the pipes, even if it does not run into a cattle trough?

Just how vital water for cattle is in the area is demonstrated by traditional water management as recalled by an early settler: Before 1962 there was no dry season flow in the river bed, and the whole Northern area had only two water sources. Springs, where water collected so slowly that women would queue from one day to the next to fill their calabashes. Everybody, natives and immigrants, had the same right to water and waited for their turn. But next to the water hole used for collection of household water, there was another hole also with water seeping in, but exclusively reserved for watering the native people's cattle!

It may finally be speculated that an unintended cause has recently helped easing management problems related to cattle watering in the present scheme area and may do so in the Northern area as well: There are indications that the introduction of a local cattle tax in the late 1980s has reduced cattle herds in the villages in the sense that cattle owners prefer to keep at least parts of their herds permanently away from the populated plain areas and the control of the authorities to avoid taxation.

6.3 Irrigation

As we have seen, intensive canal irrigated agriculture has become economically important and is practised wherever land and water resources allow it. Source water is distributed by gravity through a fine network of small canals, which can be opened and closed to allow an equal flow to all fields within a certain time period.

One spring-fed system in Irole, for example, has two main sections, each getting water alternately for two days. Within the section getting water, each small plot is ensured water in its canal two hours per day (or night). All such systems seem to have variations of the same organization.

Management, i.e. distribution of water time, is done in meetings of all the people cultivating plots in the system, with no official authority involved. As long as systems are of limited size, and there is water enough for the plots that can reasonably be reached, this management organization is said to work, which is actually in most cases.

But when so much land is located within physical reach, that the amount of water becomes a limiting factor, especially towards the end of the dry season, there is no regulating mechanism, and, as the District Agricultural Officer, who is also a local farmer, put it: "Then there is chaos!"

In Mbigiri, where some 90 ha are under irrigation, a new upper and outer canal has been added this year, and some farmers predicted that in October-November the stronger's right will prevail - especially at night - when it comes to opening and closing canals.

Normally, then, the right to irrigation water follows the use right to the land - which still follows traditional tenure rules, as valley bottom land was not included in the re-distribution taking place during villagization.

In Mbigiri, for example, this means that some 20% of the households have rights to irrigation land while another 30% borrow (rent!) such land from the former (estimate by village leaders, so probably the distribution is even more uneven in reality!).

6.4 Competing water use sectors

6.4.1 Water rights

One of the problems of the old water scheme was the competition between water use sectors over the water in Mgera River.

Upstream of the water scheme intake were the intakes from which water was pumped to the TAZAMA pumping station and the police camp and further up the large irrigation area in Mbigiri, while downstream people from Lugalo village collected household water and shared an irrigation area with Irole, and Irole Mission had been pumping water from the river since the 1940s.

In principle, such conflicting water demands should be managed in accordance with the Tanzanian law on water rights, dating back to the colonial times, changed in 1974 and with most recent amendments in 1981. According to this law, any extraction of water from a water body, be it by canal, mechanically, or by any other means for any purpose, needs a water right. Before 1974, water rights were issued by the National Water Board, but since then by either the Regional or the National Board depending on whether the source is designated as a national water body or not. In 1981, a River Basin Water Board was added, but so far only one such body has been designated.

The applicant applies for and is granted the right to extract a certain amount of water. The quantity and quality of water returned has to be stated, as well as the purpose of the extraction, and any person who may be affected by the water right. In the case of rural water supplies, the District Executive Director applies on behalf of the villages, and in other cases he has to be heard on their behalf.

Applicants pay a fee of 50 Tsh, which has remained unchanged since 1959 (now 1/4 US$).

Water rights can be revoked if other purposes get higher priority.

The water project has a national water right from 1967, which has not been renewed in relation to any of the changes since then. Apart from that, the Regional Water Engineers office had some difficulty in finding other rights on the Mgera river, but it appears that TAZAMA in 1972 received a water right for half the present use, for *domestic* purposes.

It is clear, then, that the law is hardly used as a tool for water resource management, especially since the type of extraction needing a water right is defined to exclude "traditional dry season valley bottom cultivation", i.e. most peasant irrigation in Iringa Region does not even in principle need a water right.

6.4.2 Other management tools

Apart from the allocation of water rights, no formal system for regulation of water use from natural sources exists at present. During planning of rehabilitation of the water scheme, the principal choice, therefore, was to look for technical solutions.

One such possible solution, proposed by the regional water planners, was to move the intake upstream, to give it 'priority' over oil pumping station, police barracks and tomato irrigation in Mbigiri and to improve water quality.

This solution was discussed with the involved parties: TAZAMA (pipeline), the regional police commander and the village government in Mbigiri, but with only the water project as representative for the 20 scheme villages. A compromise was reached with TAZAMA and the police, so that they would be hooked onto the Mbigiri village tank for their household needs only.

The TAZAMA pumping station was rejected connection to the water scheme by the project, and is still pumping water directly from the river. As they claim to experience water problems towards the end of the dry season, station leaders are still pressing for a connection.

In the Mbigiri village assembly (all villagers), opposition was voiced by tomato growers, but it turned out that they comprised only a minority of large landowners, while the majority of households would benefit by getting piped water in the village from the new intake.

It is actually claimed furthermore that they have been able to increase the irrigated area since the intake was moved - but only this year will be a real test, as it is the first relatively dry year since the new intake was constructed.

Further down the line, similar management decisions have also been taken by the water project, allowing missions in Irole and Ismani connection with village distribution systems, while Concern's tree nursery and Uyole's experimental substation were rejected water for irrigation.

6.5 Mgera intake catchment area

In 1984-85 the water project decided to move the intake for the water project upstream of Mbigiri to avoid settlement above the intake.

Already during the first steps by project personnel to introduce the project in Mbigiri it was, however, discovered that one of its sub-villages, named Mgodi and Kilendi after the two source branches of Mgera River, was located much further up above the new intake site.

It seems that the people had been removed at the time of villagization but had later been allowed back, and they are said to possess a document from 1978 from the Prime Minister's Office allowing them to live in the area.

Actually, this is only one small part of the fairly densely populated hill-areas rising from West, North and East towards the highland Kising'a-Lugalo Forest Reserve, which are also catchments for the water sources for other surrounding villages, such as Kitelewazi, Mazombe and Ilula.

In one of its first meetings in early 1989 the Ismani Group Scheme Committee raised the problem of contamination caused by people living at Mgodi and Kilendi. Lacking the authority to take direct action, GSC representatives soon after met with Mbigiri village government, which agreed to make people move further away from the river and take care of the environment.

The following month two environmental inspections were made by project community development and health personnel together with agricultural field officer, village chairman, GSC secretary and VWC chairman. The results, showing many sources of water pollution, were presented to a Village Council and VWC meeting in Mbigiri and to a sub-village assembly meeting (not a formal institution, but consisting of all villagers - 209 in number) in Mgodi and Kilendi in May 1989. The latter meeting agreed on a number of bye-laws on environmental hygiene, a fine for breaking them, and elected a 12 member committee to supervise enforcement.

In August it was, however, reported that the District Council after consultation with the District Party Office had planned to evict villagers form the area above the Ismani intake. The District Commissioner held a meeting in Mgodi and Kilendi to effectuate the decision and apparently police was also involved. In his July-September 1989 report the RWE laconically states, under the heading "Institution building", that due to contamination of the water source, the district decided to move the settlement. "People have been cooperative and have now moved".

Already in the 89-90 agricultural season, some were back cultivating their fields. And it is said, that when the Forest Department in 1990 employed labourers to work on boundary demarcation for the forest reserve, a good number of those employed were people from Mgodi and Kilendi using the opportunity to come back.

In 1991 agriculture and cattle boma's are clearly reestablished and most houses inhabited, although doors are locked and people take refuge in the bush when foreigners approach.

In 1989 there were some 70 households or 350 people in the area. Many are now said to maintain "twin residence" in Mgodi or Kilendi and in their new village. There were 5-6 Ten house cells and cell leaders. No formal leadership system exists today.

Apart from agriculture and grazing it is clear, that fairly widespread illegal charcoal burning takes place especially in the area between the intake and Mgodi and Kilendi sub-village - where incidentally cattle from Mbigiri proper is also grazing. It is unknown who the charcoal burners are, but some are said to carry on rather unchecked, as they have an "unofficial licence". The same may be the case with logging in the forrest reserve, not for charcoal, but for timber for building.

In 1990 the water project carried out a tree planing campaign in some of its intake catchments, apparently with limited success. The campaign did not include the Ismani scheme.

7 Economic aspects of present water management

The basic concept of water in the project area is one of a free good available to all - when it is there. A vital traditional rule, which is still unbreakable, is that you cannot deny a person water to drink, be it from the store in your house or from a source on your land. This is carried over into the very unrestrictive forms of regulating other water uses.

Until very recently this traditional concept of water has furthermore been reinforced by the strong party and government policy principle of regarding basic water supply as a free social service.

The economic crisis - and strong donor pressure - has managed to force a breach in this policy, as it is now accepted that users of water supplies must shoulder the major burden of operation and maintenance costs, while capital costs are still financed entirely by the government (read donors), except for self-help labour.

Village level responsibility for operation and maintenance was introduced early in the Danida water project and is now a well established and accepted principle.

Broken taps are replaced with contribution from tap-users. Most project villages have a water fund to which all households are supposed to contribute a fixed monthly or annual amount.

Four villages in Irole Ward, for example, had water funds of 5,000 shs, 8,000 shs, 13,000 shs and 16,000 shs, respectively, in February 1990, with contributions of 20 shs per household/month or 50 shs per person/year (50 shs = the price of 2-3 kg of maize or the daily pay for a casual labourer). The allowances for village scheme attendants vary around 600 shs/month - when they are paid.

People with house connections are supposed to pay 50 shs/month to the village water fund, and institutions which are connected also pay into the fund. TAZAMA, which got a DP for household use, is supposed to pay 100 shs/month to Mbigiri, while the police station should pay 50 shs per household/month for house connection. Both signed agreements to this effect with Mbigiri village in 1987, but until today neither have paid, so that the regional police commander has accumulated a debt of 53,000 shs and TAZAMA one of 5,000 shs to the village water fund.

Obviously, with this behaviour by public institutions in mind, it is difficult for the village chairman in Mbigiri to understand why he should reject an offer of 10,000 shs from a German settler to get his chicken farm in the village connected to the water supply!

In the Ismani GWS, villages have agreed to contribute 2,500 shs each per year to a common fund, especially for operation and maintenance of the intake. In 1989 and 90 51,000 shs were collected, but while 17 villages paid in 1989, only 9 did so in 1990, and by mid-1991 no village had yet paid its contribution.

Finally, we have seen above that where there is a shortage, water may be sold at a price - but not water at the source, only when it has been transported to another place. The price water-mongers pay to the water fund in Ilambilole is not for the water as such, but to contribute to maintaining its transportation by the water scheme.

The only form of payment for water at the source existing is the fee demanded for allocation of a formal water right. The amount of 50 or 100 shs once and for all makes it only a nominal token, however.

When Maasai cattle herders contribute to maintenance of cattle troughs and declare their willingness to cover the cost of earth dam construction, and when farmers "borrow" land for cultivation of irrigated tomatoes against some kind of rent, then it is of course because they realize that water does have a value - but it would go against strong feelings to charge it directly against the water.

The District Council has, however, introduced taxes on cattle and marketed onions and tomatoes, the main commercial crops in small scale irrigation. For the crops a 10% fee is divided between 3% to the village and 7% to the district. Channelling some of these resources into the water fund might help to introduce the idea, that in commercial production water cannot remain a free means of production, with no costs.

There are no thoughts whatsoever of using economic means to *regulate* the use of water.

8 Appropriate levels and instruments for water resource management

8.1 Physical hierarchy

Structuring available water resources - whether naturally occurring or technically improved - in a hierarchical system to be utilized in connection with the selection of appropriate administrative levels for the management of water as a natural resource, is by no means a self-evident exercise. It is, however, possible to identify a few physical aspects of the water resource that have to be taken into account:

- *Quantity*. Naturally it is of utmost importance whether we are dealing with say a *small, medium* or *large* water resource. The quantity may be measured in different units such as m^3 per year, m^3 per day or litre per second. We shall later on return to a discussion of appropriate quantitative definitions of the terms *small, medium* and *large* water resources expressed in these units.

- *Reliability* in time. For obvious reasons it is important to take into consideration whether we are dealing with a *seasonal* or a *perennial* water source.

- *Location* within catchment. The value of a water source often depends on its specific location within the catchment, and in particular whether it is located at high or low level - or expressed in another way whether it is located *up- or downstream* in the catchment or in relation to other resources. Generally speaking, an upstream water source is more valuable than a downstream of the same size, as the upstream water source can be distributed by gravity over a larger area and as its water quality often will be superior to the downstream water source.

By combining the different possible states - i.e. *small, medium* and *large* for quantity; *seasonal* and *perennial* for reliability, and *up- and downstream* for location - we obtain in total 12 different categories that can be utilized for the physical characterization of a specific water resource. Thus, one water resource may e.g. be categorized as *small/seasonal/upstream* while another may be categorized as *medium/perennial/downstream.*

In table 3, all known water sources within the Ismani area have been categorized according to the suggested system. In this connection, a water source has somewhat arbitrarily been taken as

- *small* if its yield is less than approximately 0.5 l/s - equivalent to the average yield of a single tap domestic point, a cattle trough or a shallow well equipped with a hand pump;

- *medium* if its yield is greater than 0.5 l/s but smaller than say 5 l/s; and

- *large* if the yield of the water source is greater than 5 l/s.

Table 3
Categorization of different water sources in the Ismani area

Category of Water Res.	Physical Description of Water Resource	Water Resource used for (H: Household; L: Livestock; I: Irrigation) and where in Ismani Area
1. Small Season. Dwnstr.	- Traditional water holes - Roof catchment	H,L. Everywhere H. Few missions & other houses
2. Small Season. Upstr.	- Small springs/streams in hills	H,L,I. Everywhere
3. Small Perenn. Dwnstr.	- Ground & rock catchments - Tempor. dug holes in river beds - Small springs - Domest. point & cattle trough - Shallow wells with handpumps	H,L,I. Nowhere as yet H,L. Mbunga River near Mkulula I. Near Kigasi (not intake) H,L. Everywhere in Ismani Area H. Nowhere as yet
4. Small Perenn. Upstr.	- Small springs/streams in hills	H,L,I. Mbigiri, Hambinget Makadupa, Nyakangavala
5. Medium Season. Dwnstr.	- Small earth dams - Artificially deepened depressions - Small sand & subsurface dams - Rivers/streams	H,L,I. Mkungugu, Igingilanyi, Nduli, Chamndindi (Concern) H,L,I. Ilambilole in mbuga H,L,I. Mkulula (Concern) H,L,I
6. Large Season. Dwnstr.	- Rivers/streams - Mbugas	H,L,I. Mbunga, Msembera rivers L,I. Ilambilole, Ibaka, Ilofya
7. Medium Season. Upstr.	- Springs/streams in the hills	H,L,I. Probably in NE & E
8. Medium Perenn. Dwnstr.	- Water tanks in Ismani WS - Medium earth dams - Rivers/streams - Artificially deepened depressions - Deep borehole with mechanical pump	H,L. Everywhere in Ismani Area H,L,I. Nduli, Mkungugu, Nyang' H,L,I. Ilole, Mawala H,L,I. At mbuga's. Nowhere yet H,L. Nyakangavala. Saline
9. Medium Perenn. Upstr.	- Springs in lowland - Springs/streams in the hills	H,L,I. Ilole. Presently most I H,L,I. Upstream Mgera river & Ibaka & Makadupa rivers in NE
10. Large Perenn. Dwnstr.	--------	--------
11. Large Season Upstr.	--------	--------
12. Large Perenn. Upstr.	- Springs/streams in the hills - Streams/springs in lowlands - Intake of Ismani WS - Mechanical pumping from rivers	H,L,I. Mgera River in S and perhaps Ibaka River in NE H,L,I. At Kigasi intake H,L. Everywhere in Ismani Area TAZAMA. Ground tank

It should be noted finally that the physical categories are non-exhaustive and relative, as they are defined in relation to this particular case, while different categories and criteria may be more useful at another time or in a different area. For example, instead of the seasonal/perennial dichotomy, it could be important to distinguish purely rainy season sources from seasonal sources that remain well into the dry season, or it might in some cases be argued that the water quality should also be taken into account. For the present case, however, we will - with reference to the discussion of the water quality issues in section 4.1 - restrict ourselves to the three aspects *quantity*, *reliability* and *location.*

8.2 The existing social hierarchy

The existing social hierarchy (as described in more detail in section 3.4 and presented schematically in table 4) coincides only at specific points with the physical hierarchy of water resources.

The formal politico-administrative structure building up from the household over ten-house-cell, village, ward, division, district and region to the nation, is in no instance related to the area connected to a particular water resource nor to the usage of such a resource. Politico-administrative boundaries inevitably cut across physical boundaries, and water resource management is not an important function of these institutions.

For this reason, particular social institutions have in some cases been formed with the sole purpose of managing a specific water resource. These may be formal or informal, and they may be inserted as a new level in the politico-administrative hierarchy, they may coincide with an existing level, or they may cut across existing institutions.

In Ismani area, we have seen that in the northern part, groups of a few households cooperate as water-hole groups in the dry season; tap and cattle trough users, including several ten-house-cells, have important responsibilities at the lowest level of operation and maintenance in the water scheme, for which they furthermore refer to Village Water Committees established at the village level but not part of the usual village government structure; people sharing the same source of water for canal irrigation form informal groups, usually across ten-house-cells, but within villages, though Irole and Lugalo people from both villages join in one group. The Ismani Group Scheme Committee comprises villages from 4 different wards in 2 divisions. At the regional level, there is the Regional Water Board, although it seems to be the intention of the 1982 water law amendment to replace it with River Basin Water Boards, cutting across the administrative boundaries. Under the Ministry of Water there is a Central Water Board.

Table 4
The social hierarchy in relation to Ismani area

Politico-administrative organization	Water-related institutions
1. (Household)	1. (Household)
	2. Water hole group
3. Ten-house-cell	
	4. Irrigation group
	5. Tap users
6. Village	7. Village Water Committee
8. Ward	
	9. Group Scheme Committee
10. Division	
11. District	
12. Region	13. Regional Water Board
	14. Central Water Board

8.3 Water Resource Management hierarchy

The physical and social hierarchies identified in sections 8.1. and 8.2 may now be used as the basis for a discussion of the appropriate water management hierarchy in the Ismani area.

As a tool to illustrate the discussion, a matrix of the two hierarchies is constructed in Table 5.

Table 5
Proposed Water Resource Management in Ismani area

Social hierarchy		Water resource categories									
		Small, seasonal, perennial				Seasonal, downstream		Medium, seasonal, perennial			Large, permanent
Administration	Water	1. D.	2. Up	3. D	4. Up	5. Med	6. Large	7. Up	8. D.	9. Up	12. Up
1. Household		M	M				M	M	M		
	2. WHG			M	M	M					
3. THC				(R)							
	4. IG			M	M	M			M	(M)	(M)
	5 TU			M					M		
6 Village	7. VWC			R	R	R			RM	M	M
8. Ward											
	9 GSC									(R)	(R)
10. Division										R	R
11. District										R	R
12. *Region*	13. RWB										(R)
	14 CWB										(R)

M = Management
R = Recourse (possibly including general rules)

Here, we have tried to locate the appropriate management level for each category of water resource. It was found necessary to distinguish between primary management, i.e. the formulation and direct implementation/enforcement of rules and procedures, and secondary management, i.e. a recourse authority which can reconcile conflicting interests within the primary management authority or between that and other groups or levels.

Using the matrix roughly suggests three levels of water resource management:

- Most of the seasonal resource categories (1,2,6 and 7) are proposed left to individual household management. Being rainy season, rainwater sources, they are normally so numerous and water so plentiful (and polluted anyway), that any organized management is both impractical and unnecessary.

There are some seasonal sources, however, which do hold water well into the dry season, i.e. rainwater reservoirs at dams and deepened depressions, mainly belonging to category 5, the holding capacity and use of which depend on some management. These therefore belong to the next management level.

- In addition to this last mentioned category, the next level includes all the small and the downstream medium size, perennial sources. It is suggested that such sources should (continue to) be managed by the immediate users, who usually then have to be organized in water-specific user groups as they do not coincide with any general politico-administrative unit.

If the user group has open access, there is usually little scope for conflict with others outside the group. Of course, all the small, upstream sources do eventually add up to medium and large sources, but each individual one normally has little impact further down; and again it would be impossible for an outside agency to manage them.

There may be conflicts with user groups, however, for which arbitration is required. The formal village government is probably most appropriate for this purpose at the moment, but it may also be considered to allocate formal powers to Village Water Committee on all water resource matters within the village.

The water tanks and the distribution systems attached to them usually cover a whole village, in which case it is natural to leave management to the VWC. Some villages, however, do have more than one tank. In other places, management has in such cases been vested in a tank users committee, again to make management the responsibility of those who have a direct interest in it. In the present case, that would also be possible, of course, but our suggestion is that the gain would not merit the extra complications of inserting a new level in scheme administration, making one more that would not coincide with any other formal authority.

- The third level of water management suggested by the matrix finally concerns medium and large, perennial, upstream sources. (In Ismani, there are no medium and large perennial, downstream water resources.) Such sources are vital, both to rather large numbers of people where they are located, and to even more people downstream. Also, a number of non-local institutions depend on these sources - and non-local commercial charcoal burning affects them.

Management by all important user interests would indicate that the opening in the 1981 law amendment could be used to establish a Mbunga River Basin Water Board vested with management powers over this resource category. The present Group Scheme Committee, which has very limited powers in relation to the water scheme only, could then be amalgamated with such a water board.

In a more developed Tanzania, this might become the appropriate solution. With the present economic crisis and extremely weak position of all public institutions, however, it is almost imperative that creation of more complicated structures be avoided; reform and simplification of existing ones are preferable. Building on the existing politico-administrative structure, immediate resource management would be the responsibility of Mbigiri and Mkungugu villages, where the resources are located, but with relatively wide possibilities for arbitration between the managing village and other user interests (downstream villages, institutions) by Mazombe or Ismani Divisions, where the two villages are located. Only in case of insoluble inter-divisional conflicts should recourse to the district be possible. The role of the Group Scheme Committee - if any - would be advisory to the divisional authorities.

As very strong interests are involved, most often - as we have seen - cutting across village, ward and divisional boundaries, a fairly elaborate set of management rules is required authorizing *and* limiting the village and divisional water management powers. The District Council, with representatives from all wards, has the legal powers to enact such by-laws.

Improving and simplifying water resources management through decentralization requires a radical change in the present water law.

In principle, the main management tool today is the authority of Regional and Central Water Officers and Water Boards to grant or reject specific water rights to every single water user. In practice, this is of course unworkable, leaving major parts of the country's water resources without any formal management at all.

Instead, the present system, whereby only designated sources of specified national interest are under the Central Water Board, should also apply at the regional level, while District Council rules should apply to all other sources. With the expert advice of Regional Water Board, District Councils should then make by-laws, defining categories of water resources that are left to free household use, resources that are under user group management but with recourse to village governments, and resources that are under village management and subject to District Council rules and arbitration authority at divisional level. Such District Council rules could include a division of water rights between the managing village, downstream villages and institutions.

Finally, it must be stressed again that the way the social and physical hierarchies are combined in the matrix in no way constitutes an objective model for where water resource management is to be located. It only attempts to create a framework that clarifies the context in which to discuss and decide how the different socio-economic interests and environmental concerns involved can most effectively be reconciled.

Over time, the concrete categories in the two hierarchies may change, most likely leading to subsequent changes in water management, but the latter may also need to be changed even without previous changes in the hierarchies, if new environmental problems or socio-economic interests arise.

8.4 Management instruments

The most common water management tool used presently in the Ismani area, as we have seen, is regulation, i.e. permission or banning of certain behaviours in relation to water use. Water hole and irrigation groups have informal rules upheld through common interest and social pressure. Formal regulations concerning especially the use of and environmental hygiene around taps are usually implemented by tap user groups in the same way, while Village Water Committee by-laws have to be promulgated by the village government and are often enforced by a system of fines. At the scheme level, the Group Scheme Committee has no regulating powers, whereas some of the most important rules, i.e. those forbidding house connections, irrigation and normally also cattle watering are imposed by the Danida project! Finally, the Water Boards grant (or deny - if that is ever heard of) rights to extract water from natural sources by means of canals, pumps or any other means, a regulation that includes only water users in the formal sector so to speak, and in practice even many of those do not have water rights.

The regulatory management instrument seems most effective when there is a local water source which requires some maintenance of extraction/distribution works for sustainable use, and where the management regulations are clearly in support of this maintenance and increase the benefit from the source to the large majority if not all of the users. The social group involved, the use of the resource, and the management regulation, therefore, need to have a scale which reasonably easily allows everyone a comprehensive view of the situation. Water hole and irrigation groups' and tap use regulations have these characteristics and to some extent also village level management by the VWC.

Hardly any effective water management by regulation exists beyond the village level, and there are no regulatory mechanisms to solve conflicts over water use when there is no conciliatory common interest - except for such rules that are imposed and enforced by a foreign donor.

The problem with regulatory management is that it requires a relatively strong enforcement agency which has an interest in enforcing the regulations - something which is lacking in Tanzania outside the immediate community groups.

For example, it is unlikely that the ban against house connections will be retained when Danida stops enforcing its rules. It will be quite some time before a few house connections will be a risk for village tank and distribution system capacity (with 20 years population growth design capacity), whereas the village water fund may benefit immediately from the alternative charges for house connections. Widespread use of scheme water for irrigation is less likely to be allowed as it poses a much more direct and immediate threat to an adequate supply of household water.

Similarly - though in a different vein - it has not been possible for the district to enforce its by-laws against settlement in the intake catchment area by removing people, nor for the regional water authorities to prevent unlawful pollution of Mgera River by TAZAMA pumping station.

Relocation of the regulatory power as discussed above should help to some degree. But it is also possible that economic means in some cases may be more efficient than regulation "by decree".

In Ismani area, a typical semi-arid African rural area, the overall water balance is not a problem (as pointed out above). The problem is the availability of water in forms that are easily accessible, perennial and of sufficient quantity and quality for actual and potential demands. The natural water resources that satisfy these criteria are limited especially geographically, and to make more resources available usually has both extraction and transmission costs.

The most efficient, and prohibitive, mechanism regulating water use in the area, therefore, has been the cost of making more water resources available. On the other hand, subsidizing this cost through constructing/rehabilitating a government/donor financed water scheme has been an effective way to increase water use for household purposes, cattle watering etc.

It is likely that allocation of the available scheme water, limited as it is by design capacity, may similarly be managed more efficiently through economic means instead of outright bans on certain uses. For example, a water charge on metered use for house connections could have the triple effect of: limiting water use (and waste); increasing village and VWC interest in enforcement; replenishing the village water fund. Water use for cattle watering, and possibly for irrigation could be controlled the same way -although the latter raises the problem of having water charges that are prohibitive enough to effectively keep usage down to a minimum - thus also reducing revenue.

Despite the existing concept of free water, such regulating mechanisms would probably be acceptable as costs of making water available, especially if the revenue is clearly seen to contribute to operation and maintenance.

With increasing consumption, charges would have to be raised - until eventually it becomes more profitable for users to develop alternative sources, such as dams or bore holes for certain uses.

It is much more difficult to conceive of economic mechanisms applied to access to naturally available water resources, where the traditional concept prevails that those living nearby or upstream on such sources are endowed with a natural use right. Both in theory and practice, it would also raise the same range of problems as related to the discussion of land rent; i.e. should there be a "water rent" somehow equal to the cost of extraction and transmission for the most marginal source in economic use?

One practical form which might be connected with a new, more hierarchical system of water rights, however, is to introduce an annual, quantity related charge for water rights, with the exception of household water from communal water points. For waterworks, such as the water scheme, it could e.g. relate to total metered use in house connections and cattle troughs or the estimated capacity of these. For small-scale peasant canal irrigation, the only practical way would probably be to charge according to an estimated allowed area under irrigation.

While excepting household water use, such a charge might channel water use into the most economical activities and provide an incentive for developing alternative sources; give the managing agency an interest in enforcement; and provide economic means which can be used to "maintain" the source. Actually, it should be used this way, to help legitimize the charge, e.g. by financing tree planting or subsidized latrines in the source catchment area.

The practical adoption of such a measure would necessarily have to be a gradual process - the first step of which could be to introduce metered water rights to major waterworks.

It is also important, finally, to keep in mind that regulation by economic means is not an automatic market mechanism, but requires management decisions on how to use the economic charges just as much as decisions on the use of regulatory management instruments. Consequently, the understanding of the purposes and mechanisms of using economics in management, and the learning of the necessary practicalities, requires much support and training for the involved local authorities.

9 Pilot projects

Based on the previous assessment of the problems and possible solutions in relation to the water resources management within the Ismani area, a number of demonstration projects might be recommended for testing the viability of the suggested solutions.

1. Reference is made to the discussion in section 8.3 on the identification of an appropriate water management system within the Ismani area based on recognition of the existence of physical and social hierarchies.

   Three different levels of water resources management are suggested in section 8.3: the individual household being the lowest level; user groups consisting of several households being the next level; and the highest level being the villages within the boundaries of which the major water sources are located. Recourse authorities who can reconcile conflicting interests within the primary management authority or between that and other groups or levels are similarly suggested.

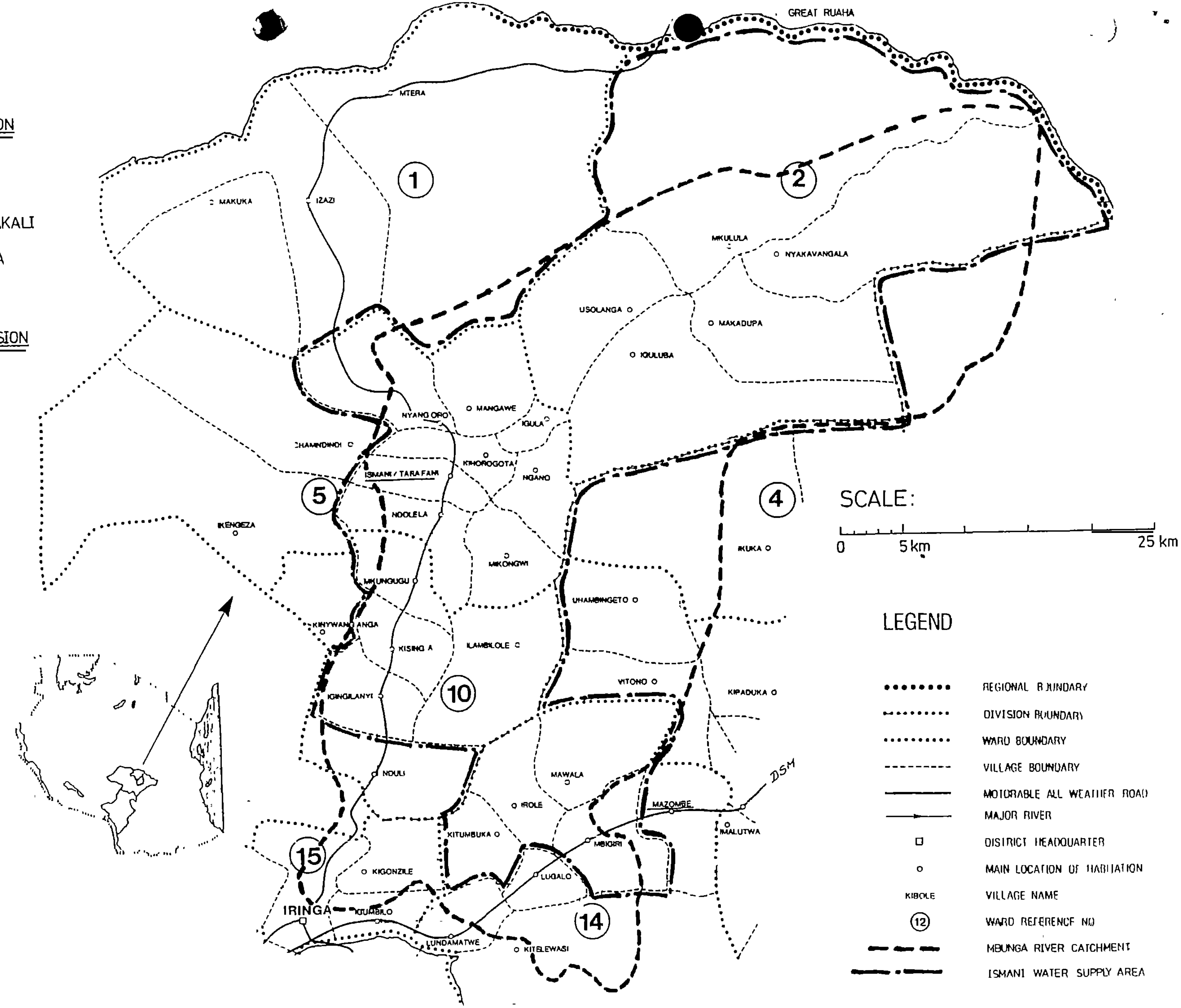
   It would be very interesting to implement - on a trial basis - the suggested system for local water resources management within the Ismani area.

2. The controversial water quality issue related to water from the Mgera intake - as described in section 4.1.2 and 6.5 - is a general problem associated with most piped water supplies in rural areas in Tanzania, not involving any kind of water treatment.

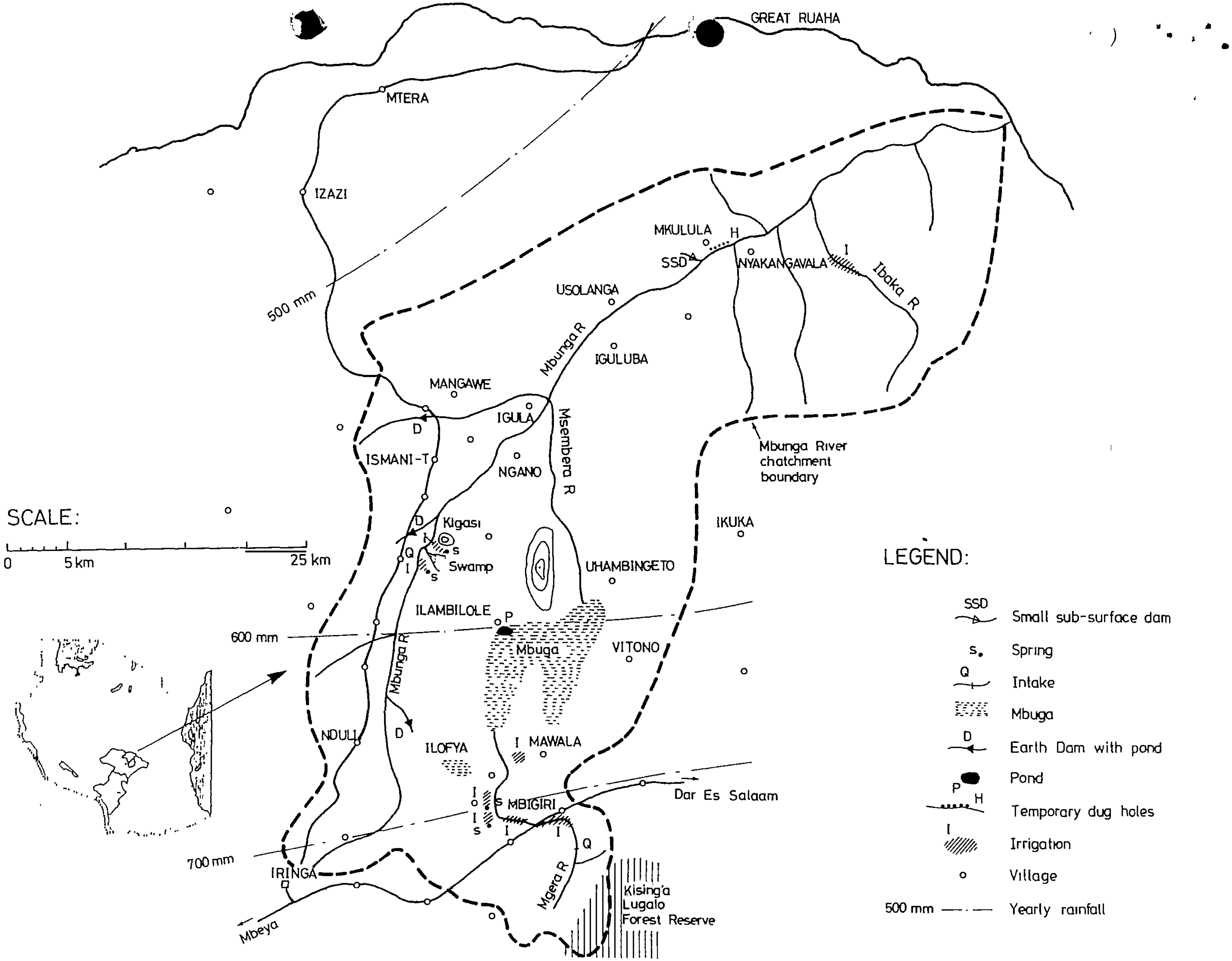
   In section 4.1.2, it is suggested that the most appropriate way of tackling this problem might be - with the assistance of community workers - to try achieving the best possible cooperation with the people settled within the Mgera intake catchment aiming at an environmentally and socially balanced and sustainable utilization of the water, land and forest resources within the area.

   It would be very valuable to undertake - on a trial basis - such activities within the Mgera catchment. It would require close environmental and social monitoring.

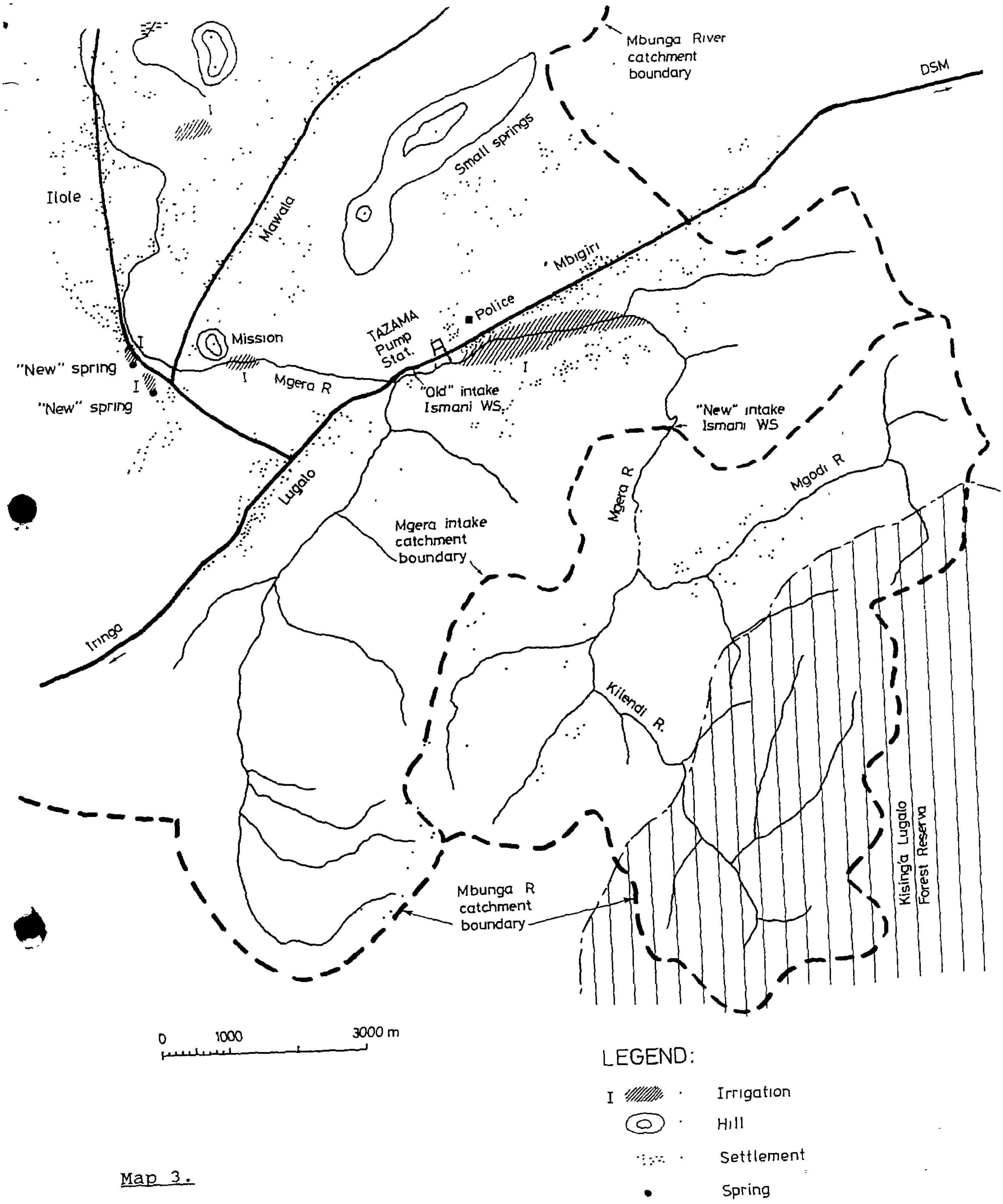
3. With reference to the discussion on management instruments in section 8.4, it might be recommended in addition to the presently existing regulation measures within the Ismani area to test the viability of economic means in connection with the introduction of water meters for house connections as well as for livestock and irrigation.



MAP 1. Administrative boundaries of the Ismani Area.

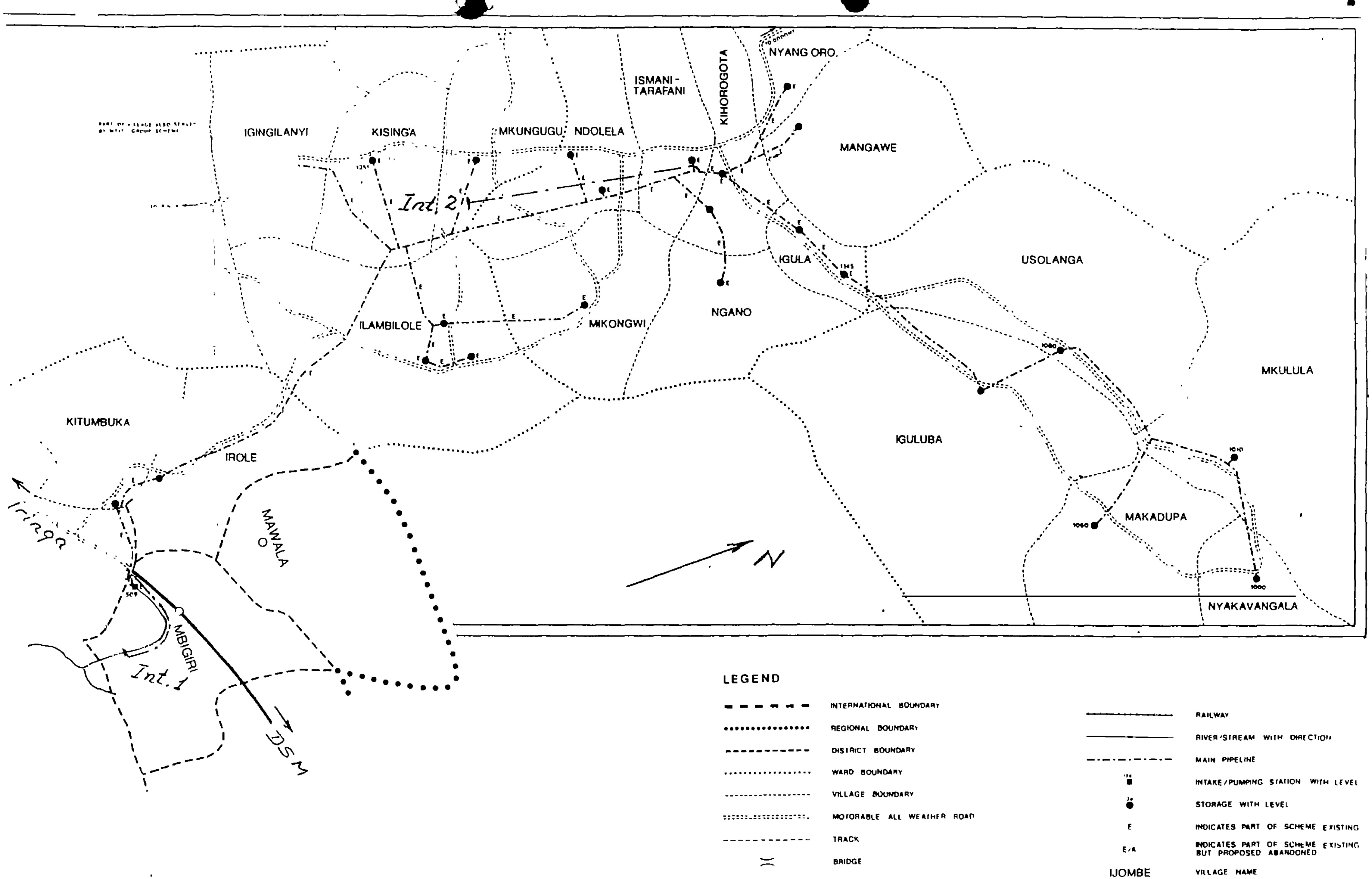


Map 2. Physiographic description of and water use within the Ismani Area.



Map 3.

Southern part of Ismani Area.



MAP 4. The Ismani Water Scheme.