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Water and sanitation in Africa

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edited by Margaret Ince

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OPENING ADDRESS

Hon. Al Noor Kassum

Minister for Water, Energy and Minerals

Mr. Chairman, Distinguished Guests, Ladies and Gentlemen, I am pleased for the honour and privilege you have extended to me by your invitation to come and open this international conference on Water and Waste Engineering for Developing Countries.

Mr. Chairman, on behalf of the Party, Government and on my own behalf I take this opportunity to welcome you all most sincerely to Dar es Salaam. It is our hope that you will enjoy your stay in Dar es Salaam and feel at home.

I wish also to convey my sincere congratulations to the Loughborough University of Technology in the United Kingdom for initiating this annual conference for developing countries. I am told that your 1985 conference was earlier scheduled for Addis Ababa but for understandable reasons the venue had to be moved. We are indeed honoured that you selected Dar es Salaam.

Mr. Chairman, I am aware that this conference has drawn many learned and experienced delegates from various developing and developed countries from around the world as well as from prominent international institutions. This is therefore an opportune moment for water and waste engineering experts from developing countries and elsewhere to get together with the objective of exchanging experiences on technical and socio/economic problems of common interest to humanity. I am delighted by the response which demonstrates the desire for cooperation among nations so that we might reach a better understanding of how we can help each other.

The world wide economic crisis has put disproportionately heavy strains on the developing nations. One way of alleviating this situation is to move towards a closer and better organised technical, economic and social cooperation among developing countries. I hope this conference will enhance implementation of the principles of Technical Cooperation among Developing Countries (TCDC) in accordance with the 1978 Buenos Aires United Nations Conference resolutions on TCDC - principles which involve, among others, voluntary sharing or exchange of technical resources, skills and capabilities among developing countries for their individual or mutual development.

Mr. Chairman, let us remind ourselves of the objectives contained in the resolutions of the 1975 Habitat Conference in Vancouver, Canada, the 1977 UN Water Conference in Mar del Plata, Argentina and the International Drinking Water Supply and Sanitation Decade (IDWSSD) which was launched by the United Nations General Assembly in November, 1980. These embody the principle that all people, whatever their state of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs. Similar considerations apply to the disposal of waste including sewerage, industrial and agricultural wastes and other harmful effluents, which are the main tasks of the public sanitation systems of each country.

Tanzania like any developing country supports these resolutions and objectives. We are very much aware that the living conditions of our people, particularly in the rural and poorer urban areas, would greatly improve through the provision of water and sanitary facilities which are essential ingredients of a healthy and productive life.

Mr. Chairman, though this conference has no specific theme, you will no doubt be deliberating issues pertaining to water development and waste disposal engineering. Therefore bear with me as I tell you that convenient provision of water and availability of waste disposal systems, being very closely related, are vital for the economic development of a country. Availability of water alone has little meaning unless accompanied by the provision of sanitary facilities, and vice versa. Without both, the health and morale of our people will suffer and having to walk long distances to fetch water results in the loss of productive time. And provision of water to certain industries has an even more direct effect upon economic growth.

Mr. Chairman, having made these opening remarks I would now like to briefly describe what we in Tanzania are doing in the field of water and waste disposal.

In implementing the Arusha Declaration policy of 1967 which stresses among other things the equitable distribution of essential services and provision of basic needs, the Government in 1971 launched a twenty year (1971-1991) water supply programme to provide the rural population with an adequate supply of clean, safe water within easy reach - which was interpreted as being within about 400 metres of each household. This decision has been boosted by the United Nations General Assembly Water and Sanitation Decade (1981-1990) resolutions.

The development of water supply to the urban sector is of course also important because most of our industries, institutions and other commercial enterprises are located in towns.

We are now making concerted efforts to rehabilitate and expand these schemes with a view to meeting present and projected water demand. To enhance the development of the urban water supply, the Government created through an Act of Parliament in 1981, the National Urban Water Authority (NUWA) which has been given the task of taking over and running all urban water schemes on an economic basis. It has begun its responsibilities by having as its first branch the Dar es Salaam Water Supply system.

Mr. Chairman, despite the various problems which our economy has faced in the last 5 years or so - among them world wide economic recession, an acute shortage of foreign exchange, droughts, and a costly war - by 1983 about 47 percent of the total population of about 20 million people in Mainland Tanzania had access to a clean and safe water supply, comprising about 40 percent in the rural and 90 percent in the urban areas.

Additionally, in order that the beneficiaries obtain maximum benefit from the water supplies efforts are being made wherever possible to incorporate sanitation aspects in the water supply projects.

Mr. Chairman, this is not an unappreciable achievement even by international comparison, especially when one considers the extremely limited resources available within our country.

But these statistics also indicate the magnitude of the task which we have ahead of us in order to provide each person with an acceptable water supply.

The strategies we have developed include soliciting financial resources from external sources: the use of least cost technologies such as hand pumps, gravity schemes, rain water collection; active participation by beneficiaries; carrying out water master plans for each Region in order to access and identify the water resources available; the training of technical manpower of all cadres; appropriate institutional set ups and rehabilitation of malfunctioning schemes.

Mr. Chairman, though sanitation is not within my portfolio the provision of sanitary facilities in both the rural and urban areas is a major problem. Most people in the rural and poor urban areas use pit latrines, but the majority of these latrines are of a temporary nature. We need to think, when the water is supplied to the people, where all this water goes after it is used. Few of our urban centres have any organised central waste disposal system. Given the high capital and running costs of central sewerage systems it is obviously sensible to encourage the use of less sophisticated technology - for example, what is commonly known as ventilated improved privy (v.p.). This technology should be made as cheap as possible so that it can be afforded and managed by the people themselves, particularly in the rural areas.

Mr. Chairman, I would also like to highlight the fact that many of our urban surroundings are dirty due to lack of awareness of the responsibility of each individual towards his own health and his own environmental cleanliness. If each individual ensured that the area around him was clean; that the garbage, industrial and other wastes were not thrown around their premises as it is now; and if each individual realised that this is something that he can take care of himself without having to depend on the Government to clean premises; our towns would be in a very different state to what they are now. This is partly a matter of education, as well as commonsense but as the Government and town authority resources are limited it is necessary that the community participates fully. I am afraid you will still find examples of what I am talking about as you move around Dar es Salaam, but we have made real efforts in the last 12 months to improve our town environment.

Mr. Chairman, pollution of water bodies by industrial or agricultural or domestic effluent is an increasing problem in Tanzania, just as it is in other developing countries. Sometimes the cost of treating effluent is purposely left out when costing projects in order to improve or even justify the projects' economic viability. This is an unwise practise since the costs of rectifying pollution can be many more times expensive than the original preventive measures. Forseeing such problems in Tanzania our Parliament enacted the Water Utilization Act of 1981 which requires each industry to treat its effluent to acceptable international standards before discharging it into the water bodies.

Mr. Chairman, the question of water conservation is becoming a problem. The consecutive droughts taking place in many of the countries in this Region in Africa require us to concentrate our efforts, individually and collectively, on ensuring an adequate supply of quality water where it is really needed.

The economic crisis in the developing world is becoming even more intolerable because of natural disasters such as drought. It is therefore increasingly necessary to accord high priority in our National Development plans to water development and environmental protection projects.

Also, by forming Intergovernmental, Subregional or Regional joint development programmes it may be possible to fight against such natural calamities as drought. These united efforts could facilitate implementation of irrigation and hydropower programmes to reduce the food and energy problems respectively.

Irrigation now seems the only solid solution for most of our countries rather than leaving everything to chance. Rain water has become in the recent past a most elusive commodity. Many African countries are experiencing successive drought years some of which require emergency assistance. People are dying in some of the worst affected countries, such as Ethiopia. Likewise there is the problem of refugees from the famine and other affected areas who need immediate attention.

Mr. Chairman, allow me to quote Robert McNamara's statement in 1980: "In order to achieve the twin objectives of economic growth and the eradication of absolute poverty countries must do two things: assist the poor to increase their productivity and assure their access to essential public services".

The message in this statement still holds true today. Diseases which are transmitted by human contamination of soil, food, water, take a dreadful toll in the developing countries, particularly of children. And it is the poor who usually suffer from the effects of lack of essential services.

Large scale food production, water, irrigation and hydropower projects require enormous financial resources. The prevailing weather disasters and tough loan conditions demanded by some international lending institutions are placing a heavy burden on the developing nations, and mean that we are not able to run our countries as we would wish. Therefore we continue to depend on food aids and tied grants as we struggle to allocate our meagre foreign exchange to provide for the remainder of our basic needs.

There is a need for the rich international community to appreciate its obligations towards assisting the developing countries. A long term solution is not the provision of drugs or food aid to feed the hungry on an emergency basis but rather the provision of essential services so that the people have the base to fight the root causes of their problems.

Mr. Chairman, this conference has, therefore, a lot of crucial issues to discuss in order to assist our Governments overcome some of the major problems. Some engineers to solve the problems of environment, irrigation, water supply, waste water disposal and so forth. We require your contribution.

I am appealing also to the Governments, to assist you engineers, so that you can assist the Governments better.

Finally Mr. Chairman, in March 1977 at the Mar del Plata United Nations Water Conference I said that for the survival of humanity the total cost of providing pure water to everyone is only about 1% of the world's annual arms bill. I expect that comparison is now completely out of date.

Mr. Chairman, with these few words I declare the 11th International Conference of Water and Waste Engineering for Developing Countries open.

I wish your conference every success.

KEYNOTE ADDRESS

Professor John Pickford OBE
WEDC Group Leader

Minister, Ladies and Gentlemen, I would like to open my address by saying how pleasing it is to see so many African (17) and other countries represented at this Conference in Dar es Salaam.

The various sessions cover a wide range of topics related to Water and Sanitation in Africa and I wish to highlight some of these using the letters WOAD, as mentioned in the song,

'What's the good of wearing braces
Shirts and pants and shoes with laces
- better far is woad!'

Woad was an appropriate costume worn by Ancient Britons in times when the climate must have been like that of Africa as woad is a blue paint!

The first letter, W, stands for the Water Decade. As Mchaile writes in his paper the Decade is turning out to be a water supply decade with the emphasis always on water, a commodity high on the list of people's priorities. We, however, have not ignored sanitation and I certainly never do. The old adage 'it may be shit to you but its my bread and butter' certainly applies to me as I have been involved in sanitation in Africa for 31 years. I have observed in this period that pit latrines are certainly not a temporary solution to excreta disposal.

At the start of the Decade there was optimism that billions of pounds, dollars, shillings, cedi etc., would be spent on water and sanitation. The Decade has had its fashions, such as appropriate technology, institution building, operation and maintenance, and affordability. Dr. Nyumbu suggests the latter fashion may result from the domination by economists.

O, the second letter, stands for Operation and Maintenance, a theme of the Decade and of this the 11th WEDC Conference. The papers to be presented in Session A relate to this, as does that of Owusu in Session D. In the first paper Mr. Akowuah says 'in recent years the system has suffered from a number of problems resulting from operational and maintenance lapses over the years'. This is true in all Africa, in all developing countries. Mr. Brown mentions 'a junk yard scenario' and Mr. Jones says that the basic cause of the existing sewerage system (Dar es Salaam) is lack of maintenance.

Papers in other sessions do not ignore operation and maintenance. Mr. Carroll says that pit emptying is part of maintenance, others talk of maintenance by villagers (Mujwahuzi), by users (Homenen and Kyber) and of the importance of planned maintenance (West). So it is obvious that operation and maintenance will be much in our thoughts during the next three days.

A is for Appropriate Technology. These conference papers include quite a lot about simple technology such as slow sand-filtration (Ellis; Mbwette; Hartung), wood and bamboo piping (Msimbe and Lipangile) and pit latrine technology (Mowforth and Aggarwal).

There has been a tendency in the past to put too much emphasis on the technology and not enough on what makes it appropriate. There has been over-use of terms such as software, community participation, etc. The January 1984 issue of the very good publication 'Waterlines' equates good hardware plus appropriate software to successful implementation. In his paper Mr. Williams says that selection of well sites is left entirely to the community, Mr. Horsfield discusses the variation in circumstances in 24 villages in Senegal and Windrum et al. describe the appropriateness of small scale irrigation for local people in dambos. The demand for community involvement is illustrated by Mr. Vuon and by Mr. Brown. The message is therefore that the technology should be appropriate for the people.

D is for Do it better, do it together.
In his inaugural lecture, Schumacher suggested that we should find out what the people are doing and help them to do it better. Sometimes we have to find out what exists and make it better, i.e. repair it (Richardson and Harris) Professor Mujwahuzi talks of the attitudes of experts towards the competence of local communities. Some experts, be they engineers, sociologists or economists, are placed, or place themselves on pedestals, whereas others feel that the more they know the less they feel like boasting. Papers at this conference are reasonably free of the mystique and jargon that often leads to 'us and them' situations. Experts and communities, professionals and non-professionals and the hardware and soft-

ware must all fit and work together and, as suggested by Andersson, use existing resources in a better way.

The decade, so far, has not provided the hoped for billions but that does not stop experts working with people to make what is existing better and helping them to operate better and maintain better.

Together WE - the experts - and THEY - the people of Africa who need good and accessible water and adequate sanitation - can achieve great things.

ADDITIONAL ACTIVITIES

ADDITIONAL ACTIVITIES

Technical Visits

Delegates visited two Pumping Stations - one in the City Centre and one in Muhimbili - both involved in the Dar es Salaam Sewerage and Sanitation Rehabilitation Programme.

The Buguruni VIP Latrine site was visited to view both the production of latrine components (slabs and superstructure) and in-service latrines.

In addition there were several events for delegates to participate in during the breaks.

Mr. B Jackson showed and discussed a tape-slide programme on 'Village level operation and maintenance'. The programme centred round a case study on the maintenance set-up for gravity fed piped water supplies in Malawi. Information was also available on the Lesotho Health Education Project.

The Canadian IDRC film 'Prescription for Health', illustrating the health hazards associated with poor and inadequate practices and provisions in both water and sanitation was appreciated by many delegates.

Several participants displayed posters or slides and discussed their ideas with others throughout the week. Among the displays was one by the DSSD of information relating to their latrine programme and the associated health education input. Several delegates acquired copies of the useful booklet 'Tuma Choo Bara'.

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E K O Akowuah

Experiences and lessons from the operation of Monrovia sewerage system

INTRODUCTION

Monrovia, the capital city of Liberia was one of the first cities in West Africa to have a central water borne sewerage system. The system was first constructed in 1952, and was expanded in 1969; major rehabilitation works were carried out in 1983.

In recent years, the system has suffered from a number of problems resulting from operational and maintenance lapses over the years, as well as problems due to unfavourable sewer routing in the original designs. Social and economic factors have also had some influence on the operations of the system.

The purpose of this paper is to highlight some of the problems that have plagued the Monrovia system; their causes, the steps that have been taken to solve them, and the lessons to be learnt from them. Some experiences with management of the system are also mentioned.

HISTORY OF THE MONROVIA SEWERAGE SYSTEM

The city has a "separate" sewerage system with one network of sewers for the evacuation of sanitary sewage, and another for the evacuation of storm runoff. The Liberia Water and Sewer Corporation has responsibility for the sanitary system whilst the Ministry of Public Works has responsibility for the storm drainage system.

The sanitary sewerage system has developed in three distinct stages. The first system constructed in 1952 consisted of approximately 15 km of sewers ranging from 200mm to 600mm in diameter, and served Central Monrovia only. Sewage collected was discharged without treatment on a beach to the south of the city.

In 1969, the system was extended to serve the suburbs of Sinkor and Bush rod Island. 30km of new sewers with diameters up to 1,500mm were laid, and four lift stations were constructed; a biological treatment plant was also constructed.

In 1983, a rehabilitation project was carried out. This involved the laying of 4 km of new sewers to replace some of the sewers laid in 1952 and the replacement or refurbishment of nearly all mechanical and electrical equipment in the system.

At present the system serves about 80,000 persons representing about 25% of the city's population.

PROBLEMS IN THE COLLECTION SYSTEM AND THEIR CAUSES

The rehabilitation project of 1983 was undertaken mainly because of very serious problems experienced in the collection system in the period from 1978 to 1980. Among the major problems were the following:-

(i) Permanent or frequent blockage of certain stretches of sewer

(ii) Frequent overflow of sewage through emergency by-passes, leading to the discharge of large quantities of raw sewage into drains and the Mesurado River which runs through the city.

(iii) Massive siltation in almost all sewers, leading to loss of carrying capacity estimated at about 20% of the total(ref.1)

(iv) Structural collapse of certain stretches of sewer.

(v) Presence of large quantities of oil in the sewers and lift station wet wells.

(vi) Frequent breakdown of pumping units in the lift stations, and frequent stoppage of pumps due to the choking of passage ways by rags, bags, etc.

Detailed investigations were carried out in 1981 by the personnel of Liberia Water and Sewer Corporation and also by a team of consulting engineers who were engaged to prepare the rehabilitation programme. From these investigations the underlying causes of the problems were identified as follows:-

(i) Chronic lack of maintenance action for the removal of grit and sand from sewers: The maintenance crews had never been equipped with tools for sand removal and therefore sand had continued to accumulate in the sewers throughout the 30 years history of the system.

(ii) Inadequate operations at the lift stations: These were operating effectively for only 8 hours a day instead of operating around the clock as designed and since the sewers had only limited storage capacity, there was frequent spillage through the emergency overflows

(iii) Buildings constructed over sewers: Many of the sewers laid in 1952 had been laid through easements behind private properties and not in the streets. Because of very loose implementation of building control regulations it had been possible for developers to build on the sewers leading to structural collapse in several instances.

(iv) Abuse of the system by individuals: Some manholes in the system had concrete covers that could easily be opened and individuals had taken advantage of this to use the manholes as refuse dumps where rags, bags, sticks, etc were disposed of; these choked sewers and choked pumps if they got to the lift stations.

(v) Unauthorized discharge of oil into sewers: It was found out that used oil was being discharged into the sewers from the workshop of the local electricity company, and from a private garage. This oil was fouling up the sewers and accumulating in the lift station wet wells.

(vi) Inadequate maintenance of mechanical and electrical equipment: Due to chronic unavailability of spare parts and due also to limited budgets for maintenance, pumps, motors, and switchgear at the lift stations were all in a poor state of repair and were functioning inefficiently.

To remedy these problems, the following measures were included in the rehabilitation project:-

(i) A sewer-cleaning truck with equipment for water-jetting and vacuum-suction was purchased to be used to implement a programme for removing sand and grit from the sewer network. A team of operators was also trained to use the equipment.

(ii) The stretches of sewer most seriously affected by having buildings erected on them were taken out of service and replaced with new mains laid in the streets.

(iii) Lift station pumps and equipment in poor mechanical condition were replaced or refurbished. In particular, all 6 dry-installed vertical-spindle lift pumps in 3 stations were replaced with submersible pumps. Automatic controls were restored at all stations to permit round-the-clock operations, as the stations are not usually manned after the regular day-time working hours.

(iv) Bar-screens at the lift stations were improved to reduce the quantity of gross suspended material reaching pump passage ways.

As at the time of writing, the sewer-cleaning programme is still in progress. It is expected that when it is completed, the performance of the collection system will be greatly improved.

Figure 1. Raw sewage spilling from a manhole forms a rivulet running to an open drain in the Sonnewein sector of Monrovia. The manhole is on a sewer permanently blocked by sand and grit.

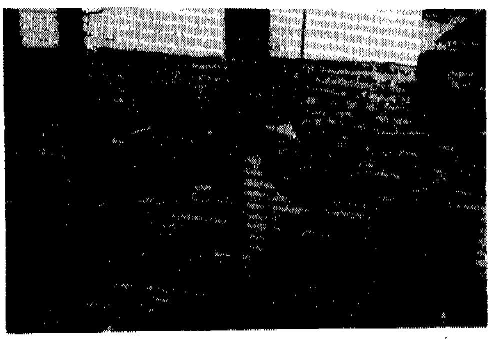

Figure 2. A house has been construc ted directly on top of this concrete sewer pipe in the Sonnewein sector of Monrovia.

PERFORMANCE OF THE SEWAGE TREATMENT PLANT

The plant which has a hydraulic capacity of 20,000 m^3/day was designed to treat 2,300kg of BOD per day;however actual load at present is estimated to be only 1,400kg BOD per day. This is mainly because there have not been any major extensions to the collection system since 1969 and therefore many newly-developed areas of the city which could have been connected to the sewerage system are still not connected.

The treatment process consists of bar screening, comminution, grit removal, primary sedimentation, biological treatment on trickling filters, and secondary sedimentation.Treated water is discharged to a nearby tidal creek,and settled sludge is treated in a two-stage anaerobic digester. Treated sludge is dried on a sand bed or discharged into a lagoon.

The study carried out in 1981 in preparation for the rehabilitation project showed that all the treatment units were functioning well with the exception of the trickling filters which were found to be achieving only a 33% removal of incoming BOD, instead of about 88% that was to be expected (ref. 1).

The possible causes of the poor performance of the filters were identified as follows:-

(i) Poor air supply:The filter walls are completely below ground level and there are no peripheral openings;air is supplied to the filter bed through 150mm-diameter vertical pipe vents open to the atmosphere and connected to an air passage below the filter bed at underdrain level. There were 8 such vent pipes for each filter 47.25m in diameter and 2.2m deep; these were suspected to be inadequate.

(ii) Inhibition of biological activity by oil in the sewage:Oil reaching the plant as the result of the illegal discharges mentioned earlier,had caused a thin film to form on the filter stones, and this was suspected to be affecting biological activity adversely.

Remedial measures undertaken as part of the rehabilitation project were:-

(i) The 8 existing vent pipes were replaced with sixteen 300mm diameter pipes in order to increase the air supply.

(ii) An oil trap was constructed beween the bar screen and comminu tor to help limit the amount of oil reaching the filters.

The filters have not yet been put back into full operation and therefore it is not possible yet to assess the effects of these improvements

MANAGEMENT AND PUBLIC RELATIONS

Operation and maintenance of the sewerage system are carried out by a division with about 70 employees headed by a Sanitary Engineer.

Operational expenditures exceed revenue generated, and sewerage operations are in effect subsidized by the water supply operations.

Charges for sewerage services are calculated at 60% of the water bill for any account liable to pay for such services. Premises located within 30m of a public sewer are billed for sewerage services, whether or not they are connected to the system.

The public attitude to the sewerage system is mixed; house owners within the mandatory billing range connect to the system readily enough, but those outside the range often prefer to use septic tanks if it is possible for them to do so. The willingness to pay for sewerage services is not very high in the community and vigorous steps including the disconnection of services are usually necessary before customers pay their bills.

CONCLUSION

The experiences gained from the operations of the Monrovia System give more "warnings" than "examples". The experiences have shown clearly that a sewerage system needs very careful operation and maintenance in order to operate satisfactorily from year to year. Inadequate maintenance and improper operations can result in serious problems developing in the system, causing it to perform very poorly.

It is the hope of the author that the experiences recorded here will be of benefit to engineers and policy makers planning the construction of new works, as well as those responsible for the operation and maintenance of existing works.

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Ato Brown

The task of renovation and operation of water supply and sanitation in Ghana

1.0 INTRODUCTION

1.1 The Government of Ghana from the time of independence in 1957, has been placing high priority on the provision of safe and adequate drinking water and improved sanitation. From a mere 35 water systems before independence, there has been a rapid expansion to about 195 systems boosting coverage from a low 5-10% to 59% today. Sanitation has also been seen a major improvement in the form of numerous public and household facilities over the years.

1.2 These trends were fueled by the very positive economic circumstances of the 1960's and the desire to meet the glorious aspirations of the independence from colonial rule. There was a sudden departure from the modest beginnings of the 1950's, with hand dug wells, shallow boreholes with hand pumps, rain water harvesting, spring tapping arrangement and pit and pan latrines, giving way to ambitious conventional high technology systems.

1.3 Today these advances have generated into a crisis following major reverses in the economy from the oil crisis of the early 1970's. The situation has been met with high maintenance and investment costs and shortage in manpower culminating into poor organization and stagnation in the delivery of water supply and sanitation.

1.4 This paper will want to throw some light on the state of water supply and sanitation in the country, outlining the task for renovation and operation and argue out some recipe for rejuvenation to meet the ambitious targets of the International Drinking Water Supply and Sanitation Decade.

2.0 THE STATE OF WATER SUPPLY AND SANITATION

Water Supply

2.1 The present water supply coverage according to community size is given in Table 1 (next page). It is seen that 59% of the total population of 12.7 million now have access to safe drinking water. Of the Urban population a little over 90% enjoy this facility as against only 37% of the rural population. The rest of the population domiciled in over 40,000 communities thus, rely on defective dug wells, ponds, streams and other unwholesome sources.

2.2 The Ghana Water and Sewerage Corporation (GWSC) since its incorporation in 1966 has been responsible for the provision of potable water and this is at present supplied to the population as follows:-

(i) Pipe borne water, where treated water is distributed through household connections and standpipes from 195 systems. These are made up of conventional treatment plants, package treatment plants and ground water mechanized systems serving close to 5 million people.

(ii) Non-pipe water supply from drilled borehole fitted with hand pumps. There are in all about 6,000 of these all over the country serving 2 million people.

2.3 Water supply services in many urban and rural areas are intermittent and unreliable due to inadequate maintenance funds and foreign exchange support for spare parts and replacement of equipment, chemicals and high energy costs in operation. In the Volta Region alone out of the 36 systems only 18 were ever operational in 1984. Revenue from water tarrifs has been met annually with a subsidy of ¢550 million (¢50.00 = $1.00, Dec. 1984). Water supplied to consumers is in most cases as low as 13.5 - 22.5 litres per capita per day. The situation is further compounded by the shortage of manpower, both skilled and sub-professional. It is said that the GWSC has only a third of its requirement of Engineers and Technicians.

Sanitation

2.4 As data on excreta disposal facilities is not available, a conservate estimate based on studies in a few large urban towns shows that 30% have private water closets, 35% have private pan latrines and 21% use public facilities. The rest use nature such as beaches and bush, etc. There are at present 3 community water-borne sewerage systems in the country, 2 in newly created townships, Tema and Akosombo and the third in Accra where to date only 50% of the older section of the city has been sewered by GWSC.

2.5 There are some 30 water-borne sewerage systems in various institutions throughout the country. 7 with oxidation ponds, 15 are of the trickling filter type and 8 use the activated sludge process. Most of them are either "abandoned" or "not functioning".

2.6 In the rural areas only a small percentage say 10% of the houses have private privies. All others use public facilities which are usually pit (trench) latrines without lining or super structure and logs for squatting slabs. Indiscriminate defecation is common

Table 1

POPULATION SERVED WITH DRINKING WATER IN 1984 (In Thousand)

		Population Group			(Rural)			Total	
		Below 100	101-199	200-499	500-1,990	2,000-4,999	Rural	Urban above 5,000	Urban and Rural
1.	No. of Communities (1970 census)	35,974	4,449	4,268	2,621	332	47,634	135	47,479
2.	Estimated 1984 pop.(final details of 1984 not yet out)	1,629	816	1,733	3,049	1,231	7,858	4,863	12,721
3.	Pop. served with drinking water in 1984	12	80	300	1,700	860	2,952	4,557	7,509
4.	% of Pop. served with drinking water in 1984	1.2	9.8	13.7	55.8	69.9	37.6	93.7	59.0

in many rural communities.

2.7 The management pan latrines has suffered in recent times due to a general break down in dehumanizing conservancy system. Hands are not readily available and replacement of pans are delayed. The public latrines maintenance especially around the urban fringes has also deteriorated remarkably following mass break down of vacuum trucks. This situation is seen in a more hopeless dimension in refuse disposal.

2.8 Low budgetary allocation for improvements has put the district councils and department of community development (responsible for provision of sanitary facilities, urban and rural respectively in a very poor performance shape with regards to sanitation. Moreover low water supplies makes water related sanitary systems less feasible and will remain so for many years to come.

3.0 TASK OF RENOVATION AND OPERATION

31. From the above the tasks for the second half of the decade are clear; close to 50,000 communities covering a population of about 5 million in the rural areas should be provided with access to safe drinking water. Efforts should be doubled to maintain the modest 93% coverage in the urban setting and expand to cover the full population. There is also the task of providing close to 1,000,000 units of latrines to push coverage to the estimated 15 million people by the year 2000. This ambitious programme must be accompanied by parallel programmes for training operators, professional staff and research.

3.2 The development objective for improved water supply could be summarized as follows:

(a) Rehabilitation and stabilization of existing water systems to restore these to original capacities.

(b) Review of on-going projects where physical work is in progress or is yet to start for possible implementation.

(c) Rehabilitation of all hand dug wells and shallow boreholes with unserviceable hand pumps and installation of hand pumps on boreholes which have been capped.

(d) Provision of hand dug wells and shallow boreholes in communities with 100 to 2,000 inhabitants.

(e) Provision of supporting services, workshops, stores, transport, etc.

(f) Strengthening of institutional framework and manpower base for responsible renovation and operation of supply systems.

This programme which was estimated to cost about ¢3,000 million in 1982 is now ¢30,000 million in present day prices out of which about ¢10,000 million is required as off-shore complement for equipment and spares and raw material for locally produced items.

3.3 For sanitation the task for renovation is categorized as below:-

(a) Improvement of public toilet facilities in the low income and urban fringe areas by the construction of improved latrines such as pour flush latrines and V.I.P. latrines or possibly connecting these facilities to existing sewers where feasible.

(b) Improvement of sanitary services by the provision of vaccum trucks, transport vehicles and other needed spare parts for rehabilitation. This is to ensure efficient excreta disposal and refuse management in the urban areas.

(c) Provision of improved pit latrines in all rural villages not served by the district councils.

(d) Re-organization of the institutional support system within both the Rural Development and Local Government ministries for effective delivery and management of sanitary systems.

These development works are estimated at about ₵4,000 million with close to ₵1,000 million as off-shore component for the provision of equipment and raw materials for local production.

3.4 These tasks as contained in the national action plan consultation paper in 1982, remains the same today since not much improvement has been seen in the 'junk yard' scenerio that has plagued the country particularly in the water supply and water-related excreta disposal systems. The total of ₵34,000 million is also accompanied by a 'support programme' for training, demonstration, education and research at a cost of ₵200 million with ₵90 million required as offshore cost component.

3.5 A closer look at the world today, present Africa as a very ostentatious continent calling for higher capital investments to meet the Decade goals compared to WHO's South-East Asia region which is pushing initiatives based on community participation and choice of appropriate technology. But I must say that, the 'warning' signals have not gone unheeded in Ghana and recent experiences with appropriate technology and community participation is already defining an alternative path for renovation and operation of water supply and sanitation.

4.0 RECENT EXPERIENCE IN APPROPRIATE TECHNOLOGY AND COMMUNITY PARTICIPATION

4.1 The promotion of shallow boreholes fitted with hand pumps has made such an impact that the signs are clear that this low technology renovation will receive a major promotional effort. The Joint Ghana Government/CIDA project in the Upper Region has a water utilization component that has brought hand pump usage and maintenance closer to the people. Activities such as well head pad construction and well head sanitation, cattle watering facilities have been promoted with the active participation of the communities.

4.2 This encouraging development has expanded into the Northern Region through the test boreholes drilling project and plans are afoot to start another extensive rural water programme. UNICEF is assisting the drilling unit of the GWSC in the rehabilitation of most 'abandoned' boreholes and with a long term objective to produce hand pumps and their spares locally. The VLOMP project has moved into yet another successful phase whilst the Roman Cath. Church is also financing borehole programmes in the same critical regions of the country. This departure from the conventional high technological approach is seen as a healthy response to the crisis. But at current prices a shallow borehole fitted with a hand pump cost ₵500,000. Compared with the cost of ₵50,000 for a 14m deep, 1.3m diameter hand dug well with a wide apron, well head and well cover, this impressive start at renovation should be met with cautious realism.

4.3 The rural people in their own wisdom are mobilizing themselves day in and day out engaged in hand dug well activities and this is gradually becoming a national phenomenon dovetailed into the P.H.C. programme underway in the country. These efforts are being backed by churches, volunteer groups, multilateral agencies and a host of NGO's around the country.

4.4 In one particular hand dug well project in the Central Region light precast concrete blocks have been used to line wells cheaply for domestic use and irrigation. The use of a simple lifting mechanism; the rope and plunger hand pump has been exhibited with much success that there is much hope to travel a little beyond the pollution strife days of the traditional bucket and line, given wide popularization. The same system has been used to rehabilitate abandoned boreholes at about ₵8,000 compared to about ₵25,000 needed to instal imported new hand pump. All materials are available on the local market and the only 'expert' needed for construction and maintenance is the village carpenter and mason with community participation.

4.5 Research on alternative sanitary systems by the University of Science and Technology has produced the Alternating Ventilated Indirect Pit (KVIP) which is fast becoming a household word among village/town development communities around the country. This innovation has been given quite a big push by the Rural Development Ministry which is engaged in the construction of about 100 ten-seater units all over the country, through communal labour. This system has also provided the answer to the question of how to convert an estimated 200,000 household pan latrines into improved pit latrines. It must be said that all has not been well with this excellent innovation. At a staggering cost of ₵500,000 for a 10 seater communal facility and ₵40,000 for a private 1-seater facility most communities are being pushed out of their enthusiasm.

4.6 As research is going on to push the cost to affordable levels, less dimensional efforts on the introduction of the Mozambique slab type and Zimbabwe VIP latrine in the Upper Region (CIDA Project) and Nima slums of Accra (with support from UNICEF) respectively have seen such great potential in community participation and cost recovery operation. Costs range between ₵1,000 to ₵5,000 and all these are paid for by the beneficiary households with maintenance assured. The take over of public latrines by community committees in most parts of Accra and in other urban centres since 1983 has also seen a remarkable rehabilitation and maintenance virtually taking most of the operational load off the backs of the district councils.

4.7 All these isolatory developments are being consolidated in an integrated manner under the Ghana Government/UNDP Joint project "Improvement in Drinking Water and Sanitation" intended to support national participation in the International Drinking Water Supply and Sanitation Decade (IDWSSD) programme. A three-component programme involving rural water supply, sanitation and health education is seeking to bring together GWSC, Department of Community Development, Ministry of Health and the National Service Secretariat to relate to the issues at stake with a responsible and appropriate philosophy.

4.8 This project has taken off in two pilot regions with training programmes synchronizing theoritical and practical perceptions on available low level technology (hand dug wells, spring, etc. and simple improved pit latrines) and community motivation techniques. Emphasis in this project is on the encouragement of participation of local people in the planning, design, implementation and management of the projects through their own local water and sanitation committees. The project also foresees the training of a large cadre of 'bare foot' community motivators to project future operation and maintenance.

4.9 Experience has shown in a very short time the need for a dynamic and flexible approach to meet the aspiration of the rural people. In one village the question of financing a 10-seater KVIP latrine was confronted with a choice of ten, 10-seater **less** expensive option.

All over the country simple and less expensive innovations are taking place and if well coordinated and systematized will make the task of renovation and operation of water supply and sanitation very easy.

5.0 CONCLUSION

5.1 The task appears nebulous. It is quite clear that the glorious days of high technological advancement are over and the breather provided by the recent experiences with low level technology and community participation is a good enough indicator on the path to a healthy and production life by 1990. There is little argument that community participation coupled with the choice of a dynamic and flexible appropriate technology at a range of levels are central to success in this crisis management.

5.2 The recipe for rejuvenation and sustainance should thus be;

(i) A strong Government priority and commmittment to improved water supply and sanitation. Operation and maintenance costs should be met realistically through increased budgetary allocation and tariff adjustments.

(ii) Restructuring of the delivery systems to ensure parallel support from the Rural Development , Local Government and Health Ministries through the institutionalization of rural water supply and sanitation extension services that reflect community participation in planning, design, implementation, operation and maintenance of systems.

(iii) Improvement in manpower position and manpower orientation.

(iv) Increased renovation through the choice of least-cost technologies with corresponding low operational and maintenance costs and effort.

5.3 Experiences of people all over the world has shown that the task is surmountable if guided by the search for a sustainable philosophical approach. This humble appraoch constitutes development capital in its own right and if invested will establish the foundation of all development activities.

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Frank E Jones

Operation and maintenance services for Dar es Salaam City Sewerage and Sanitation

INTRODUCTION

This paper is one of a series on a complex and involved project. Others will deal with the main Civil Engineering works and provision of facilities. My main concern is the establishment of a new Department of the Dar es Salaam City Council, the Sewerage and Sanitation Department (DSSD), which will take over and run efficiently all the sewerage and sanitation facilities of the city, so that the city will continue to benefit from the project.

Without an effective operation and maintenance organisation, the benefits of the project would be shortlived.

BACKGROUND

The project is the first stage of a long term programme to improve sewerage and sanitation in Dar es Salaam.

The original proposal was to concentrate on sewerage - a conventional water-borne waste disposal system, but this, both now and for many years to come, could serve only a small proportion of the city's population.

The city centre system, which was constructed between 1956 and 1959, discharges through an ocean outfall, just North of the harbour entrance. Nine other separate systems have been installed for residential, institutional and industrial developments. In each of these, treatment is by waste stabilisation ponds.

The condition of the existing systems is exceptionally bad. The ocean outfall pipes are damaged and broken in several places. Only one of the waste stabilisation ponds is still operating, and of the 17 pumping stations, only one is usable, and that only partially. Some of the pumping stations have been out of use for several years. Some major sewers are completely blocked and septic conditions have caused serious corrosion and collapse.

The existing sewerage system could serve only about 12% of the population. About 10% have septic tanks, and 78% use pit latrines or other methods. There were about 8,400 septic tanks and 60,000 latrines in 1979, when the population was estimated at 932,000. It has since increased considerably.

The basic cause of the state of the existing sewerage system is lack of maintenance, especially in the period from 1974 (when the City Council was abolished) to 1978, (when it was re-established.)

The implementation period and scale of the project have been changed considerably during project planning. A key decision was made to give new sewerage a low priority and restrict this to areas where on-plot sanitation facilities could not be used. Pit latrines have very much lower construction and operation costs than sewerage, so many more can be served for a given cost. On-plot sanitation - pit latrines and septic tanks - provides similar health benefits to sewerage, when properly designed and constructed. The facilities to serve them, (mainly pit emptying and sludge disposal), must be adequate, and people made aware of proper use and cleanliness.

DEFINITION OF PROJECT ELEMENTS

The project comprises five parts, for all of which Ministry of Lands, Natural Resources and Tourism (ARDHI) is responsible, except for C 1, C 5, E 1 and E 3.

Part A Sewerage Rehabilitation and Upgrading

1. Rehabilitation and part replacement of about 130 km of sewers and pumping mains.
2. Repair of sea outfall and construction of screen house etc.
3. Rehabilitation of 17 pumping stations.
4. Repair and improvement of waste stabilisation ponds.

5. Construction of about 600 new sewer connections.
6. Equipment, vehicles etc. for operation and maintenance.

Part B Low Cost Sanitation (LCS)
1. Construction and upgrading of about 3,600 pit latrines.
2. Construction of dumping stations for pit emptying vehicles.
3. Rehabilitation and purchase of new pit emptying vehicles.

Part C Dar es Salaam Sewerage and Sanitation Department (DSSD)
1.* Establishment of DSSD and training of its staff.
2. Construct Headquarters for DSSD, and temporary offices.
3. Construct DSSD workshop and storage facilities.
4. Equipment for DSSD workshop
5.* Establish a billing, collection and accounting system.
6. Upgrade three existing maintenance depots.
7. Construct a field office for the Low Cost sanitation Programme.
(* only these two are defined as DCC/DSSD responsibilites)

Part D Studies
1. Preparation of studies including
   (i) a system of charges for sewerage
   (ii) solid waste management and
   (iii) pollution.
2. Review of legislation.
3. Survey of existing connections to sewerage, water supply and electricity.
4. Design for future sewerage.

Part E National Urban Water Authority (NUWA) ARDHI, Tanzania Electricity Supply Company (TANESCO)
1. Technical assistance to NUWA (NUWA responsible)
2. Strengthening ARDHI's Public Health Education and sanitation services.
3. Study of proposals to increase TANESCO's computer capacity for use for DSSD billing, collection and accounting procedures. (TANESCO responsible)

FINANCE AND CONTROL OF PROJECT

(The costs below are July 1982 estimates) The project has been financed mainly through a World Bank, I.D.A. Credit of 20.6 million S.D.R.s (Special Drawing Rights - approximately equal to 1 dollar U.S.) which covers about 87% of the total cost of the sewerage and sanitation component, and 85% of the technical assistance. The balance of project funds would come from Tanzanian Government contribution and internal cash generation.

The proposed I.D.A. financing is equivalent to 100% of the foreign exchange cost and 74% of the local cost, before taxes.

Under agreements between the I.D.A., the Government of Tanzania, and Dar es Salaam City Council, the works, facilities and equipment constructed or acquired under parts A,B and C. of the project, are to be transferred to DCC (effectively DSSD), who then have the responsibility of repaying the cost to the Government, with interest. The Government, in turn, repay the I.D.A.

The project is being carried out jointly by ARDHI and DCC, with ARDHI having prime responsibility. The project Implementation Unit, headed by a Project Manager, has been established in ARDHI. This Unit is responsible for control of design work and contracts for all major project construction, supplies and equipment. However, it is proposed to transfer responsibility for the construction of pit latrines to DCC/DSSD.

THE ROLE OF DSSD

The establishment of DSSD was approved by the City Council, Prime Minister's Office and Treasury in May 1982. DSSD is to operate on semi-commercial lines. It is a self-contained semi-autonomous department, reporting to the City Director, incorporating all the services and functions, including administration, personnel, finance and accounting, necessary to carry on all the sewerage and sanitation operations throughout Dar es Salaam. DSSD must generate, mainly from charges, sufficient funds, not only to operate and maintain the existing facilities and those provided under the project, but also to repay (over 25 years), the capital value, with interest, of the assets transferred to it.

Previously, responsibility for sewerage and sanitation within Dar City Council was divided between the City Treasurer, City Engineer, Chief Health Officer and Chief Workshop Mechanic.

The Primary Operations of DSSD will be:-
1. Sewer maintenance and repair
2. Pumping station maintenance and repair
3. V.I.P. latrine construction
4. Pit and septic tank emptying service

These activities require Secondary Operations
5. Vehicle and plant service and repair

6. Depot and stores operation.

and to support this work Financial and Administrative organisation covering:-

7. Finance and Budget control
8. Revenue collection (Sewerage and pit emptying charges etc.)
9. Collection of V.I.P. latrine construction repayments
10. Manpower and training
11. Health Education
12. Vetting and approval of proposed sewerage for development.

DSSD DEVELOPMENT

As part of the technical assistance component of the project, a team of experts has been provided to staff key positions in DSSD, train couterparts and introduce the management and financial measures necessary.

The team comprises:-

1. Head of Department (myself) who reports to the City Director.
2. Finance Officer
3. Senior Training Officer
4. Senior Sewerage Engineer
5. Senior Sanitation Engineer
6. Senior Transport Engineer
7. Health Education Officer

An examination of the elements of DSSD's role, given above, shows that DSSD cannot fully take up that role until ARDHI, their Consulting Engineers, Contractors and Suppliers, have all completed their part, and operating funds have been provided.

DSSD activities are, therefore, a gradual build up in a multitude of areas, passing through stages of investigation, planning preparation, recruitment and training, until fully operational.

One of the first matters to be put in hand was the preparation of a departmental staffing proposal. This involved the examination of the nature and extent of all the department's future activities, the preparation of a proposed organisation chart and job specifications.

Each operation was then related to the provision of equipment and facilities as then programmed. This enabled a manpower forecast to be prepared, related to a timescale. This gave the data for preparation of a budget, and outline training programme.

As an illustration, we can examine in more detail, one of the more straightforward Primary Operations of DSSD, the pit and septic tank emptying service.

Some of the factors involved in its introduction and build up are:-

1. Repair and rehabilitation of Pit Emptying vehicles (PEVs)
2. Purchase of additional PEVs.
3. Provision of repair and maintenance facilities.
4. Provision of fuel facilities
5. Construction of suitable disposal and treatment facilities.
6. Driver and operator selection and training.
7. Establishment of charge collection (in advance) arrangements, office staffing, levels of charge etc.
8. Vehicle operation schedules, logs and controls.
9. Supporting cash handling, clerical, employee pay and other financial and administrative procedures.

Most of the investigations, planning and preparation stages for all the Primary Operations, Secondary (service) operations and Financial and Administrative works are now complete.

The recruitment of staff depends on receipt of funds. These are now about to be provided, it is believed. Training and the take-on of responsibility for operations will follow.

PROGRESS

This paper is written from the point of view of 'the end of the chain'. DSSD is the recipient of all the new and rehabilitated works, plant and equipment, when these are completed or provided by others. It will also receive most of the bill.

Consequently, all delays, in almost any part of the project, affect the time when DSSD can take up fully its role of operation and maintenance, and its programme of work. This being so, our concern at present tends to be more with the problems and delays, than the successes of the project.

The format of the project is an unusually complex one, with construction, repair, procurement and training activities, covering a wide range of work and numerous contracts. It involves many organisations, -primarily ARDHI, DCC and DSSD, employing Consulting Engineers, Architects and

Contractors, with the World Bank, Ministry of Finance, and Prime Minister's Office, (responsible for Local Government) all involved.

The many and complicated procedures for securing tenders and money, in accordance with World Bank and Government requirements have led to severe delays in many parts of the project, and the relative timing of many of the project's activities has been adversely affected. However, most tenders have now been let. Work on site and delivery of vehicles and equipment has commenced.

The first of the DSSD key staff arrived in September 1983, having been originally programmed for April 1983, but most of the procurement and construction contracts are 12 or 18 months behind original schedule. Sewer rehabilitation is just starting, (originally due August 1983) and vehicles for ARDHI and DSSD just arriving were planned for March to August 1983. Some programmes are even further delayed. The new workshops for DSSD are not now expected to be completed until some months after the Transport Manager's contract expires. At the time of writing this paper, DSSD still has no budget funds, and so no employees. It has only just received project transport, some 16 months after the team arrived.

However, a scheme for construction of up to 3,500 Ventilated Improved Pit Latrines households in the Temeke area, on a repayment basis has been approved by DCC, and construction of 100 demonstration V.I.P. latrines is about 75% completed, being done under DSSD supervision as a pilot scheme. Staffing and organisation proposals, a budget, job descriptions and training programmes for DSSD staff have been prepared. An active sanitation health education programme has been prepared and successfully launched.

EXPERIENCE GAINED AND SUGGESTIONS

It is apparent at this stage in the project, that there are substantial benefits to be gained from close co-ordination and co-operation in all activities of the many different bodies involved in a complex project such as this.

In order to achieve maximum benefit at least cost, it is essential that a clear understanding is gained by all concerned as to the role of each organisation, and the effects their decisions, actions and expenditure have on the project as a whole, and on the programmes and responsibilities of the other participants.

Project planning and control must take into account all the procedural, technical and financial requirements of all the bodies involved, so that these may be dealt with at the right time, and with a minimum of delay and cost.

One suitable technique for planning the relative sequence and timing of activities is 'Network Analysis'. The drawing up of a network diagram, showing all the activities and their relationship, taken together with the estimated times, will give information which can be analysed to identify the critical activites.

Given this information, all involved in the project can see where and how delays affect the project as a whole, and where more time can be taken without adverse effect.

Also essential, is the regular provision of full and up to date financial information, including cash flow for the remainder of the project. For example, when planning training, it is necessary to know, not only the physical stage and timing of works, but also the resources and finance available or already committed. Only with this knowledge can realistic plans, capable of execution, be made.

Where responsibility for different aspects lies with various bodies, such project planning can only take place by careful co-ordination of information from all parties, and full and open co-operation. The more complex the project, the greater the benefits to be derived from such planning.

Information flow is more easily acheived when a minimum number of organisations are involved. For very large and complex projects, a careful study of the best form of organisation to carry out the work, is desirable, before the project commences. In some cases, a separate responsible body, with adequate authority and funds, may well be the most efficient arrangement.

The views and opinions expressed in the paper are the personal views of the author, and are not to be taken as the views of any organisation.

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

David Sims and Dr Adrian Coad

Waterworks operation: how designers can help

Statistics have often been quoted during the Decade to show what fraction of the world has access to a supply of safe water. But in fact they do not give the numbers who receive safe water from their taps. The figures refer to those who are served by a water supply system that has the potential of offering safe water, if properly operated. A treatment plant that is not run correctly may produce water of an unsatisfactory standard such that the health of the community suffers. Operational aspects must therefore be given careful attention if the full beneficial potential of the world's water supply systems is to be realised.

In this paper the authors show how decisions made at the design stage influence the ease with which a water treatment plant can be operated; they also make recommendations for designers based on their observations of operational problems in Africa, Asia, and England. Observations regarding operational techniques will be the subject of another paper; this one concerns design.

1. RIVER INTAKES. Screens should be designed for easy cleaning. They should preferably be inclined to facilitate raking, with no cross bracing or lips to obstruct the path of the rake before the debris is clear of the screen. (Some intakes do not even provide a place for the operator to stand while cleaning the screens). Fixed screens with openings smaller than 25mm should not be used because of the difficulty of cleaning them.

The regular removal of silt must be made as easy as possible. Silt will collect in areas of low velocity. Silt pumps have a very local effect unless the silt is first stirred or fluidised.

River channels move. The low flow channel of a meandering river may take a different route each year (Cotton and Sanousi, 1983) and extraction of sand from the river bed or flood control works may lower the water levels experienced during the dry season. The careful designer will examine such possibilities.

2. PUMPING. Many modern pump motors run at much higher temperatures than older models, so that operators in hot climates are reluctant to run them continuously. The designer should verify that the motors are suitable for the expected ambient temperatures. It is wise to choose a motor that can deliver ten percent more power than is required.

Pump chambers should be sized to allow access to every nut and bolt. Pipe diameters should be increased to the full delivery main size as close as possible to the pump. Floors of dry wells should slope to a sump, with perhaps a handpump to keep them dry.

3. AERATION. Aerators seem to be incorporated in some plants more out of habit than out of necessity. Bypasses should be fitted so that pumping heads are lower when the aerators are not needed.

4. CHEMICAL DOSING. Flows of chemicals should be visible and easily measured (for checking calibrations). Tanks containing lime suspension need constant stirring; if this is not possible a soluble chemical such as sodium carbonate should be used if the pH needs to be raised. Pipes carrying lime suspension are prone to blockages and so should be as short as possible and either have ports for rodding or be flexible. Lime pipes should be duplicated so that treatment can continue when one pipe blocks. Provision should be made for flushing the pipes with clear water.

Rapid mixing of the chemicals should not depend on electric stirrers, because of maintenance problems. A reliable system that operates well over a range of flowrates is the addition directly above a weir - the downstream turbulence quickly disperses the coagulant. (Reactions between water and coagulants take place very quickly, so mixing must be immediate). It is advisable to spread the coagulant across the channel as shown in Figure 1.

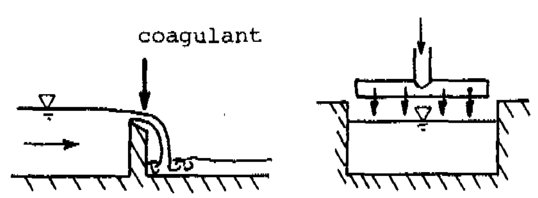

Figure 1 Addition of Coagulant

The optimum position for lime dosing is best determined experimentally and so the operator should be allowed some freedom in this.

5. VERTICAL FLOW CLARIFIERS. Clarifiers which rely on a floc blanket which is held in suspension by an upwards flow of water should only be used where the flow is continuous - 24 hours a day, 7 days a week. When the flow through such clarifiers stops, the floc blanket falls, and it will take hours to form again (if it does at all) after the flow is restarted. So the designer should satisfy himself that the power supply is dependable and that pumping will be continuous before specifying such a process. (If the flow may be intermittent a horizontal flow sedimentation tank should be selected). Control of the floc blanket is a delicate operation, and so the operator must be able to observe easily the nature and colour of the sludge as it is drawn off. The inlet pipe of a hopper-bottomed tank must be located exactly on the axis of the tank so that flow is uniform, and a satisfactory sludge concentrator for such a tank is a canvas cone, suspended near the middle of the tank. (Figure 2). Clarifiers for small treatment plants should preferably not rely on electric motors - the authors remember several plants where, in each case, the only clarifier was out of action at the time of their visit because of mechanical failure.

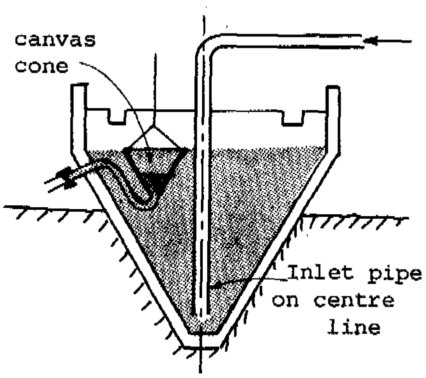

Figure 2 Hopper-bottomed Clarifier

6. HORIZONTAL-FLOW SEDIMENTATION TANKS. Such tanks are strongly recommended when the flow is not likely to be continuous. They must be preceded by an adequate flocculation stage. The flocculation in many plants is insufficient, resulting in poor sedimentation. Attention should be given to the velocity gradients or shear within the flocculator (which should be high enough to promote inter-floc collisions but not so high that large delicate flocs are ruptured) and to the retention time within the flocculator (Barnes et al(1981) state that typical retention times are 20 to 40 minutes). Again the simple is better. A hydraulic flocculator, in which the water flows around baffles, is to be preferred to a system of motors and impellers which will one day need repair. The hydraulic flocculator should be designed to be satisfactory at expected low flows as well as high flows. Proponents of mechanical flocculators claim that a variable speed motor makes the mechanical system much more flexible than the baffled channel, but flexibility can be a curse rather than a benefit. (One author vividly remembers a works where the electric flocculator was turned on for him to see it, and then turned off. Few small plants have staff who are sufficiently trained to tune the equipment to its peak efficiency on a daily basis, so that it is quite possible that it might be running at an unsuitable rate, and the extra cost and complexity of variable motors or transmissions are a further disadvantage to weigh against the potential benefit of flexibility).

Sedimentation tanks are best cleaned manually, for which a 1 in 50 floor slope is appropriate. A large plant, supplying 400 Mgd (1800 Ml/d) and recently commissioned in Manila, uses manually cleaned horizontal tanks, so it appears there is no upper limit on the size of works that can use manually cleaned tanks. There should always be at least two tanks so that one can be on-stream while the other is being cleaned.

7. RAPID SAND FILTERS. A lot can be deduced about the health of a rapid filter from observation of the washing process; therefore pressure filters are not recommended because their filter beds are out of sight. Pressure gauges are very unreliable and cannot be depended on to tell the condition of the sand. Manually-operated rotating rakes within a pressure filter can give a 'feel' for the condition of the sand but the gland around the rake shaft may give trouble.

In an open, gravity filter a ladder or step irons leading to the filter bed might encourage operating staff to monitor and maintain the condition of the filter bed more regularly.

Flowrate controllers at most works visited have been inoperative, though the float-and-lever types seem to be more reliable than those actuated by a venturi. Because of the unreliability of these devices the outlet of the filter should be marginally above the bed level so that the bed is always immersed and filtering properly. The filtrate from each unit in a bank of filters should be kept separate until it can be sampled or observed, so that the state of each filter bed is known - if the filtrates are mixed a turbid product from one bad filter could be masked by the high quality water from the others. The quality of the filtrate is impaired by sudden changes in filtering rate caused by poorly maintained flowrate controllers, or rapid adjustments of hand-operated valves. (Variable-head declining-rate filtration avoids such sudden changes by controlling the flow through the filter by changes in the level of the water above the bed, so that all flowrate changes are gradual).

Water temperature has a significant effect on the flowrate necessary for effective backwashing - warmer water must be pumped at a higher rate to give the same bed expansion. Washwater collection troughs are sometimes undersized, perhaps because they were designed for cooler climates.

8. SLOW SAND FILTERS can produce an excellent quality water provided the water they treat has a low turbidity (less than 30NTU). Simple pretreatment systems such as bankside filtration, plain sedimentation, vertical flow roughing filters or horizontal gravel filters may be used to lower the turbidity. The high quality of the filtered water means that failures in the disinfection system will not be a serious threat to public health.

The downstream pipework should be so arranged that the water surface in the filter cannot fall below the top of the sand bed if the filter is left unattended at night or if the filtrate is running to waste (Figure 3.) It should also be possible to fill the filters

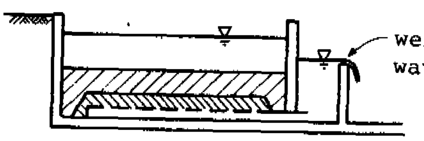

Figure 3 Slow Sand Filter

from below. It is necessary to monitor the quality and flowrate of the filtrate from each individual unit.

Flow down the easy path next to the walls should be discouraged by roughening the walls or inserting a horizontal groove, and by stopping the underdrains and gravel short of the walls.

A platform level with the top of the filter wall is necessary for the removal of dirty sand.

9. DISINFECTION. If chlorine gas is used the cylinders should be stored in a cool, well-ventilated place. The chlorinator should be at a higher ambient temperature than the store and the temperature gradient of the chlorine gas feed line should never be reversed since this would cause the chlorine to condense. The feed line should be as short as possible. Cylinders should be firmly secured because a very dangerous leak would result from a cylinder falling and fracturing the feed pipe.

If bleaching powder is used separate mixing and dosing tanks should be provided so that solid deposits do not clog the dosing mechanism. A point of application at the entry to the contact tank should be provided and the dose at the point of application should be visible.

10. GENERAL. The designer should endeavour to make all water levels and flows easily visible for casual observation. Provision should be made for measuring flows of chemicals. White tiles and direct sunlight aid in quick observations of turbidity. Where inspection covers are necessary they should be easy to move; otherwise they will be always left on or always left off.

All tanks need cleaning; this should be allowed for by providing falls to the tank floors and sumps or drains, and easy access. Weirs must be exactly horizontal and so adjustable weir plates are recommended to compensate for inaccuracies in the concrete. Splitting a flow into equal portions is not easy to achieve and so provision for measuring and modification should be made so that the commissioning engineer can make the necessary adjustments to obtain an equal division of the flow.

The simplest control systems are the best. Pneumatic actuators for remote control may cause maintenance problems, and prevent the operator from seeing the result of his action. Manually-operated valves are robust and encourage observation.

11. CONCLUSION. Conventional engineering education has laid great stress on design and on the efficiency of equipment under ideal conditions, rather than on actual conditions and operational experience. Designers are thereby taught to think of their plant as it will be in the first week of its life, rather than as it might be after fifteen years of arduous use. This shortcoming in a designer's formal education can be overcome by giving him operations experience and by encouraging him to visit schemes he has helped to design that are now in operation.

It is hoped that the comments made in these notes may form the beginnings of a checklist for designers. These observations are offered in the hope that they will strengthen friendships between operators and designers!

12. REFERENCES

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WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

SESSION A

CHAIRMAN:- Professor John Pickford OBE
WEDC Centre
Loughborough University of Technology U.K.

Discussion

1. Mr MAXWELL commented that the financial constraints on operation and maintenance, at both urban and rural levels, necessitate a suitable institution to manage, operate, and raise funds to enable good husbandry. This institution should be able to argue cases at local and government levels to obtain the funds required to maintain services.

2. Mr MBWETTE requested comments on the inclusion of comminutors in the Morovian treatment plant plus clarification of the effects of air supply on treatment efficiency.

3. Mr AKOWUAH replied that comminutors were included to deal with considerable amounts of material escaping the bar screens, a result of the high levels of suspended material. The absence of air draft through the vent pipes was attributed to filter stones blocking the pipes.

4. Mr BROWN in response to a request by Mr MBWETTE for information on the causes of failure of the waste water treatment plants, said that the failures could be connected with a whole array of causes related to operation and maintenance e.g. overloading of pumps, lack of operators for organised maintenance, plus design faults and incomplete construction.

5. Mr ELLIS suggested that wooden screens and frames should be avoided as they warp and that an adequare amount and rate of waste water should be used in rapid gravity sand filters. He instructed delegates that slow sand filters only work well if properly designed and operated, which requires operator training and regular supervision. In addition Mr ELLIS informed delegates that it is common to see water doesed with chloride of lime from which all chloride has been lost; care should be taken to prevent this.

6. Mr SIMS gave thanks for this information.

7. Mr MUGONDO questioned the future availability of dispersible lime.

8. Mr SIMS thought that availability was unlikely in the near future and that such lime would be very expensive. Lime is cheap but care is needed with its application.

9. Mr JACKSON suggested that clients/ funding agencies should extend consultants briefs to include operation of a works for a period during which operators and supervisors could be trained, routine procedures instituted and project running evaluated.

10. A discussion followed on the advantages/ disadvantages of separate or combined authorities for managing water, sewerage and sanitation with contributions by MESSRS. MTEY, NJAU, JACKSON, JONES, HAMAD, URONO, KABBAH and DIPATE. The reasons voiced for the separation of departments ranged from a historical basis to the avoidance of water engineers providing water at the expense of sanitation funds (in response to community and political pressure). Arguements favouring combined water, sewerage and sanitation services included the ability to enforce payments for all servicies (by cutting off water supplies) better coordination and cooperation in the use of resources and anticipation of greater improvements in the community's health.

11. Mr URONO expressed the view that joint authorities are only possible in urban centres and that the crux of the matter is the lack of importance accorded to sewerage and to operation and maintenance rather than the lack of funds.

12. Mr ISHENGOMA requested clarification of the method whereby the Dar-es-Salaam City Sewerage and Sanitation services would be able to work on semi commercial lines, and be able to repay the loan with interest.

13. Mr JONES replied that the Government of Tanzania had undertaken to introduce economic charges for pit emptying and for connection of properties to the sewerage system. Project funds were allocated to study tarrif levy details, probably based on different categories of users, e.g. domestic, industrial, commercial and institutional.

14. Professor KILAMA, after commenting on the emphasis on Institution building, wished to know how long the Dar-es-Salaam Sewerage and Sanitation Department had been in operation, how many Tanzanian nationals were among the seven experts and were able to take control when the other experts departed?

15. Mr JONES replied that the project had run for half of its three year contract period, that fifty Tanzanians were under training or working on the project; almost all would become employees of the Dar-es-Salaam Sewerage and Sanitation Department. All seven ex-patriot experts would be replaced by trained Tanzanian counterparts on completion of the project. The team worked on an 'advise and assist' basis with existing City Council Staff.

16. Mr RUKOIJO asked why design deficiencies occur and how could they be avoided.

17. Mr SIMS responded that cheap consultancy is not cheap if it is not appropriate. He believed that treatment works in Developing Countries should have minimum mechanical components and should reply more on good shift workers rather than on automatic components. Communication of deficiency lists back to the consultants may prove valuable.

18. Mr HORSFIELD, continuing on the subject of design deficiencies, commented on the reports of 'massive siltation in almost all sewers' (A1, ALOWUAH). He queries the availability of information on sewer design velocity used in past and present schemes, and mentioned the trend towards more careful consideration of self-cleaning velocities.

19. Mr AKOWUAH replied that the self-cleaning velocities designed for were only possible if sewers were able to run freely. The real problem in Monrovia was that inoperational lift stations led to surcharge conditions, and therefore, low velocities and heavy siltation.

20. Mr MWALE said that the problems of maintenance of both water and sewerage installations involved more than faulty designs and poor monitoring: Developing Countries were having greater difficulty obtaining the foreign exchange necessary to import parts and chemicals. The success of the IDWSSD programs was dependent on attention to these issues.

21. Mr MSIMBE stated that the question of operation and maintenance calls for a multi-disciplinary approach. Often problems were caused by lack of facilities and funds, ignorance of operators and maintenance crews or changes in the conditions assumed during the design period. He suggested that the problems should be solved when a system is at the planning stage.

22. Mr AGGARWAL said that inspection of projects should be carried out at regular intervals for better operation and maintenance and to safeguard major breakdowns and costly repairs.

23. Mr RADNAKRISHNAN requested information on the difference in cost between the normal hand pump and the rope and plunger pump mentioned by Mr BROWN (A2).

24. Mr BROWN replied that handpumps imported into Ghana cost \$500-1000 (average \$900) with maintenance costs of \$100-200. In constrast the rope and plunger pump costed out at \$100-160.

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

R F Carroll

Mechanised emptying of pit latrines in Africa

1. INTRODUCTION

A major emphasis in sanitation during the 1981-90 International Drinking Water Supply and Sanitation Decade, has been the improvement of the basic pit latrine. These improved designs are mainly single and double ventilated improved pits (VIP and VIDP) (refs 1, 2). This need for simple forms of sanitation is because, even if adequate funds were available, there would be insufficient water to operate waterborne systems.

In the foreseeable future, sanitation for the mass of low-income families is likely to involve the storage of human excreta on the housing plot. The eventual handling of the material is now recognised as a major part of on-site sanitation technology. Indeed, it is seen as an important and problematical feature of pit type sanitation schemes, particularly in urban areas, where relocating a pit latrine on a housing plot may not be feasible when an original pit is full.

Considerable effort is being made to persuade householders to upgrade latrine design, by such methods as including a ventilation pipe to each sludge chamber. Apart from the obvious appeal of reducing odour nuisance, this investment of resources is encouraged if the latrine system is seen to be a permanent installation. Consequently, if a pit latrine is to be permanent, then it will need periodic desludging to allow continuing use.

2. WHY MECHANISED PIT EMPTYING

Much disucussion has taken place on the desirability or otherwise of using mechanised methods to desludge pit latrines. There is the attractive idea that hardware for developing communities should always be hand operated and of basic technology. However, to lift compacted pit latrine sludge, commonly of a relative density of from 1.2 to 2.0, through even a short length of 100 mm diameter, flexible suction hose, the energy requirement could be as high as 30 kW (40 BHP). A single man, working continously, can only produce about 75 watts (0.1 BHP) of useful energy. Even if his output is doubled (a strong man working in short bursts) he would only produce about 150 watts.

If it is required to remove compacted pit sludge by suction hose, then an appropriate and sufficiently powerful energy source must be utilised. The only manual alternative is sludge removal by bucket; for a typical pit latrine containing around 1,000 litres of sludge this would be a long, very unpleasant and hazardous operation. Skin contact could not be avoided with likely pathogen laden sludge. For a large proportion of African communities however, manual handling of sludges associated with human excreta is unacceptable.

Botswana is one African country that is urgently seeking solutions to the problems of pit desludging. The expressed need there is for effective mechanical equipment that can remove sludge of a wide range of consistency from chambers and transport it to disposal. This is required to be done in a manner that involves the minimum contact of personnel with the sludge and hence does not pose a health problem.

The UK Building Research Establishment (BRE) has had links with Botswana for many years, concerned with drafting Building Regulations and advising on building matters. In 1979, in collaboration with the Ministry of Local Government and Lands, BRE proposed the adoption of shallow, double chambered pit latrines, which were the forerunners of the many thousands of VIDP latrines now installed there. As an option for desludging these new latrines, as well as the many old single pits, BRE has developed a suction tanker called BREVAC to do this job. The development of BREVAC was necessary because ordinary vacuum tankers (cesspit emptiers) were not capable of handling pit latrine contents, which often consists of organic sludge, grit and general domestic rubbish.

3. IDENTIFYING THE PROBLEMS

The need for methods and equipment for pit desludging has been the subject of recent research by BRE, funded by UK's Overseas Development Administration, the World Bank/Technology Advisory Group (TAG) and the International Reference Centre for Wastes Disposal (IRCWD). IRCWD carried out a study to identify the range and nature of pit latrine sludges in Dar es Salaam, Tanzania and Gaborone, Botswana (ref 3). BRE used this data to produce simulated sludges, so that currently available suction equipment could be evaluated.

The following constraints have to be considered in the evaluation of methods and equipment for chamber desluding:

(i) Limited access to the house plot (perhaps no access road).
(ii) Limited access to the sludge chamber (inaccessible siting of chamber on plot, sometimes access only through house).
(iii) Limited access to the chamber contents (sometimes access only through the latrine inlet hole, limited hole size and headroom).
(iv) Nature of the chamber contents (sludge and other debris):
  (a) high resistance to flow (viscous composition)
  (b) highly abrasive nature of the sludge (high grit content in unlined pit latrine sludge)
  (c) presence of sticks and stones (sometimes used for anal cleansing).
(v) Flow problems of getting sludge from a pit or tank into a pump system (eg reciprocating pumps need to be self-priming).
(vi) Shortage of skills to operate and maintain equipment (planned maintenance is essential for efficient utilisation of mechanical equipment).
(vii) Social implications (reactions of householders to odour and general disturbance).

The main constraints on system selection are those of access and the abrasive nature of the sludge. The only system likely to be feasible is a suction system, employing a flexible hose of between 75 mm and 100 mm diameter. Specifically for emptying pit latrines, a 100 mm diameter hose is most appropriate, to minimise blockages by large items (rags, beer cans, etc) and still be manoeuvreable by the operating crew when full. The facility to draw sludge through a long horizontal hose is desirable, where access to a chamber is restricted.

4. THE BREVAC SUCTION TANKER (ref 4)

Resulting from experimental work at BRE, using simulated sludges and various suction systems, a specification was prepared for a suction tanker that could satisfy all of the constraints. The BREVAC suction system combines a partial vacuum effect with pneumatic conveying, in order to draw a range of sludges, from water to heavy viscous sludge.

To achieve effective sludge conveying, a liquid ring vacuum pump was selected, to extract air from a 4500 litre 'vacuum' tank. A maximum vacuum is achievable of up to 0.9 bar, together with high air flow. A major advantage over other types of vacuum pump, was the minimal risk of damage to the pump, by accidental carry-over of sludge particles with the air, and very little maintenance requirement. Getting sludge out of a pit and into a tanker was one problem, but due to the likely flow characteristics of the sludge, possible difficulties were predicted in getting the sludge out of the tanker for disposal. The BREVAC specification therefore, included a full sized opening rear door, with the facility to tip the tank.

5. BREVAC IN BOTSWANA

A BREVAC tanker was shipped to Gaborone, Botswana, in November 1983, to commence two years' of field trials, in service with the Gaborone Town Council. This was part of a collaborative project between BRE and the Botswana Ministry of Local Government and Lands.

Comparative testing of five suction systems, including BREVAC, has taken place in Gaborone, from November 1983 to February 1984. The tests were organised by IRCWD and the World Bank/TAG; a report of these tests is being produced by IRCWD (ref 5). In the report BREVAC was described as easily manoeuvered, having a very powerful suction, with easy access for tank cleaning.

The objectives of the long term trials of BREVAC are not only to assess its performance and durability, but to determine the likely costs of running a BREVAC tanker emptying service for pit latrines and small sludge tanks.

The data obtained so far indicates that BREVAC is performing very well, with little maintenance requirement. The vehicle chassis however, has presented some minor 'wear and tear' problems, common in running vehicle fleets in developing countries. Because of delays sometimes in obtaining basic spare parts, the utilisation of BREVAC in Gaborone is estimated provisionally to be about 75%.

BREVAC is in regular service, emptying a range of sludge chambers:

(i) Single chamber pit latrines (basic design) 0.5 m^3 approx capacity.
(ii) Single chamber pit latrines (ROEC offset pit) 4 m^3 approx capacity.
(iii) Double chamber pit latrines (RECII) each chamber 2 m^3 approx capacity.

BREVAC in Botswana

(iv) Aqua privies (Botswana type B) 1 m^3 tank capacity.
(v) Septic tanks (commercial premises) various capacities.

Trials have been carried out using long horizontal hose runs; BREVAC has pulled the heaviest sludge, with over 80% solids content, over 64 metres through a 100 mm diameter hose. However, the most convenient hose length is around 10 metres, requiring the tanker to be close to the sludge chamber. Short hoses mean minimal washing after use, as well as keeping the number of possible leakage points at joints to a minimum.

6. COST OF A BREVAC EMPTYING SERVICE

It is common commercial practice in UK to set aside a proportion of income from a vehicle fleet to cover the cost of vehicle replacement ie capital is not raised by borrowing (ref 6). This basis is used here for estimating the cost of a BREVAC chamber desludging service.

To obtain a realistic indication of cost for a pit and tank desludging service, some data from BREVAC's field trials have been used in the calculations. The data available so far indicate that a typical working day for a BREVAC tanker allows for three round trips, ie visiting housing plots, collecting sludge and delivery to a disposal point. The volume of sludge collected on each round trip is limited to 4500 litres (tank capacity). Typically four to five chambers can be emptied per trip, at an average volume of sludge moved per chamber of 1 m^3.

Taking a working year as 185 days (at 75% vehicle utilisation) and at three trips per day, then 2,497 m^3 of sludge can be handled per year. Also, 2,497 chambers can be serviced per year. For an emptying cycle for pit latrines of at least three years, a population of 7,490 pits can be serviced by one BREVAC.

To establish a cost per household per year as a service charge to be levied per plot, the following have been taken into account:

Note: The value of the Botswana Pula has been taken as P1.645 = £1 (exchange rate at mid 1984)

(i) FUEL
Diesel fuel consumption per year = 4,625 litres (based on an estimated consumption of 25 litres per day and a diesel fuel cost of P0.63 per litre). Fuel cost = £1770 per year.

(ii) LABOUR
Operating crew of three plus driver, at a total cost per day of P24.6 (£15). Labour = £2770 per year.

(iii) MAINTENANCE
Notional maintenance cost, taken as the recorded cost of spare parts and labour over the first year of operation x 2 (for typical year) = £2,520 per year.

(iv) GENERAL OVERHEADS
Overheads taken as 20% of other costs (i), (ii) and (iii) = £1,420 per year.

(v) VEHICLE REPLACEMENT
Vehicle life notionally ten years. Therefore replacement cost should be covered by income in ten years.

The vehicle life could be less than ten years, but also there will be a residual value of the vehicle. However the notional annual sum for vehicle replacement taken here is based on a vehicle cost of £42,000 every ten years, using interest earning income from plot levies = £3,340 per year.

Because a vacuum tanker service in Gaborone is a small part of the work carried out from the Town Council Depot, no allowance has been made for a share of the cost of facilities at the Depot (other than vehicle maintenance), buildings depreciation, etc, or organisational costs of Council staff (other than the operating and servicing personnel).

The total annual cost for a BREVAC desludging service is the sum of items (i), (ii), (iii), (iv) and (v) = £11,820.

If one BREVAC services a population of 7490 plots (pits) ie empties 2497 pits per year at an emptying cycle of three years, then the cost per pitemptied = £4.73 (P7.79). Therefore the annual emptying cost per pit = £1.58 (P2.60). This charge can be recovered as a monthly levy, such as the present practice in Gaborone. This levy would need to be £0.13 (P0.22) per plot per month. At an average capacity of 1 m³ per pit, the cost for sludge handling = £4.75 (P7.79) per m³.

In the case of a Town Council desludging service in Gaborone, a notional service cost of P0.25 per month has been included in housing plot charges, this plot charge being considered as income for the emptying service. The annual income for a pit emptying service is therefore P3.00, equivalent to £1.82, per annum per plot. If accrued interest is taken into account, the annual income per plot could be of the order of £2.00.

In fact, in Gaborone, the emptying period for the new generation of double pits is likely to be around four years; this could reduce the necessary plot levy. Other factors that may effect the cost calculations are the write-off period and a residual value for the tankers, as well as the effect of inflation on interest that is earned on the accumulating plot levies.

Another saving might be made by careful planning of periodic chamber emptying. By arranging for sludge collection from adjacent plots, rather than widely scattered plots; it is likely that the number of round trips of BREVAC each day could be increased from three to four. This would proportionally increase the population of pits served per tanker, increasing the income to the emptying service, as well as reducing the cost per pit emptied.

7. SITE ACCESS

Even though BREVAC has the capability of drawing heavy sludge over long horizontal distances, it is laborious and time consuming to lay out long hose runs and clean the sections after use before stowing on the tanker.

The long hose facility, therefore, should be considered as only for occasional use, eg where a temporary obstruction prevents normal access to a sludge chamber.

An ideal solution would be to provide planned vehicle access to all housing plots that have, or are intended to have, on-site sanitation, such as a pit latrine.

In recent 'site and services' housing schemes around Gaborone vehicle access has generally been provided. In older low-income housing areas, where the original access was by footways only, considerable effort has been expended to provide vehicle access as part of an upgrading programme which includes mechanised pit emptying.

8. FURTHER DEVELOPMENTS OF BREVAC

As a result of experiences so far with running BREVAC, minor improvements can be made to its specification, not only to improve its function, but also to simplify servicing. Wider application of BREVAC is important, not only to bring added capability to Town Councils for desludging pits and tanks, but also to obtain feedback on site running at different locations to aid future development.

BRE has licensed Airload Engineering Ltd in UK to build BREVAC suction tankers, incorporating pump systems similar to the original BREVAC. Options are available on such features as tank capacity and therefore vehicle size. Details and prices for commercial BREVAC tankers can be obtained from:

Airload Engineering Ltd
Unit 8, Pembroke Dock Industrial Estate
London Road, Pembroke Dock, Dyfed SA72 4RS
UK

ACKNOWLEDGEMENTS

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11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

K Mowforth and Aggarwal

Development of the Buguruni-type VIP

INTRODUCTION

In May 1982 H.P. Gauff GmbH, Consulting Engineers, were commissioned by the Ministry of Lands, Housing and Urban Development of Tanzania (ARDHI) to design and construct prototypes of a permanent emptyable pit latrine (VIP) suitable for use in the Buguruni squatter area of Dar es Salaam and other urban areas of Tanzania. Funds for the Project were provided by the West German aid bank Kreditanstalt fuer Wiederaufbau (KFW). For research and development work the Consultant used the facilities of the Building Research Unit in Dar es Salaam (BRU).

DESIGN CRITERIA

The principal design criteria established for the VIP were that it had to be cheap, be suitable for self help construction and make maximum use of local materials. The VIP also had to have a minimum life of 20 years and be suitable for emptying at least 4 or 5 times during this period. A target cost of 2000 Tanzanian Shillings (Tsh), about pds.118, was set for the basic latrine elements of substructure, squatting plate and vent pipe.

SUBSTRUCTURE

A fully lined pit type of substructure was adopted to meet the requirements of a 20 year lifespan and the need for emptying. This also eliminated any doubts concerning the long term stability of the pit in the variable local soil conditions.

Concrete and concrete products are technicaly suitable for use as pit lining materials. In Dar es Salaam concreting aggregates are expensive, 4 to 5 times that of sand and as a consequence concrete items are more expensive than their sand cement equivalents. Also at this level of construction the crushing strength of concrete is more than required for a stable structure and so its use represents an extra cost with no technical advantage. Large concrete items such as one piece pit liners were considered but they pose problems in the field due to their weight, taking them out of the self help catagory and their cost, more than twice that of the target cost set for the basic latrine elements.

A number of building materials were identified as being potential pit lining materials and test samples were made up and immersed in the first chamber of a septic tank for an initial period of 30 days. The contents of this tank were taken as representative of those in a pit latrine.

In Table 1 below details of the results of this test are given. For comparison a thin section (50 mm wide) concrete block was also included in the test.

TABLE 1 Pit Lining Material Test

No.	Description	Condition
1.	Sand/cement block	No deterioration
2.	Crusher dust/cement block (30% clay)	Minor deterioration
3.	Sisal cement panels and blocks	Cracked/softened
4.	Soil cement block (50% clay)	Major deterioration
5.	Sun dried mud block	Complete collapse
6.	Concrete block	No deterioration

On cost and durability grounds sand/cement blocks gave the best result. In a subsequent test when the clay content of the crusher dust block was reduced to 15 to 20% then the durability of the block increased. Two latrines were constructed from blocks of this material and after two years use no deterioration of the pit lining has been observed. Although technically suitable crusher dust was not widely used in the Project because it is slightly more expensive than sand.

It had been hoped to use sisal fibre reinforced cement panels for pit lining. There is a lot of research being carried out on this material in Tanzania. Unfortunately, when exposed to the pit contents the fibres swell and rot causing the panels to crack with a consequent loss in strength. It may be possible to use this material in the future, if the absorption and deterioration of the sisal fibres can be inhibited by a chemical treatment.

After a number of trials at the BRU an optimum sand/cement ratio of 6 to 1 was determined for 50 mm by 200 mm wide blocks.

The blocks were made by hand in simple timber moulds. Various lengths of block were tried 225mm, 300mm, 330mm. An optimum length of 300 mm was determined as the standard size. This length allowed the construction of either a 1.03 m square or a 1.17m diameter circular substructures using the same square squatting plate and superstructure.
For leaching purposes standard size blocks with two 50mm by 100mm tapering to 40 mm by 80mm holes in them were developed. These blocks were produced in standared size block moulds. Use of such blocks allowed better control of the available leaching area and the structural integrity of the pit lining compared to the alternatives of open joints or half blocks. Details of the leaching block are given in Figure 1.

Experiments with ferrocement squatting plates made in timber moulds using a sand/cement mixture with galvanised chicken wire reinforcement proved successful. In normal use the squatting plate is bedded in sand on a ferrocement supporting slab. The squatting plate is removed during emptying. The opening in the supporting slab is large enough to accommodate a variety of suction hose types and permits agitation of the pit contents to facilitate emptying.

The squatting plate, although thin in section, 35mm tapering to 22mm at the hole is quite strong. It was tested in a concrete crushing machine and failed, i.e the plate cracked but the chicken wire matrix held it together with a load of 2500 kg across the plate. Field tests on completed latrines have been made with 5 or 6 adults inside the latrine causing no damage to the plate/slab combination.
Details of the squatting plate and supporting slab are given in Figure 2 and Figure 3.

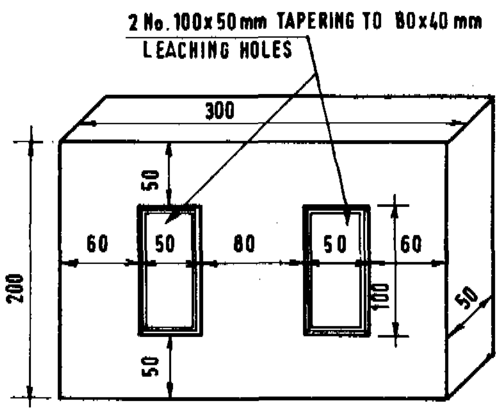


FIG. No. 1 — LEACHING BLOCK

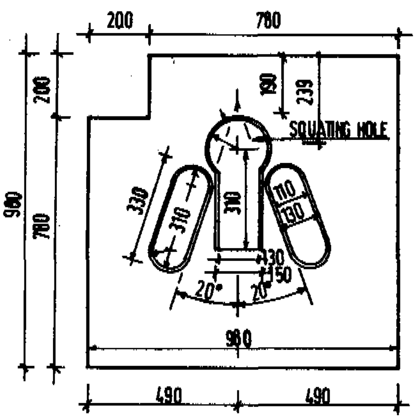


FIG. No. 2 – SQUATTING PLATE

SQUATTING PLATE

The opening in the squatting plate on top of the pit had to be large enough to permit emptying by vacuum tanker and yet small enough to prevent children from falling into the pit. To meet these twin demands the concept of the removable squatting plate was developed. The key dimensions for the hole and foot-rests in the squatting plate are in accordance with World Bank recommendations.

A number of materials were proposed for the squatting plate including reinforced or mass concrete and fibreglass. Concrete is an expensive material and steel reinforcement is almost impossible to obtain locally. Fibre glass would have to be imported and the use of this material is uncommon in Tanzania.

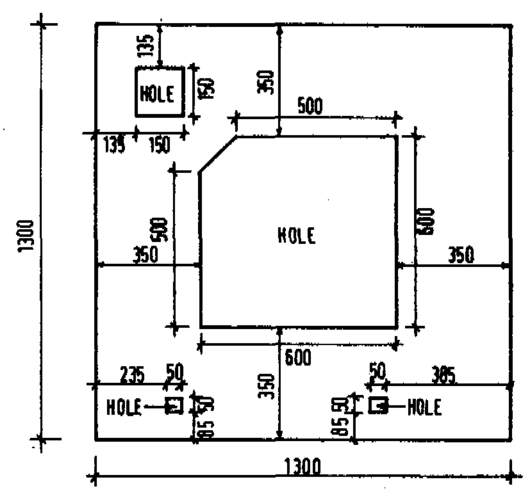


FIG. No. 3 – SUPPORTING SLAB

VENT PIPE

For consistency with the rest of the latrine the vent pipe was constructed from sand/ cement blocks made in timber moulds with a central 150mm diameter hole. The diameter of this hole its position in the latrine, in the right or left rear and its final height above the roof line were determined after tests were made using air velocity meters and similar equipment by staff of the ARDHI Training Institute. The vent pipe block is shown in Figure 4. The vent pipe is capped with a nylon flyscreen in a timber frame. Later research by the World Bank has shown stainless steel or fibreglass to be better fly screen materials.

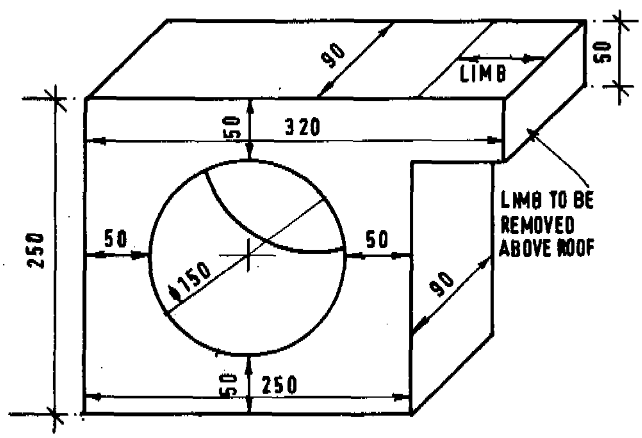


FIG. 4 - VENT PIPE BLOCK

SUPERSTRUCTURE

Standard section blocks as used for the pit were used for the superstructure. A timber door and frame and roof purlins were used.

From research work carried out at the BRU, sisal cement sheets were developed for the latrine roof. These sheets are made on site by un-skilled labour from locally available materials, unlike the more expensive alternatives of corrugated iron or asbestos cement sheets.

PROTOTYPE CONSTRUCTION

Twelve prototype latrines were constructed in the Buguruni area of Dar es Salaam by local masons. This was to prove the concept of the latrine and to try out a number of varients including square and circular sub-structures, a pour flush type of squatting plate and a latrine with an extended super-structure with provision for bathing. Two latrines with local mud and wattle super-structures were tried but these were expensive, required constant maintenance and were not popular with local people.

The conclusions drawn from the prototype construction were the standard latrine with a square pit, was suitable for immediate mass production. The circular pit type latrine needs corble blocks to step from the circular pit to the square supporting slab and this requires a more highly skilled mason than for the square pit. More research needs to be done to develop a pour flush plate suitable for local conditions. The bathing type latrine is available, if there is a demand. All of these latter types are more expensive than the standard latrine and are moving away from the low cost, low technology, design objectives of the Project.

CONCLUSION

In conclusion, the key elements of the latrine, i.e. substructure, squatting plate and vent pipe were produced for Tsh.1660 (pds98) in 1982 prices, well below the design target of Tsh.2000. The complete standard latrine was produced and built for Tsh. 3000 (pds. 176). The only imported items used were the nylon flyscreen and the metal door furniture, both of which were available in the local market. The latrine was fabricated and constructed by local labour using simple tools and equipment, thus meeting the low-technology design objectives.

MASS PRODUCTION

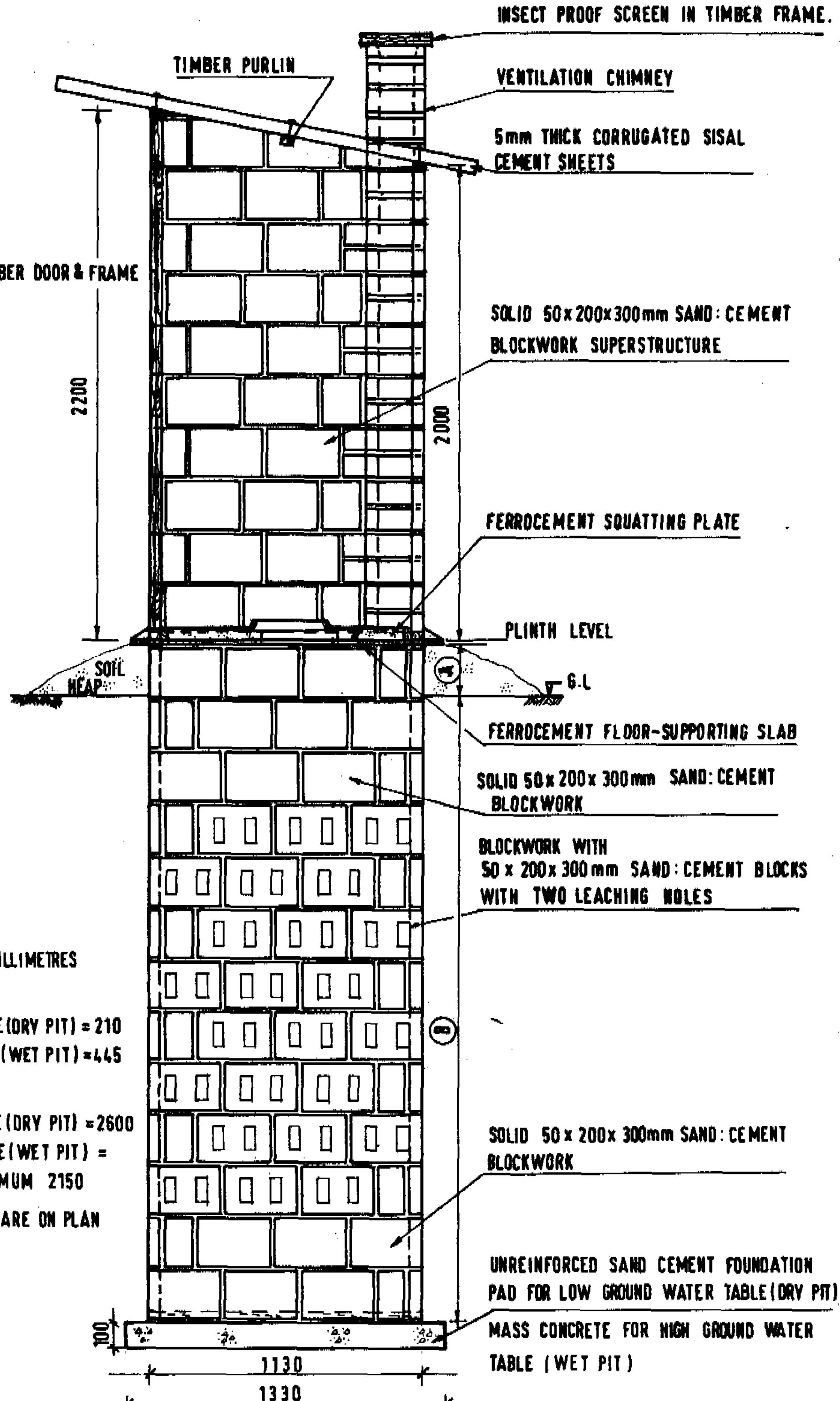
To meet an estimated demand for 2000 latrines in Buguruni the Project has been extended to include the construction of an appropriate technology plant to manufacture components for between 3 to 5 latrines per day. This phase of the Project is funded by KFW, ARDHI and the Dar es Salaam City Council World Bank financed Department of Sewage and Sanitation (DSSD).

The plant is being constructed directly by the Project Consultant using local labour and hand tools. Earthworks were done free of cost to the Project by the City Engineers Department of Dar es Salaam. Production is scheduled to start in April 1985. After full commissioning operation of the plant will be handed over to the DSSD.

In the design, construction and operation of the plant the low cost, low technology aspects of the Project have been maintained. All sand/cement items will be made in locally produced moulds and equipment. The only imported equipment apart from hand tools will be woodworking equipment. This could be dispensed with if a reliable source of planed and cut timber were available.

The latrine design has been adopted by the DSSD for use in Dar es Salaam. Initialy they plan to construct some 3600 units in the Temeke area of the City.

In Figure 5 an elevation of the standard latrine is given.



NOTES.

1. ALL DIMENSIONS ARE IN MILLIMETRES
2. DIMENSION 'A':
   LOW GROUND WATER TABLE (DRY PIT) = 210
   HIGH GROUND WATER TABLE (WET PIT) = 445
3. DIMENSION 'B':
   LOW GROUND WATER TABLE (DRY PIT) = 2600
   HIGH GROUND WATER TABLE (WET PIT) = MINIMUM 1720 TO MAXIMUM 2150
4. SUB/SUPERSTRUCTURE SQUARE ON PLAN

FIG. 5 - STANDARD LATRINE ELEVATION

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

I A Blakely, M G Mwangamila, C D Ngwaeje and C L Swai

UNICEF Assisted Wanging'ombe Projects

Gravity water supply and rural sanitation

TANZ.

Prior to 1978, the 80 000 people of Wanging'ombe had a long history of water shortage, especially during the 8 month annual dry season. This prevented their development keeping pace with that of their more fortunate neighbours in the Njombe highlands. For this reason Unicef tried to respond positively in 1976 when an initial request was made by the government to provide water as a basic service, thereby raising the living standards of the Wanging'ombe people and setting them on a course towards their development.

The eventual concept, in January 1978, was of a large gravity reticulation system covering all of the 50 villages within the area. Such a water supply, if successful, would be a permanent solution to the whole of the Wanging'ombe area.

Among several major objectives of the water project, one was to improve health by decreasing the incidence of diseases related to poor water supply. Another was convenience i.e. the reduction of the burden on the traditional water carriers, namely women and children who spent long hours each day in search of a few litres of mostly polluted water from unprotected sources.

The first phase of the project, completed in December 1981, brought the water through 270 Km of pipes to 43 village reservoirs for which it was intended. The seven additional villages since the original layout was designed in 1973 have now also been provided with water from the new gravity system.

Phase II of the project which began in June 1983 is well advanced to nearly 60%. It was recognized that additional water points beyond the one or two at each village reservoir would be necessary to reduce the walking distance in obtaining water. Some 8 to 12 public taps will be provided in each village during the second phase, hopefully in 1985/86, so that no villager will have to walk more than 400 metres to the nearest water point.

Included also in phase II is the completion of the slow sand filtration system of which a battery of 6 cells has already been constructed and part of which is presently being used as sedimentation tanks. Meanwhile pending the completion of the filtration system the Wanging'ombe people are being reminded through the environmental health education campaign, of the importance in boiling the water before drinking.

COMMUNITY PARTICIPATION

The measure of success to date of this huge water supply has been sustained by the mass response from the villagers and their leaders towards community participation and their willingness to be involved in all aspects of the work. More than 80% of all unskilled labour is being provided by the Wanging'ombe people on a self-help basis. This in turn has helped to create a feeling of ownership which will be of vital importance in the role of organized "operation and maintenance" at community level.

As a significant component of the Wanging'ombe water project in terms of National Policy, and also as a pre-requisite for Unicef assistance, community involvement and participation in the actual implementation on a self-help basis was among the agreed conditions. This not only reduces capital costs, but also serves as an initial introduction to a new facility which the community itself as the owner, would eventually be called upon to operate and maintain as far as possible within its capacity.

Having identified water as one of their topmost priorities which would enhance their living standards, the Wanging'ombe people responded as a community determined to take up the challenge and rid itself of at least one obstacle impeding its development. When the time came for action, however, the marshalling of such an operation called for routine disciplines as hundreds of villagers queued for the distribution of digging tools, while others assembled along the routes of the pipe trench waiting to be shown their section of five or ten metres which each individual would dig for that day.

Not all villages were involved simultaneously in trench digging. This exercise was geared as far as possible to the pipe laying programme, or a specific schedule projected on a three or six months basis as it was found out in the early stages that trenches remaining open for long periods tended to collapse especially during wet weather, thus requiring to be re-dug at the time of pipelaying.

Community participation in the water project was therefore an on-going operation throughout the area for the total period of construction. The villages in the upper areas played their part first, and were actually using the new water for two or three years before their neighbours in the lower areas. The total period of actual concentration in each village was only approximately 2 to 3 weeks for the water supply. Community involvement included the excavation of all pipe trenches within the village boundary, not only within the residential area but within the total area related to each village including grazing and forest land. Together with this was the task of back-filling the trenches as the pipes were laid, and in many cases where access by lorry was not possible, it was necessary to carry the pipes some distance and place them alongside the trench before laying took place.

Although the Steering Committee, with its regular meeting proved to be extremely valuable in monitoring progress and resolving problems encountered during implementation of the project, other smaller committees were formed at the same time in 1978. These dealt specifically with the community participation component, with a feedback to the Steering Committee through the Divisional Secretary. These committees were established at Divisional, Ward and Village levels, with fortnightly, weekly and daily meetings respectively during the whole operation. Being closer to the community, the committees dealt mostly with practical matters on a day to day basis, such as organizing the trench digging schedule, fixing times and dates, also boundaries in consultation with neighbouring villages, checking and distribution of tools, and ensuring the general completeness of the exercise in all villages throughout the project area.

At site level, community participation was under the leadership of the Divisional Secretaries. There were altogether three Divisions involved in the water project, the largest being Wanging'ombe with 34 villages, next was Mdandu with 14 villages, followed by Makambako with 2 villages.

THE SANITATION PROJECT

In realising the close links between an abundant supply of clear water and proper sanitation facilities and improvements in the health standard of the people by minimising the incidence of water related diseases, it was agreed that the Wanging'ombe water supply should be accompanied by a comprehensive health education campaign and the introduction of better sanitation technology. This was supported by a cross-sectional survey of the area in four villages by the Regional Medical Officer, together with a TAG mission and Unicef in August 1980, and again in October 1980. In addition villagers were prepared to take up a second challenge by participating in the same way as they had done in the water supply.

The Unicef assisted Wanging'ombe rural sanitation project began in April 1982 and is well under way in 34 out of an eventual total of 50 villages within the project area which is the same as that covered by the water supply, namely the same 50 villages consisting of approximately 17,000 households. The sanitation programme calls for 100% coverage throughout each village. This means that a newly designed ventilated improved pit latrine will be constructed by every single household which has access to the new water supply.

The sanitation programme began with the selection of 4 pilot villages in which household latrine construction commenced during the period 1981/82 after demonstration models had been built. The project was extended to a further 15 villages during 1982/83 as part of the main construction programme designed to embrace the whole target area in three stages at approximately 1½ year intervals. The project was extended to the second group of 15 villages during stage II in 1983/84 and was recently extended to the last group of 16 villages (March 1985) meaning that all 50 villages are now under an improved latrine construction programme.

TECHNOLOGY

The first step in the design of the project was to develop a variety of suitable low-cost pit latrines, using locally available resources and technology as far as possible. The objective was to create a selection of options, each of which would be an improvement on the existing latrine technology, and would also be readily affordable to the villagers, and from which they could choose in accordance with their needs and preferences.

Basically two types of ventilated improved pit (VIP) latrines were considered, and these were a) permanent type, of which two versions were offered, and b) semi-permanent type, of which 5 versions were offered. In all models the main component was burnt bricks with sand/cement mortar joints, as traditionally, Wanging'ombe is a "brick-making" area. The average number of burnt bricks used in the demonstration models was 1390, for the complete structure including the privy shelters and vent stacks was 630.

After initial construction at the Unicef base camp, all seven options were later built at each of the four pilot villages. This was eventually followed by a briefing from the Resident Health Officer, on the merits and de-merits of each model, with the intention of assisting village councils in making the most appropriate selection. The final result was a unanimous choice of the permanent alternating type latrine.

Soon after construction of household latrines began, some irregularities were noted in the measurements and shape of the twin vaults. To eliminate this problem and also to simplify further the construction up to slab level, a wooden template or frame was designed. This frame is the exact size and shape of the double pits, and when placed on the ground the householder has only to mark around the outside of the frame with a hoe to get the lines of excavation. When excavation has been completed down to 1.5 metres, the frame is again used, this time in the bottom of the pits, and the lines around the inside of the frame are the exact dimensions for the brickwork. One of these templates is being provided to each village. Unicef also provided a limited quantity of building tools to speed up the construction of new latrines, which had in some areas been retarded through lack of sufficient tools. In all 15 sets were issued to each village.

In areas where shortage of masons was a constraint, village councils decided to select a number of Std VII school leavers to be trained by the few existing masons to enable them to participate in latrine construction.

Lack of firewood within a reasonable distance for brick burning would seem to be a possible constraint in the near future. To try to eliminate this problem and also to try to enhance replicability of the project in other areas, the technology is under further review. The use of sun-baked bricks, and several alternative uses for the two bags of cement normally used for building the pit linings, are still being studied at the base camp.

COSTS - AT COMMUNITY LEVEL

In terms of input, the sanitation project is basically one of self-help, with assistance from government and Unicef only in providing materials not available within the project area. The Unicef input consists mostly of 'hardware' such as cement for building the pit linings and concrete squatting slabs and two pieces of fly-screen, whereas government input is mostly 'software', such as the health education campaign.

In 1982, the total cost, or 'face value' of one completed household latrine was established at T.Shs 1026/=, this included all construction materials and labour. The total value of the Unicef input for one complete household latrine was approximately T. Shs 198/=. This means that the value of the input by the householder was approximately T. Shs 828/=.

A table showing the relative costs, attached as an appendix to this paper, includes a complete breakdown of the various tasks assigned to both the householder and Unicef.

HEALTH EDUCATION

Albeit, after rather a slow start, this campaign has taken up new dimensions in the past 18 months. The provision of a visual aid kit for use by the resident health officer has greatly facilitated his work. More kits will be used by health education helpers, one being based in each of the five wards within the project area.

The object of the health education campaign which has been extended to 34 villages out of 50, is to create awareness of health hazards and means of prevention in every village and literally every household within the project boundaries. The magnitude of this work is just as great as that of the hardware component. The resident health officer together with his small group of helpers has tried to formulate a strategy to bring the health education component to every family.

PROGRESS

The most recent statistics on pit latrine construction prepared on 26 March 1985 show that in the four pilot villages there is 82.5% coverage(1343 latrines) whereas in the 15 villages in each of the second and third phases there is 66% and 16.7% coverage respectively (3573 and 775 latrines respectively).

APPENDIX 1

Item	Task/Materials	Unit	Quant.	No. of Man days	House Holder Value	UNICEF Actual Cost
01	Prepare sun-baked bricks	EA	2,000	8	144/=	
02	Build Kiln for burning			6	108/=	
03	Collect Firewood for burning			2	36/=	
04	Collect sand for burning			2	36/=	
05	Excavate Pit - 1½m. deep			4	72/=	
06	Mason - Construction to slab level			4	72/=	
07	Labour - Attending Mason			8	144/=	
08	Construction of Privy shelter			12	216/=	
09	Steel Reinforcement - slabs	Kg	3.4			17/=
10	Cement for 1 set slabs	Kg	16			19/80
11	Cement for Pit Linings	Kg	100			123/75
12	Labour - slab making	Set	1			12/50
13	Wooden Moulds for slabs					2/=
14	Fibreglass fly screen	Ft^2	2			4/=
15	Aggregate for slab-making					2/=
16	Sand for slab-making					1/50
17	Transport slabs/cement to villages - per Unit					7/60
18	Transport firewood to villages - per Unit					8/=
		Totals in T. Shs.			828/=	198/15
		Total Value		T. Shs.1,026/15		

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

B.M. Jackson

Involving the private sector in sanitation improvements, with special reference to experience in Lesotho

Discussion Note

The importance of effective communication for sanitation programmes is increasingly being recognised. Communication may be necessary to motivate the community to improve their sanitation, to ensure that sanitation facilities are properly used and maintained to promote the hygenic practices that are needed to obtain the health benefits from improved sanitation.

The Lesotho Health Education Project has been set up by The Urban Sanitation Improvement Team of the Department of Interior of the Government of Lesotho, with assistance from the Overseas Development Administrator of the United Kingdom. Dr John Hubley of the Department of Health Education, Leeds Polytechnic has been brought in as project consultant.

Over the 14 month period from July 1984 to August 1985 the Consultant will make three visits to Lesotho and carry out the following activities.

1. Prepare a communication strategy to support urban sanitation initiatives.

2. Preparation of a series of tape-slide programmes in English and Sesotho to support the various Urban Sanitation initiatives. These include: briefing sets for school managers/teachers and pupils on school sanitation; training sets for health workers on sanitation/maintenance/use/hygiene practices and briefing sets for local administration personnel.

3. Advise on purchase of equipment for showing communication materials including portable VHS video, tape-slide unit and overhead projector (items to be purchased by ODA).

4. Run local courses for personnel in teaching/communication techniques.

5. Provide a training in health education for key personnel on the Leeds Polytechnic Diploma in Health Education in Developing Countries.

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

SESSION B

CHAIRMAN:- Mr. Fred Mjau
ARDHI
Dar es Salaam Tanzania

Discussion

1. Mr HAWKINS itemised the shortcomings in the Bugurini VIP design, that had come to light during the project implementation, together with the design modifications. These were:-

a) superstructure too small, front to back measurement was too small for pregnant women, side to side was insufficient for bathing.

b) the squatting hole is too large, leading to user fear and low use.

c) chicken wire, as reinforcement, is difficult to obtain so currently testing the use of 'mtazi' wood as traditionally used for reinforcing latrines and as septic tank covers.

d) pre-cast slabs are large and tend to break in transit.

e) square pits are not satisfactory under many conditions in Dar es Salaam.

f) leaching blocks allow huge quantities of sand to enter in sandy soil conditions.

2. Dr MINJAS wished to know what proportion of the prototype pits built at Bugurini had 'free water' and therefore could be considered potential mosquito breeding sites.

3. Mr MOWFORTH replied that there were three.

4. Mr MCHAILE stated that the design criteria did not include 'acceptability'. He highlighted the difference in size between the Bugurini type and that commonly used in Dar es Salaam. He wondered if this was a direct violation of the basic philosophy that the people have to be involved in decision making.

5. Mr AGGAWAL replied that people were fully involved in the development and that their views were thoroughly considered before finalising the Bugurini VIP. The social, cultural and economical aspects and cost effectiveness in relation to latrine performance and the technical skill of the builder were constantly considered during the development of the Bugurini VIP to meet the target cost of Tsh 2000 (approx. £118) for the basic latrine, elements of substructure, the squatting plate and the vent pipe. People using the twelve demonstration units at Bugurini were satisfied with the latrine and happy with the chamber size.

6. Mr MTEY stated that in Dar es Salaam slum areas the latrine is also the bathroom. He wished to know if the Bugurini design had taken this in to account in terms of size and in terms of dealing with the concomitant mosquito problem.

7. In reply Mr AGGARWAL said that a combined VIP latrine-bath facility had been developed by increasing the size to 1030 wide by 1745 mm long, and drawing the bath water into the latrine pit. This design included an additional ferrocement bath plate. Drawing 4081/LCS/7 gives all the details. He emphasised that the drainage hole of the bath plate should be plugged after bathing and that the latrine surround should be kept as dry as possible.

8. Professor KILAMA questioned both the possibility of complications arising from the variation in measurements for the squatting plate and supporting slab and the unnecessary demand for scanty available materials by providing a slab and plate capable of supporting more than six adults.

9. Mr AGGARWAL explained that complications did not arise as the plate and slab were cast extensively by hand using simple re-usable timber moulds. The ability to support 6 adults was related to provision of a structural factor of safety of 2.5 to 5.

The thickness of the slab was required from the structural/drainage point of view.

10. Mr MAMBALI wished to know what precaution was taken against ground water pollution from the pits, especially where the latrines were constructed near wells used for drinking water.

11. Mr AGGARWAL informed delegates that dry pits were used when the water table was below the foundation pad, whereas mound latrines were built where the groundwater table was at or above this level. Obviously information on groundwater table fluctuations were necessary to ascertain which type of structure should be constructed. In areas near wells, double-vented compost latrines, fully rendered outside and inside were recommended if no suitable site was available (8m downhill or more than 30 m uphill from a drinking water

well).

12. Mr NYUMBU wished to know the reason for painting the vent pipe white on the Lesotho VIP latrine. He also queried the availability of corrugated iron sheeting for the superstructure of VIP latrines in rural areas of Lesotho.

13. Mr JACKSON replied that research had shown that the colour of the vent pipe was unimportant. He confirmed that the Lesotho VIP latrine superstructures have adequate ventilation. The latrines are made in the towns; materials were readily available in the Rand monetary area - without the need for foreign exchange.

14. Mr MBWETTE asked for details of any research into the pros and cons of covering the squatting hole slab. He commented that research had shown that the influence of the colour of the vent pipe was minimal in comparison with the suction effect of wind over the vent.

15. Mr AGGARWAL replied that research had shown the covering the hole would stop the ventilation circuit, so the hole should be left open at all times.

16. Mr EDMONDSON queried the costing of the Dar es Salaam latrine and challenged the ability to construct and install it at a cost of 4500 TAS. He also requested methods of procedure if, whilst acceptable from an engineering point of view, a 22 m slab was unacceptable from a social and community point of view.

17. Mr AGGARWAL assured Mr Edmondson that, at 1985 prices, the cost of the latrine, if the exact construction sequence was followed, was 4650 TAS. This cost increased if a World Bank loan was taken out to purchase the latrine.

    With regard to the slabs, demonstration units in the Bugurini Area were in continuous use.

    Confidence could be developed by demonstrating both the strength of the slab (5-6 adults) and by presence of reinforcing chicken wire.

18. Mr BROWN stated that Africa was already saddled with mechanised emptying of sludge from septic tanks or pit privies and with the associated economic technical and organisational problems. He asked for clarification of the philosophy for the introduction of the mechanised system, other than the selling of high technology. Could not the issue of cultural 'manual handling' using wheel barrow cartage be an educational question?

19. Mr CARROLL answered that mechanised emptying of pits is not necessarily the only option. Indeed manual emptying, with long-handled shovels or buckets, is potentially the cheapest option where it is socially acceptable: currently this is not in most of Africa. He therefore advised that, if mechanised emptying was required, methods and proven equipment are available. BREVAC has shown its robust, long-lived properties in service in Botswana.

20. Mr OMAMBIA commented that the tape-slide presentation had shown a zinc-sheeting VIP latrine next to a house built of local materials. He wished to know how appropriate and affordable were the VIPs in rural areas.

21. Mr JACKSON explained that the house cost was 6-8 times that of the latrine and that there was a long-standing trade in wood and zinc-sheeting latrines, regarded by most Basotho as the only 'proper' latrine. He added that USIT had merely sponsored an improvement in existing technology and commercial practice. The latrines were not affordable to all but were becoming widespread throughout Lesotho. As these latrines cost 1.5-2 months wages the people were obviously motivated, in both rural and urban areas in taking the responsibility for the provision and maintenance of VIP latrines.

22. Mr SWAI asked what were the provisions for the control of fly-maggots that may escape from the latrine pits.

23. Mr JACKSON answered that the pit is sealed all round by a zinc-sheet skirting; all 'insect life' is contained in the pit and assists with digestion.

24. Mr MUGONDO wished to know if transfer of the Lesotho VIP latrines was affected either by corrosion of the reinforcement or by the increased weight if the reinforcement was protected.

25. Mr JACKSON explained that the wood and zinc-sheet VIP latrine had an untreated wooden frame which did not deteriorate in Lesotho's dry climate and termite-free terrain. He acknowledged that this solution is not suitable elsewhere in Africa.

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Dr Layi Egunjobi and Professor Paul Maro

Community self-help in the provision of drinking water

Introduction

Community self-help has long been recognized as a strategy which can effectively be adopted to complement government efforts in forging local development. In the area of water supply, community initiatives can be very important not only for health purposes but also for community economic upliftment. It is in recognition of this that communities are expected to contribute in making the International Drinking Water Supply and Sanitation Decade (1981-1990) a success. In this regard, an earlier observation in one local government area of Nigeria showed that community development objectives and activities were not channelled towards solving the area's critical water shortage (1). This, it was inferred, might have been due to lack of awareness of need or difficulties arising in drawing out areas of priority among a host of perceived needs. However, a more recent observation from another nearby local government area shows that community development efforts have in fact been made to focus on provision of water to aleviate the problem of water shortage in the particular locality. It has represented a success story which idea may be used in other areas possibly with modifications according to local peculiarities.

This paper therefore sets out to relate the history and experience of this community water dam project in terms of organization, financing, technical input, government involvement, as well as identify the general motivating factors.

Background

The community observed is Igboho. This is a town located in the extreme northern part of Oyo State of Nigeria. According to the 1963 population census, Igboho had a total of 46,776 inhabitants (2); and using the officially recognized annual rate of growth of 2.5 per cent, 1984 estimated population of the town is 113,994. Compared with other parts of the state, the northern area-where Igboho is situated - is generally recognized as among the least developed in terms of size and distribution of infrastructure, social facilities and industrial establishments. Of particular significance is the problem of water shortage in the area. This is occasioned by the fact that the area lies within the drier zone of the state. Average annual rainfall is 125 cm as against 200 cm in the wetter southern zone. The rate of run-off is high consequent upon the relatively higher altitude of the area which is about 500 metres above sea level as against 300 metres in the south. Inhabitants are faced with more serious water shortage in the dry season (November - March) when the traditional shaft open wells get dried up and distances up to 8 km have to be covered daily in search of spring or brook water.

Initiation of Water Project

The origin of the water dam project can be traced to the activities of a Young Farmers' Club (YFC) which existed in Igboho in the 1960s. The leader of the group - a school teacher - had advised on the desirability of building a fish pond in the vicinity of the town. It was argued that fish yield from the pond would constitute a source of revenue to the club and that production of more fish would improve the protein contents of the people's diet. Members of the club intimated their relatives about this proposal; and the issue had to be taken to the meeting of Ifelodun Omo Igboho (IOI) - a community association of the traditionalists, which had long been pre-occupied with the issue of finding solution to the problem of community water supply.

Meanwhile, there was an unusual incidence during one of the dry seasons: A pregnant woman who went out at dawn in search of water had failed to return home. Her body was discovered somewhere in the bush after two days of search. This seemed to be the last straw that broke the camel's back. The IOI had to do something and therefore approached the Igboho Literate Union (ILU) on what sould be done to the community's perenial water problem and the desirability or otherwise of a fish farm. The ILU at the instance proposed the building of a dam where water could be obtained all year round. This has in a way followed the YFC's proposal to build a fish pond even though in a modified form. The ILU's proposal was to have a dam primarily for water supply and secondarily for fish farming. This idea was bought by the entire community.

Community Organization

By early 1970s, serious discussions had started about the challenges and prospects of a community water project. As already discussed above, there had existed the necessary organizational resources in the IOI, ILU and the YFC. All these have the same basic objective of seeking through practical ways the socio-economic development of Igboho. However, the initiation of the water project served as a uniting force for all the community organizations. In fact both the IOI and the ILU now merged into two and adopted the name IOI. It has since become a mother union for every able bodied person of Igboho origin whether literate or illiterate, christian, muslim or animist, male or female and whether living at home or abroad. Even though, there are presently other minor social clubs, those are necessarily subsumed in the mother union.

The IOI has an executive committee of fifteen members. These are changed every three years. The president, secretary and treasurer must be based in Igboho; other officers may not ordinarily be resident in Igboho. There are branch unions in 48 other towns in Nigeria, Republic of Benin, Upper Volta, Niger and Togo. Two congresses are held every year: the 'mini congress' which is held in June and the 'major congress' held in December. During the mini congress, at least 50 per cent of all levies are expected to be in while the balance for any given year must be paid by December. The major congress lasts for a week during which programmes of activities including religious whorships, social dances, lectures and business meetings are accomplished.

On average, each able bodied person pays a compulsory levy of ₦20 (£17.7 sterling) per year towards community development efforts (3). Voluntary donations of any amount could be made in addition. Payment is strictly enforced while enforcement is assisted by churches, mosques, clubs and branch unions. Defaulting members attract such penalties as seizure of their personal belongings until they have paid outstanding dues. Since the resident community members supply communal labour, they are expected to pay 50 per cent of normal annual levies. So, while a member who normally resides in Igboho pays ₦10 per year, his counterpart who lives in Lagos or Lome pays ₦20 per annum.

Two bank accounts are in operation. There is the 'home branch' account signatories of which are resident in Igboho. This account is earmarked for the day to day running of the union or carrying out phases of stipulated community development projects. The other is the 'general union' account signatories of which may be scattered all over the country, indeed over West Africa.

Description of Project

There were initially some wranglings over the location of the project. Every neighbourhood in the town wanted a location that would minimize the distance its members would travel to the proposed water source. This prompted the intervention of a neutral person - a technical man, in fact. The Water Corporation was approached to give the necessary technical assistance. A water design engineer was therefore sent to Igboho and having considered all information at his disposal decided that the ideal location was along Sanya River at the north-eastern part of the town. This helped to settle the wranglings once and for all. And so, work began on the project in 1974 through direct labour. Officials of the state Ministry of Agriculture and those of the state Water Corporation assisted in supervising the construction. By 1977, the earth dam had been built. The table below shows some technical details of the earth dam: As can be seen from the table, a big body of

Description	Data
Length of dam	238.90 metres
Deepest part of dam	8.00 m.
Approximate area impounded	101,115.00 sq.m
Approximate volume of water impounded	808,920.00 cubic m.
Design capacity of service reservoir	450,000.00 litres per day

water was impounded and this became an invaluable resource to the community. The water was not treated; however it served as a steady source of water supply for drinking and for other domestic uses. Nonetheless, the project suffered a serous set-back in 1980 when the earth dam gave way. This was attributed to the fact that the earth dam had earlier shown signs of high rate of seepage. In any case, no engineering studies were known to have beeen carried out initially to ascertain the strength of underlying rock formation on which the dam was built. Furthermore, it is believed that there was no proper compaction of the earth dam. What appeared to be the immediate cause however, was a baobab tree stump which was left in the mound during construction. When the stump got rotten, a weak point was obviously created which allowed water to seep and so led to eventual collapse. The Ministry of Agriculture and the State Water Corporation later came to the aid of the community in advising on how to get the mound back in shape. The community on its part now appointed a water engineering company to supervise the reconstruction. The dam was eventually repaired with two spill-ways built into it instead of the pre-existing one. The dam has since re-filled up and community members have continued to fetch its raw water for use.

Government Involvement

Government involvement has taken two forms. The first is through the Community Division (Self-help Section) of the state Ministry of Information, Social Development, Youth, Sport and Culture. This government department is responsible for advising and assisting communities on self-help projects, and it has been performing this role in respect of Igboho Water Project. Essentially, it has made available some grants to encourage the community. Since the beginning of the project up to impoundment, a total grant of ₦1,600 (£1,415) was made available to the community. Another ₦5,000 (£4,422)) was budgetted to help the repair work when the dam gave way but this was not released.

A second aspect of government involvement has been through the regional water corporation. As earlier stated, this corporation was able to provide technical advice to the community of the ideal location of the dam. In addition, when the dam gave way, the Water Corporation collaborated with the appointed private company to put it in shape.

In 1984, the government took a bolder step by getting much more involved in the project. It decided to undertake distribution of the water supply. No longer would people have to walk up to the dam site to draw untreated water, as the water would now be treated through a package treatment plan and distributed through communal stand pipes. At the time of writing this report, the corporation has awarded contracts in respect of the different aspects of the work as shown in the table below. Work has actually commenced on rehabilitation aspect of the work. A survey of the communities to

	Contract Value	
Water Description	₦	£
Construction of a well-type intake	98,000	86,671
Rehabilitation of existing dam and the impounding reservoir	76,000	67,214
Construction of the rising main	31,000	27,416
Construction of service reservoir	21,000	18,572
	226,000	199,873

ascertain the extent of distribution need has also been undertaken. With this combined efforts of the community and government, the people of Igboho will in no distant future be served with abundant and safe drinking water.

Evaluation

The Igboho Water Dam Project certainly had some technical problems to contend with, but its eventual achievement in water provision can be considered as a success in community self-help. It, in fact, represents a model to be encouraged in other areas of Nigeria and Africa in general. Here, it has been possible to see a good example of community initiative-taking, a demonstration of community enthusiasm, a manifestation of mutual trust between elites and traditionalists, and an effective cooperation between government and community. In particular, those motivating factors that are more significant include effective community organization and the influence of education. The type of organization observed in Igboho is such a sophisticated and powerful one that has continued to record high levels of achievement in other areas of community development outside the water project. Furthermore, the educated group in Igboho has provided the necessary leadership in community mobilization. This appears to accord with the essertion that in any community, "the ability to grasp ideas was a characteristic of those who had some education. (4) These two factors provide the moving force behind the Igboho Community Water Project. The potential benefits this exercise may generate can be seen from the community side in terms of health improvement and general socio-economic development. The benefits can also be viewed from government side as representing substantial savings on financial resources as government cannot possibly be all things to all communities at all times.

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Professor M R Mujwahuzi

Constraints to effective community participation in rural water supply schemes

INTRODUCTION

Participation of rural communities in the development of water supply schemes is regarded as an essential ingredient for the success of the whole rural water supply programme (ref. 1). It is strongly recommended that the intended beneficiaries of rural water supply schemes should be fully involved in the planning, construction, operation and maintenance of water schemes. In some countries it has been made more or less a condition that no rural water supply scheme is to be built if the beneficiaries are not prepared to share in the responsibilities of construction, operation and maintenance. So far no country can boast of having achieved full community participation in all phases of scheme development and this has been so due to organizational and technical constraints. Unless these constraints are solved one cannot expect to achieve full community participation in all the phases of water supply schemes.

Tanzania is one country in which the strategy of community participation in water supply schemes has been pursued vigorously for over a decade now. Using Tanzania experience as an example, this paper will attempt to highlight what appears to be the main constraints to community participation and to make some suggestions as to what may be done to improve on the performance of this strategy.

PLANNING

This is the first and crucial stage in the water supply development programme. It involves identification of the water problems confronting the community. The identification of the water problems involves such activities as the collection of data on the physical surroundings including the water resource base, habits of people and the resources they command, their likes and dislikes in so far as water uses is concerned and analysis of the data gathered so as to arrive at some conclusions concerning the prevailing conditions. After the identification of the problems, decisions on how to solve these problems have to be made taking into consideration the nature of the existing water resources and the available finances. The design of water schemes usually takes place when the above steps have been made.

Collection of hydrological data, analysis of such data and the design of water schemes are activities which call for special skills which are always not available in our rural areas. That is why most water technicians and other experts regard this stage of scheme development to be beyond the reach of rural communities. Most experts do not believe that rural people can contribute effectively to the planning process. They tend to regard participation of village people at this stage of scheme development as a waste of time and the experts would prefer not to involve local people in the planning activities. Thus, besides the real technological constraints which tend to exclude the village people from participation, there is also the attitude of the experts towards the competence of local communities. Because of this preconceived notion that the village people have nothing to do with planning, the expert is usually not motivated to look into alternative ways in which he can get the local communities to be involved in planning.

If planning is interpreted as simply collection, analysis of hydrological data and design of water schemes, then we can agree with those who argue that rural communities should not participate in planning because they do not possess the necessary expertise. But if planning means something more than the above activities then there is great possibility for rural communities to participate and contribute effectively to the planning process of rural water schemes.

During the implementation of the Water Master Plans for the three regions of Iringa, Mbeya and Ruvuma in Tanzania, an attempt has been made to involve the beneficiaries of rural water schemes in the planning process. The involvement of local communities has taken a form of calling village meetings at which the schemes to be built are discussed between the representatives of the Water Department (MAJI), the donor agents (in this case the representatives of the Danish International Development Agency - DANIDA) and the village community (ref. 2). Such meetings contribute to the planning process by acting as a forum for the exchange of ideas and a very valuable source of important information which is necessary for planning purposes. It has been observed from several villages that water schemes which have been designed after village meetings have taken place and local people have been given an opportunity to express their needs, wishes and to provide information about their environment, have resulted in water distribution systems which are more responsive to the needs of the community than schemes which have been designed without such village meetings.

To facilitate and improve on the participation of village communities in the planning process, villages which are earmarked for water supply are required to form Village Water Committees (VWC) which have to cooperate with MAJI in the development of water schemes. The limited experience we already have with these VWC is that they have been found to be very useful tools in planning. One of the planning activities which the VWCs are required to do is to suggest the location of Domestic Waterpoints (DPs). So far the distribution patterns of the DPs which are suggested by the VWC have been found to be satisfactory as no part of a village is left out which has sometimes been the case when the distribution pattern had been worked out without involving the village people. In addition to location of DPs, Village Water Committees have also proved to be successful in locating reliable sources of water for the schemes. It is evident from the information we already have that although village people cannot perform certain tasks which require special skills such as design of schemes, yet their involvement in some other aspects of planning is very crucial for the success of the planning process. It is imperative that if community participation in planning is to continue and succeed there is need of identifying those areas in which village people can participate effectively and abandon the idea that village people are ignorant and can therefore contribute nothing to planning.

CONSTRUCTION

Among all the phases of water scheme development, the construction phase is believed by many people to be the most suitable stage in the development process in which community participation can take place effectively. The belief is based on the assumption that the tasks which the village people would be required to perform do not require special skills. During this stage of scheme development village communities would be called upon to perform such tasks as site clearing for pipelines and construction camps, trench digging and filling them up after pipes have been laid, brick making, gathering of sand, stones and other building materials and so on. Besides the fact that the above tasks require no special skills, they can be performed by all able bodied adults. It is therefore possible to involve all the adult population of any village.

During the implementation of the Water Master Plans for the regions of Iringa,Mbeya and Ruvuma village participation has been more prominent in the construction phase than in the other stages. The unskilled labour of both sexes has been successfully mobilized in all the villages where new schemes have been built or old ones rehabilitated. Inspite of this general success in mobilizing village communities for construction work, there have been some constraints to full utilization of people's enthusiasm for participation in scheme development. The constraints have been mainly organizational although other problems such as the delay in procurement of necessary materials has sometimes slowed down the rate of construction. Let us examine briefly the main constraints.

In DANIDA sponsored water schemes, after the intended scheme has been explained to the villagers at a village meeting, the village government is required to sign an agreement with MAJI. The agreement is a contract which, among other things, requires the village community to participate in the construction, operation and maintenance of the particular water scheme. At the construction stage all able bodied people are required to participate in the tasks already mentioned above. The main problem in the performance of these tasks is how to mobilize and distribute work among the village people. Should all the village residents turn out for work on the same day? How should work be distributed among the villages which share the same scheme? How much work should each village resident do? etc.

It has generally been found out that if all those who have to work on the scheme turn up for work on the same day, there are problems of control. It becomes very difficult to control the quality of work. There is also a problem of keeping proper records of who has attended and who has not done so. It also turns out that when the whole village reports for work on the same day, it becomes very difficult to monitor the time people spend on the scheme. There are always some elements in the community which tend to take advantage of the confusion and leave their place of work unnoticed. Furthermore, when so many people turn up for work at the same time, there is always shortage of working tools such as pick axes, shovels, etc. The end result is that some peopled do the work while others remain idle.

In trying to solve the above organizational problems, the approach which has been taken in DANIDA sponsored schemes is to distribute work among village people by using the existing political organization structure, at village level, of ten cell units. Each ten cell unit or a manageable group of two to three ten cell units are required to work on a particular task on a specific day. The advantage of using this system is that all members of those units know each other and therefore no one can abscond without being noticed. It is also easy to provide a limited group with working tools as well as to control the quality of work.

Economic status has in some villages (although not all) created some problems. There are cases where people who are financially better off have refused to work on the construction of water schemes. These are usually business people. Much of their time is spent on their business. There are cases where, because of their'financial might', these business people have 'bought' their freedom from work from their ten cell leaders who are supposed to recruit them for communal work. The conspicuous absence of the 'rich' elements from communal works tends to create disatisfaction among those who cannot 'buy' their freedom from work.

To deal with this unwanted absence, a system of penalizing absentees has been developed in many villages. Any person who absents himself/herself from work without valid reason is required to pay a fine of about 50.00 Tanzania shillings (£2.5) for every day he/she does not show up for work. In addition to paying the fine, the concerned person has still to do the job he /she was supposed to do before. This system of penalizing the defaulters seems to work well where it has been strictly adhered to.

Although the use of the ten cell unit system in mobilizing people for work has proved useful, yet there are cases where it has not been very successful. Poor performance has been observed in those villages where the ten cell unit leadership has been weak. Some weak ten cell leaders have failed to instil discipline among their people which has sometimes resulted in people not turning up for work when they are required to do so thereby delaying the completion of scheme construction.

Delay in procurement and delivery of construction materials such as pipes and fittings has as well had a negative impact on the spirit of community participation. Sometimes village people have been required to dig trenches for pipelines before pipes have been delivered. By the time pipes arrive, some sections of the trenches are found to be filled up and village people are required to do the same job once more. People resent doing the job twice. One would prefer to ask people to dig trenches when all the necessary materials are on sight. Theoretically this arrangement would be acceptable although in practice it is not always possible.

Conflict of interest sometimes creates a problem in the mobilization of village people for communal work on village projects. In many areas of Tanzania digging of trench would best take place during the rainy season when the soil is soft and therefore easy to work on. Unfortunately this is the time when village people have to work on their farms. It has been noticed that people prefer to work on their farms during this period rather than working on digging trenches for pipelines although they are usually aware that this is the ideal time for trench digging.

OPERATION AND MAINTENANCE

One frequently comes accross statements that good operation and maintenance by beneficiaries of water projects in developing countries are essential if new and existing schemes are to continue serving them. Several arguments are advanced to show the validity and the strength of the above statement. It is, for example, argued that the governments of developing countries do not have enough financial and human resources to take care of all the rural water schemes strewn throughout the countryside. Whereas if the people who benefit from the schemes take the responsibilities of operation and especially maintenance they would be able to generate enough resources locally for the maintenance of their schemes. Furthermore since village people are the users of the schemes, it would be easy for them to know immediately when the scheme falls out of use and it would therefore not take long before it is put back to order.

The arguments in support of village participation in operation and maintenance are convincing and attempts to get beneficiaries to operate and maintain their water schemes have already been made in some regions of Tanzania. Full participation of village communities in the maintenance of water schemes has however not been achieved due to lack of clear guidelines on how to deal with certain maintenance issues. The issues which which have remained unanswered concern the availability of spareparts, the training of maintenance personnel and ownership of water schemes.

In almost all the villages of Tanzania where water schemes have been developed, the local community has been found to be willing to meet the costs of repair and maintenance of schemes. The problem has however been the availability of spareparts. So far this problem has not been solved. The village communities do not know where they can purchase the necessary spares for their scheme. MAJI is as well not clear on this issue. The result of this uncertainty is that village people have bot been able to take full responsibility for the maintenance of schemes although they are willing to do so and they have the money to meet the costs involved. There is therefore a need of establishing centres where local communities can purchase spares needed for their water schemes.

It has also been suggested that a village should have one or two people from the village whou should be in-charge of operating and maintaining the scheme. These maintenance people should be trained in the basic skills. The problem with this training is that there is no formal institution where such people can be trained. They are expected to acquire the skills during the construction phase. If after construction the trained personnel decides not to work on the scheme, the village in question is left without trained personnel and there are generally no facilities where other village people can be trained.

The question of formal ownership of the scheme has also affected operation and maintenance. There is no where in Tanzania where a rural scheme has been officially handed over to the beneficiaries. The existing schemes are regarded as government schemes. Consequently in some villages people are reluctant to incur the costs of operation and maintenance. They argue that they cannot pay for the maintenance of a government scheme. There is therefore a need of making it clear to the village communities that they are the owners of the scheme. Once this is done, I think this problem of not accepting maintenance responsibility would be solved

CONCLUSION

From what has taken place in Tanzania, it is clear that great strides have been made in getting the beneficiaries involved in water schemes development. However, if full participation is to be achieved, there is need of solving the constraints mentioned above. It will definitely take time to solve them, but with village committment and determination a solution to these constraints will be found before long.

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Keith Richardson and Roger Harris

Urban Water Supply Systems - The Repair Option

ABSTRACT

Faced with a neglected, malfunctioning, inefficient or broken down water supply system there is a temptation to overlook the repair option in favour of replacement. Considerable savings can be achieved through well conceived repairs or improvements. Additionally the efficiency and treatment capacity of existing works can often be significantly improved by introducing new management or operational techniques.

INTRODUCTION

Now halfway through the International Drinking Water Supply and Sanitation Decade launched by the United Nations, it is generally recognised that the cost of meeting the Decade's objectives will be many times more than was originally expected. In the present climate of worldwide economic difficulties it is therefore becoming increasingly important to identify means of reducing the costs of providing these essential public health services in order that the limited available funds can be used to benefit the greatest number of people.

Much has been done in this respect in Tanzania and our firm was priveliged to be engaged by the Ministry of Lands Housing and Urban Development in 1979 to execute the Dar es Salaam Sewerage and Sanitation Master Plan and Feasibility Studies. Two other papers being presented at this conference relate to some of the key recommendations emerging from these studies - the low cost sanitation programme and the technical assistance programme to establish the proposed new management organisation. Howard Humphreys are currently project managing the major rehabilitation of the existing sewerage in Dar es Salaam, whilst in Kenya they are responsible for the Nairobi Water Supply Project, the latest stage of which includes the review and repair recommendations for some of the existing facilities in addition to the provision of new capital works. The authors are involved with both of these projects.

This paper sets out to provide guidelines as to how improvements can be made to existing urban water supply systems at relatively low cost through the adoption of a repair and improvement strategy as opposed to one of renewal. The benefits to be attained by such a strategy are twofold, the reduction of operational costs and the deferment of capital expenditure. It must be recognised however that physical improvements alone will not produce or maintain optimum capacity/production and that equal importance must be given to the need for operational management improvements.

A water supply system comprises three operational areas, distribution systems, trunk mains and treatment works. The following guidelines and case studies are therefore presented in relation to these groupings.

DISTRIBUTION SYSTEMS

As the demand for water in urban areas increases the new sources are carefully planned but the extensions to distribution systems tend to occur in a piecemeal fashion. There is therefore usually much scope for improvement of these systems at low cost in order to improve efficiency and/or provide additional capacity to meet projected increases in demand.

An important preliminary to the preparation of an improvement programme for a distribution system is the acquisition of 'as constructed' or record drawings together with reliable data on consumption, pressures, and variations in reservoir storage usage. Such data is not only essential for good day to day management of the distribution systems, it also ensures that improvements are planned in sufficient time.

The first phase of an improvement programme would comprise the installation of district meters, to accurately determine, the overall consumption the installation of accurate level recorders on all service reservoirs, and pressure and flow surveys of all districts to determine daily peak and minimum flows. This work should be followed up by analysing the distribution system using network analysis techniques.

Once an analysis of the system has been carried out a phased programme of improvements to the system to meet increasing demands can be implemented and would typically be along the following lines:-

a) Adjust pressure zones where necessary to keep pressures to the minimum compatible with providing an adequate pressure to properties. Install additional pressure control valves where necessary.

b) Choose key pressure points in the system and install pressure recorders.

c) In each district set up waste water zones.

d) Introduce additional valves and short link mains to ease operational problems and facilitate the setting up of waste meter and pressure zones.

e) Assess the true cost of water in each district, and use these values to prepare waste prevention operational guides.

f) Consider the installation of booster pumps or pneumatic booster systems for small high level zones as these can be cheaper than new mains.

g) Standardise equipment, particularly in pumping stations to ease maintenance problems.

h) Review bye-laws.

i) Consider the provison of storage by industrial users. This not only safeguards their supply but reduces peak demands and hence size of main.

j) Interconnect systems to provide alternative supply in case of emergencies.

k) Review service reservoir requirements and ensure effective use is being made of the them. These not only help to reduce peak flows, but give cover at times of emergency due to major failure. Independant high level inlets at service reservoirs although more expensive help to give better control.

l) Optimise the usage of pumps to effect power saving.

Regular night flow assessments in each district and waste zone will allow staff to concentrate their efforts in areas where there should be the best return. Unsatisfactory trends are identified before major troubles arise. The provision of good data will enable the distribution system to be better managed and improvements to be designed based on knowledge of what actually happens rather than what is thought to happen.

It is difficult to generalise on the savings which can result from carrying out such improvements to a distribution system, but the reduction in wasteage and more efficient use of the existing system must result in a delay in the need for new capital works, and therefore be measures which are worthy of thorough examination before proceeding with new capital schemes.

TRUNK MAINS

The sources of supply for many towns and cities are frequently some considerable distance from the area being supplied. Consequently large diameter pipelines have been laid to transfer water from the source to the distribution system. These pipelines represent considerable capital investment and any loss of capacity is a matter which needs serious investigation. The problems associated with the deterioration of mains are summarised in the table below.

Problem	Effect on Water Mains
Encrustation	Reduced carrying capacity. Increased friction head in pumping mains.
Corrosion	Reduced strength Discolouration Leakages and bursts.
Accumulated deposits or coatings	Water quality problems Reduced carrying capacity Increased pumping friction head.

The materials from which the mains are made clearly has a considerable influence on their performance as not all materials are subject to the problems given above.

The five principal materials used for water mains are iron, steel, asbestos cement, unplasticized polyvinyl chloride (uPVC), and prestressed concrete.

The uPVC, asbestos cement and prestressed concrete pipelines do not normally give rise to problems because of reaction of the material with water. This is not so with steel and iron pipes where the natural tendancy is to revert to iron oxide which is the cause of many water main problems. In all cases build-up of deposits can occur from poor treatment control or from old iron pipes upstream.

Once these problems have begun then consideration must be given to the feasibility of carrying out renovation of the pipeline. Generally, particularly in developing countries where labour costs are relatively low, it is cheaper to renew small diameter mains. Large diameter mains may however be renovated economically using methods such as:-

a) Swabbing - cleaning out deposits by passing through foam swabs.

b) Pressure jetting - removes deposits and some encrustation.

c) Air scouring - removes deposits and some encrustation.

d) Scraping and relining - the linings can be of concrete, bitumen and epoxy-resin.

The use of these renovation techniques in the right circumstances can restore a trunk main to almost full carrying capacity again.

WATER TREATMENT WORKS

Generally water treatment works, particularly those for large urban communities have been designed and constructed to a high standard. Frequently however it is found that they are not able to be operated at the designed capacity. Rarely is the fault found to be due to structural weaknesses, but rather it is due to lack of operational experience and poor maintenance of electrical and mechanical equipment.

Recent inspections were carried out of three treatment works in East Africa all of which were unable to produce more than 85% of design capacity during a period of good raw water quality. The findings of these inspections are summarised below:-

Works No. 1

A works rated at 60,000 m^3/day, with treatment consisting of sedimentation, rapid gravity sand filters, chlorination and pH corrections.

The faults found were:

1. Air scouring of filters was not possible - resulting in clogging up and reducing capacity.

2. Broken penstocks on the filters - lack of capacity.

3. Alum dosing - not working properly giving reduced capacity.

4. Flow meters for dosing and backwash pumps not working - control of further backwash rates and chemical dosing not reliable resulting in reduced capacity.

The estimated cost of all these repairs was £22,000.

Works No. 2

A works rated at 5,000 m^3/day with treatment of spring sources by microstraining and chlorination. The plant was 26 years old.

The faults found were

Damaged straining fabric
Wash water pumps not working

The cost of repair is estimated at £11,000. The alternative of replacing with slow sand filters would have cost £150,000.

Works No. 3

A works approx. 50 years old with full treatment - i.e. filtration, sedimentation and chlorination.

The faults found were

Restricting flows on inlet pipelines
Washwater pumps and alum dosing pumps not working (16 years old).

Local water supply pump and trunk main flow meter - not functioning.
Estimated cost at £19,000

In all the above examples the costs of repair are minimal compared to the costs of replacement. Where problems on treatment works are not so readily identifiable, alternatives such as conversion of existing works to another type of treatment e.g. change of filter media are worth examining in depth. Where problems occur with river or reservoir sources due to algae, jetting in reservoirs and microstraining are possible solutions.

CONCLUSION

Our experience has shown that in many instances considerable savings can be achieved by repairing existing assets as an alternative to renewal.

Although renewal cannot always be prevented or deferred over a long term a significant deferment will normally make repairs and improvements an economic option.

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K. Stutterheim

Rehabilitation of water system of Ambohitrolomahitsy village - Madagascar

BACKGROUND INFORMATION

The village of AMBOHITROLOMAHITSY is located in the highlands of Central Madagascar approximately 40 kilometers north of the capital city TANANARIVE. The village has a population of approximately 2500 persons, of which the largest percentage earns their living by rice production.

The village is perched on a hilltop surrounded by 3 valleys which are used for irrigated rice production. Since the irrigation canals follow the periphery of the valley it was necessary for the villagers to descend to the edge of the rice fields to obtain water for household use.

Because of the inconvenience encountered in obtaining water for domestic uses, a water supply system was constructed for the village in the late 1960's. This water system utilized the "capping" of a spring, about 500 metres from the village, as its source. A small water distribution system was installed however after a period of time the water from the one small spring was not enough to supply the needs of the villagers. The villagers attempted for a period of a few years to obtain financial assistance to rehabilitate the water system. In 1982 they received financial assistance from the Miororealisation Projects Division of the Presidency (Malagasy Govt) together with the French Corporation (French Govt) to rehabilitate the water system. FIKRIFAMA (a non profit Malagasy PVO), through the channel of the Malagasy Ministry of Population, was requested to do the work of the water supply rehabilitation.

PROJECT DESIGN CONCEPT

After a brief preliminary review of the Project, FIKRIFAMA decided to undertake its design and construction, however it was evident that it would be necessary to implement the following guidelines:

1) To obtain a sufficient quantity of water to meet the future domestic needs of the villagers.
2) To take the necessary measures to provide potable water for the users.
3) To ensure that the maintenance and security of the water system would be provided after the completion of the project.

Quantity of water: various means are used for calculating the quantity of water for village consumption, however the following guidelines have been used by FIKRIFAMA technicians for a period of 10 years and these have generally proved to be satisfactory:

a) Consumption: 20 litres/person/day.
b) Village growth factor for 15 year period:
   i) for villages less than 1000 population multiply by 2
   ii) for villages more than 1000 population multiply by 1.5.

It should be mentioned that the results obtained in using the village growth factor depend entirely upon the accuracy achieved in getting the correct existing village population. One method often used by FIKRIFAMA is to count the number of the houses. This technique tends to avoid underestimating the number of the existing population. By using the above techniques it was determined that the 15 year design population of AMBOHITROLOMAHITSY Village was 2500 x 1.5 or 3750 people. The quantity of water required would be 3750 x 20 litres/day or 75 cubic metres per day. The required continuous water flow rate would be a minimum of 52 litres/minute.

Water quality: a satisfactory tool used in evaluating water quality for rural communities is the WHO guidelines. It should be remembered that the guidelines pertaining to the total coliform limit of 1/100 ml (MPN) in 90% of the samples will be difficult to obtain if there is no chlorination or disinfection as a final treatment stage.

Maintenance and Security of the Water Supply: It should be emphasized that the most positive factor regarding maintenance and security is the involvement of the villagers in the planning, construction and follow-up phases of their water supply system. Self-help village participation projects are ideal because the villagers become involved and feel that the project belongs to them. This strengthens the village ownership concept and thereby the people feel responsible to maintain and take measures to ensure the security of the project. It has been noted that if the villagers work on the construction phase of the project, they become knowledgeable in the skills required for minor repairs and maintenance in the future.

AMBOHITROLOMAHITSY Water Supply System

A reconnaissance of the area showed that a sufficient quantity of surface water could be obtained to supply the needs of the design population of the village. This supply of water is held in a retention dam about 2 kilometres from the village. The retention dam is fed by a number of small springs located in the valley above the dam. Some repairs on the water retention dam were to be required. It was also required that water laboratory anayses be completed.

Since the dam was located at an elevation of more than 30 metres higher than that of the village gravity flow could be utilised. To improve and ensure the security of the water quality, a filtration system would be required.

In reviewing the water filtration techniques, both the slow sand and rapid sand filtration techniques are accepted as standard techniques in water purification, however maintenance consideration for both need to be evaluated.

Rapid sand filtration units are compact and are successful only if clean water is available for the backwash process. In standard design practices, the filtered water is pumped to a reservoir to be stored and used for periodique backwashing. This requires a pump and is a maintenance consideration. Should the pump be out of use for a brief period of time, then the filter can become overloaded, which can result in very little or no filtered water passing through it, thereby, making it difficult to obtain a sufficient supply of water for the backwashing process. Since the filter media would have to be removed to cleaned to solve the problem, it is quite likely that by-passing the filter, at least for a time, would result. Slow-sand filtration does not require backwashing however it requires a sizeable surface area. Maintenance of the units, such as "skimming", and sand replacement, need to be considered.

Further reconnaissance of the AMBOHITROLOMAHITSY area revealed that it was possible to cap springs of the "point source" nature in the valley above the retention dam. Because the springs were located at a higher elevation than the retention dam it was determined that the pure water from the springs could be stored at a sufficient elevation and that it could be used for filter backwash water by gravity flow in a water filtration-backwash scheme. The flow-schematique on Page 3 outlines the water purification process. Some technical characteristics are as follows:-

1. Retention dam ... 4000 square metres surface
   ... 3000 cubic metres volume.

Note: Dam Construction of Stone masonry reinforced by concrete on lower section of dam. Siphon inlet installed.

2. Sedimentation basin: 5 metre particle path length 3 hour detention period
   60 litres/min-rate of flow.

Note: Path flow in vertical direction to utilise "contact zone" - See Basin Section on Page 3.

3. Rapid Sand Filter:
   76 $l/min/m^2$ - loading rate
   450 $l/min/m^2$ - backwash rate
   0.7 stm - backwash pressure.

Note: For filter media see Sand Filter Section on Page 3.

4. Water Storage Reservoir: 50 m^3.

5. Pure water backwash reservoir:
   7.8 m^3
   15 litres/min - rate of flow from springs.

PROJECT CONSTRUCTION

FIKRIFAMA was responsible for the design and construction of the project. During the construction phase, one technician was on the job-site to implement the day-to-day work activities. The villagers provided the labour for the construction of the water purification plant as well as the digging of the trenches for the pipelines. They also provided food and housing for the FIKRIFAMA technician.

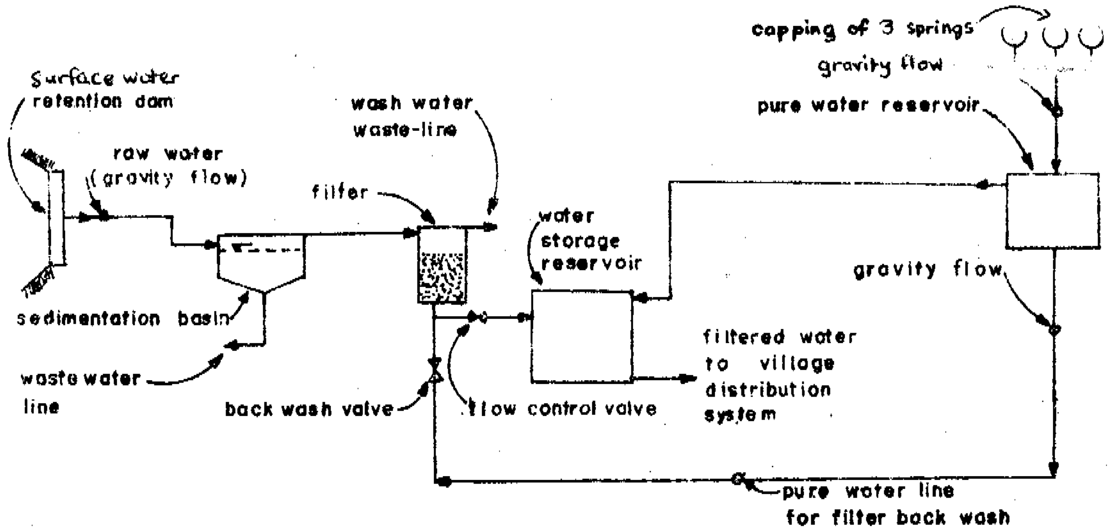
Reinforced concrete was used in all areas of the construction. Concrete rings were used in the capping of the springs and circular steel "slip" forms for reinforced concrete were used in the reservoirs, filter and sedimentation basin construction.

Flexible polyethylene pipe was used for the majority of the pipelines, however galvanised steel pipe was used for road crossings and in rocky terrain.

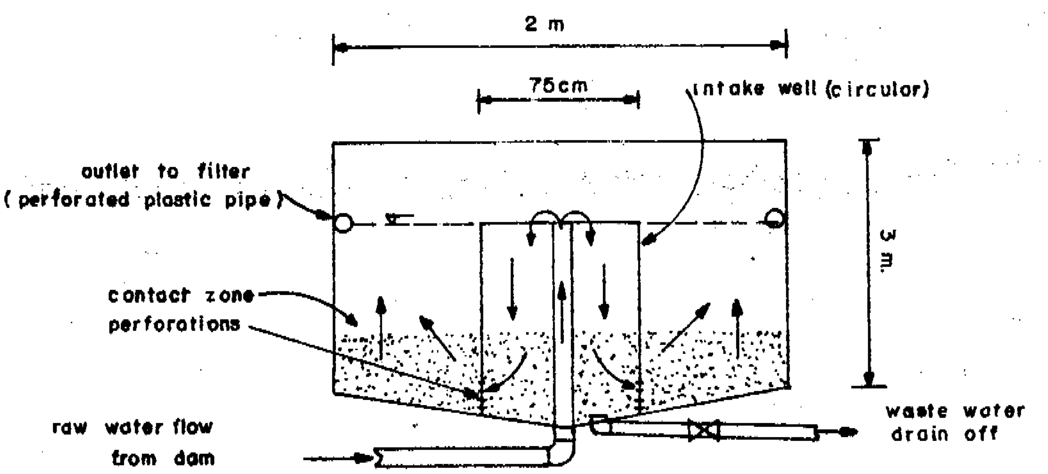
The total cost of the project was approximately U.S. $ 27,500 out of which an amount of $ 2500 was evaluated as the contribution (in-kind) from the villagers. These are 1983 construction costs.

PROJECT MAINTENANCE

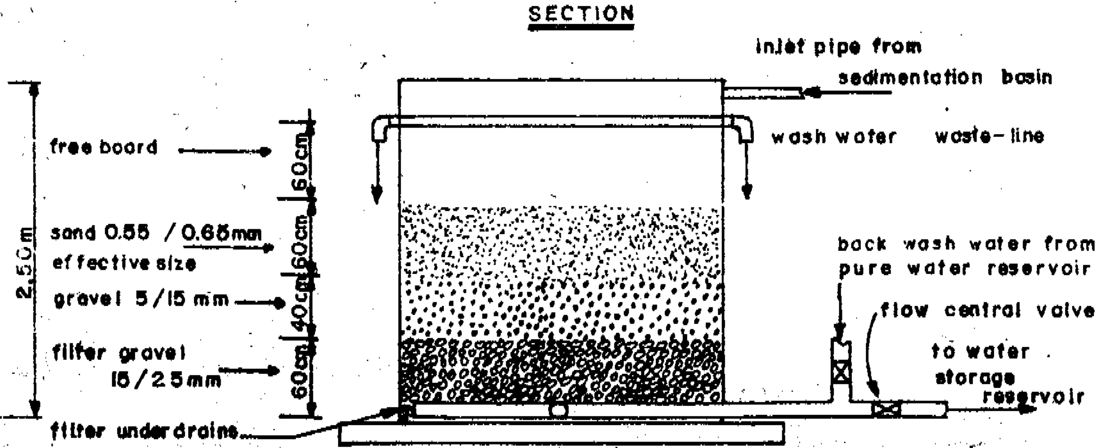
The village employs 2 part-time workers for the maintenance of the water supply system. These workers were trained by the FIKRIFAMA technicians and are now familiar with the water purification process as well as the backwashing of the filters, spring protection reservoir cleanliness etc. These workers are paid by the village governing committee which is responsible for assessing each household



FLOW SCHEMATIQUE



CIRCULAR SEDIMENTATION BASIN SECTION



RAPID SAND FILTER SECTION

with a water-charge. There are no private household hook-ups however the hospital complex and school science laboratory are supplied with water. There are 24 public taps in the village and the use of each of these is under the supervision of someone living nearby.

PROJECT EVALUATION

The water supply system has been in operation for approximately 18 months and FIKRIFAMA has continued to assist in the maintenance training of the 2 water supply workers. The workers are familiar with the filter backwash process however they have encountered some difficulty in the regulation of the flow control valve. This is manually operated and has to be regulated daily as the head loss in the filter increases. It has been noted that an increase in the freeboard to allow more fluctuation of the waterlevel above the sand layer would make the flow control operation easier.

The sedimentation basin has proved to be quite efficient for its short detention time. It should be noted that the retention lake greatly assists in the reduction of turbidity. Some erosion around the lake has produced significant water turbidity during heavy rains. It is felt that to assist the turbidity removal process after heavy rains, it would be useful if the detention time were increased by 50% and the particle path length increased by an amount of 1 to 2 metres.

It has been noted that continued efforts are needed to properly protect the watershed surrounding the retention lake. The villagers have begun such a program however additional regulations limiting the planting of crops upstream from the retention lake need to be implemented.

APPLICATION FOR FUTURE PROJECTS

The rehabilitation of the AMBOHITROLOMAHITSY Water Supply System has proved to be a positive factor for future development projects in the surrounding area. Because the village people have been able to complete this project they have confidence in their own ability to organise and implement projects. They are now beginning projects in the fields of health sanitation and nutrition and are showing an interest in agriculture and afforestation projects for the future.

The technical knowledge gained from the project has also been of assistance to the FIKRIFAMA staff. Similar projects are now being planned, however it should be noted that characteristics of the terrain make this type of project feasible, and these characteristics do not normally exist for a broad range of project sites. Certain design modifications using rapid-sand filters with solar powered or wind driven pumps for pumping the backwash water to the storage reservoir, are now being considered for other construction sites.

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David O. Omambia

Agency versus community participation approach in development of water supply and sanitation programmes

The modern concept and focus of development has seen a shift from a traditional approach of top-down planning to a new approach that recognises the need for more emphasis on decentralised administration and flexible planning to allow for support for locally formulated approaches to development issues. In the traditional approach where development paradigms were based on capital investment, e.g. big power water schemes, there was no need for dialogue or involvement of the poor recipient majority in decision making related to development. 'Policies were to be decided by university-trained technocrats and carried out by rationally organised beauracracies'. (Uphoff 1979 p.2.). The poor communities remained dependent materially and psychologically on the authority of these detached elites. In many cases, whether the criteria of these technical decision-makers included community participants, their backgrounds and values, their biased, isolated perspective on society related in part to their interest in maintaining the status quo, often leading to formulation of development priorities which were culturally and technologically inappropriate for the populations they were supposedly intended to benefit.

The legacy of control of development decisions by such elites in the absence of any input from the poor majority has been detrimental to adequate development. Rachman, a Bengali economist discusses the material and psychological victimization of the masses this way:

"In large parts of the third world, the lack of participation by the rural poor in development reflects the domination of rural society and its development effect by certain privileged society groups or classes on whom the rural poor are critically dependent for their material subsistence. This material dependence inhibits them from taking independent initiatives of their own to improve their lives and status in society, and produces in them an attitude of mental dependence on the dominant social groups. Together, such material and mental dependence enables the dominance/dependence relation to perpetuate". Rahman, 1981 p.3-4.

This traditional approach has not only been evident in water supply and sanitation projects only but also in other aspects of develop -ment. Large scale water schemes with an emphasis on urban piped water supplies and other expensive schemes made both urban and rural communities dependent on the providing agency (Government or NGO).

The modern trend in development planning has taken a different approach of community involvement and participation. The development model which is seemingly becoming universally accepted includes the need for the increased participation of those under developed rural communities for whose benefit such efforts are undertaken. The call for such participation is consistent with Nyerere's insistance that 'People cannot be developed, they can only develop themselves'. (Nyerere 1973 p.60). With this emerging development paradigm, it is advocated that not only must communities have more input into the kinds of programmes which will affect their lives, but that they must have the opportunity to actively participate in the process of development from beginning to end. This paper's content is drawn from experiences of three water and sanitation projects. Busia in W. Kenya, Kibwezi in Eastern and Kwale in Coastal Kenya.

The new approach implies significant change not only in the content of development activities but radical change in the process through which such activities are realised. This shift in the empowerment of communities to influence their own destinies implies a break in the dependency on beauracratic elites, an increase in community self-reliance through their concrete experiences in the process of defining and resolving certain problems. Hall, an author especially concerned with community participation in the process of development writes:

"Development is more and more seen as an awakening process, a process of tapping the creative forces of a much larger proportion of society, a liberating of more persons' efforts instead of a 'problem' to be solved by the planners and academicians from afar". (Hall, 1979 p.1).

With the advent of the proclamation by the United Nations of the years 1981-1990 as the International Water Supply and Sanitation Decade, community participation has been seen as an important aspect to achieve the decade objectives. During this decade, governments and development agencies would develop water supply and sanitation projects that are responsive to the needs of low-income urban fringe and rural areas, affordable by the beneficiaries, and which could be realised and widely implemented within institutional, financial and socio-cultural constraints (WHO:1981). Adequate water supply and sanitation through community participation have been given special emphasis because this will improve community quality of life, facilitate other development activities and reduce the time and distance to the water source, etc. 'Focus on the drinker not the well' brings home the point that the success of water supply systems does not rest solely on drills, pipes and installations, nor on technicians and engineers. Any system whether based on sophisticated imported pumps or simple bamboo pipes - can only be effective if accepted and supported by the people who use it.

The greatest assurance of this comes when:

- Users participate in planning and choosing the location of wells, pipes, taps or latrines.
- local labour and skills are mobilised for construction.
- community residents are trained to maintain the completed system in good order.
- the relationship between clean water and sanitation, and between them and better health and productivity are understood and visibly proven by community members themselves.

The analysis of water supply systems in Kenya for example, falls into four categories according to whether initiation, ownership, management and operation is by the community or by a government agency or NGO. The categories are - (Oendo, 1983):

a) projects that are initiated, managed and operated by agencies e.g. large scale urban pump systems or Ministry of Water systems where people either have individual connections and/or collect water at a fee.

b) projects initiated and managed by the communities e.g. usually self-help small scale water wells with or without hand pumps and sometimes in rich communities, diesel pumps. These projects are self supported by the communities within a limited area.

c) projects initiated, managed and operated by the community but with substantial inputs from external agencies. Normally these projects are pump systems donated to communities by developmental agencies with some operational funds.

d) projects initiated by external agencies but managed and run by communities.

Assessing the feasibility of participation helps determine whether project objectives requiring community decision-making or cooperation are achievable and helps identify appropriate ways to facilitate participation. This assessment should be done during the earliest design stages, before a project's purpose and strategy are finalised. Many community participation advoates agree that participation is possible if:

a) Communities have had previous experience in water supply activities or organising and managing resources. This greatly facilitates participation in any new project. Existence of such grouos, as women's groups, self-help groups is evidence of a communities organisation around an issue or need and can provide a point of entry for the community organizer. In Kibwezi Division of Machakos District of Eastern Kenya, there existed self-help groups, women's groups and organised indigenous village development committees. The activities of these community groups included digging of water wells, access roads, construction of primary schools, etc. These groups and their activities provided a good entry point for the Community Based Health Care Programme that was introduced by the African Medical and Research Foundation in 1980. Small-scale water activities have been organised in the Kibwezi villages without any participation problem because, besides the organised water committees, water was a felt need. (Omambia, D.O. 1980).

By contrast, in 1975, in a cholera control programme in Busia District of Western Kenya, many wells were dug and fitted with hand pumps. Labour and all materials were paid for by the Ministry of Health. During this control process the Community Health Committees were formed by the control team with a hope that they could maintain the safe water points that had been provided. It was only after a few months, after the control team had left that the pumps broke down and people returned to their traditional water sources and/or using buckets to get water from the wells. This contaminated the well water and cholera continued to recur as before. Not enough feasibility research work was done on community participation that would have ensured continuity after the control team left. (Omambia, 1984).

Secondly, water was not a problem since during the rains, there was stagnant water and two permanent rivers. What was lacking was an awareness concerning the transmission of cholera through unsanitary health behaviour and the use of contaminated water.

b) Attitudes of civil servants, a funding agency or an implementing agency are not paternalist. They may refuse to share authority with those who are less educated, less well placed socially and less technically qualified. The attitude leads officials to underestimate local capabilities and leads rural people to resent officials, refuse co-operation and sometimes actively oppose official projects. A survey conducted in Kwale District of Kenya showed that in 1964 and 1978 respectively two development agencies covered some traditional wells and fixed hand-pumps without consulting communities. (Oendo, 1983). These hand-pumps broke down and since there was no manhole left to get water the wells were abandonded much to the disappointment of the villagers. The introduction of a hand-pump testing project in the same area of Kwale has seen very little cooperation and active participation from communities because of the frustration they had had previously.

c) Political, organisational, socio-cultural, economic and physical characteristics of the specific communities within a project area are examined. Communities are rarely homogenous entities, and planners should examine the community's internal structure, degree of stratification and decision-making processes. Preference for certain water sources or a supply system may be more common in one cultural community than in others.

d) Some degree of flexibility is built into a water supply and sanitation project's design. This has important remifications for community participation. If projects follow a 'blue print' or detailed plan they are less likely to succeed than those that pursue a 'learning' approach to planning.

Although the extent of community participation in development-orientated projects is an essential determining factor in the success of the decade approach, few projects systematically monitor or evaluate community participation. References in evaluation documents have little emphasis on the factors that influence participation. The implicit purpose of many evaluations is to secure continued funding for current and future projects with results only being shared by funding agencies and government officials. The emphasis should change to continuous monitoring and evaluation and also involving community in the on-going evaluation.

CONCLUSION

The benefits of the community participation approach can neither be over-emphasised in water supply and sanitation activities nor can the importance of agencies be under estimated. Community participation is designed to lessen dependence on outside agencies and increasing community self-sufficiency. But we should realise that self-sufficiency cannot be and is not absolute but the point is rather to find the optimum point to which self-sufficiency can be carried for each community and in respect of its needs. It cannot ve expected that once a community has embarked on an autonomous path of development, external input will be disregarded.

From the analysis of the activities in these three projects we find that the use of indigenous resources needed for relatively self-sufficient development requires the stimulation and encouragement by government or other agencies which hold and emphasise such ideas of self-reliance.

There is normally, even inevitably, some form of dependence on either the government or other agencies. It is unrealistic to call for an ideal form of community participation which would be at the same time endogenous (self-generating) fully community controlled (self-determinant) and maximising the self-sufficient use of local resources. A more realistic policy recognises the reality that the relationship between an agency pursuing a development project in a community, and that community, is one of negotiated collaboration. When this is recognised it is possible to plan an approach which provides for an appropriate level and type of community participation and contribution from an external agency: By 'appropriate' is meant one which is technically feasible and which takes into account the interests and needs of the local communities and does not disregard the national socio-economic structures and apirations. I will conclude by quoting Nyerere - a leading proponent of the participatory approach in development.

He says:
"....people cannot be developed; they can only develop themselves. For while it is possible for an outsider to build a man's house, an outsider cannot give the man pride and self-confidence in himself as a human being. Those things a man can create in himself by his own actions. He develops himself by what he does; by making his own decisions, and by his own full participation - as an equal - in the life of the community'. Nyerere, 1973.

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SESSION C

CHAIRMAN:- Professor W.L. Kilama
National Institute of Medical Research
Dar es Salaam Tanzania

Discussion

1. Mr TAWAH stated that, in Tanzania, the Government's introduction of a development levy, payable by all able-bodied adults, discouraged some people from volunterring to keep the environment clean as they considered it the responsibility of local authorities receiving the levy. In light of this experience, he questioned the functioning of community participation in rural water supply schemes.

2. Professor MUKWAHUZI replied that in urban areas some people may not feel ready to do community work, arguing that the levy should take care of this. However, a survey conducted in some villages after the introduction of the levy suggested that this may not be the case in rural areas, especially for water supply schemes. In these areas people are anxious to contribute to the maintenance fund, albeit contributions are delayed by the lack of a fund for them to be sent to. He expressed the opinion that the levy would not affect people's enthusiasm for community work, at least in rural areas, provided the community feels that the project/scheme is their property.

3. Mr ISHENGOMA stated that people from roadside villages earned their living by selling goods and, hence, were unwilling to attend to non-profit making activities such as community participation. In addition he opined that there is a lack of control over quality and progress of works carried out under such schemes, resulting in overspending of funds allocated to them.

4. In reply, Professor MUJWAHUZI said that due to the village government structure and spirit of community responsibility, the few reluctant participators felt compelled, either by law or by society, to cooperate. With regard to water schemes, the quality control is carried out by site engineers, foremen and social economists who are always at the work site instructing the community. In rural areas, people are shown how to do the jobs before actually doing the work themselves.

5. Mr MBWETTE wished to know the best solution with regard to businessmen who are able to pay fines and are still not ready to participate physically in work later (as proposed in paper C2).

6. The author replied that so far there had not been such a case. An habitual absentee faces increased fines, also the village government would devise other control measures which would educate absentees as to the importance of their participation in communal work. An example of control would be the removal of a businessman trading licence.

7. Miss OMBAI suggested that when talking of community participation people should have the whole community in mind. She expressed the opinion that stress should be on the acceptors, promoters, users and beneficiaries of the new water and sanitation technologies; these are usually women. They should be involved in the planning, designing, implementation and the operation and maintenance stages. In this way the decade goal of 'Water and Health for all' could be achieved.

8. Mr LINDEIJER supported these suggestions, saying that the roles of women were absent from the papers presented and the discussions. He also suggested that rural water supply and sanitation were essentially a women's issue. He wished to know what had been done, so far, in Africa above the involvement of women in rural projects. He requested specific references to the female beneficiaries of rural water supply and sanitation schemes and to the incentives offered to them.

9. Mr HORSFIELD commented that in the Senegal village water supply project (F3) the study team was composed of four men (engineers) and two women (a social anthropologist and an economist). During question and answer sessions organised in each village, the women were accepted readily by both sexes, whereas the men were really only able to talk to the males of the village. In addition the women obtained better responses to their questions than did the men.

10. There followed several contributions from other delgates and authors.

11. Dr EVANS stated that community participation should involve not only technical issues but also the encouragement of the

behavioural adjustments necessary to obtain benefit from the improved technologies. Women have a key role to play as educators, helping to establish lifelong patterns of behaviour. This role should be built on and may, ultimately, be the key to the success of decade activities.

12. Mr MOSESE explained that, in the Rural Sanitation Project in Lesotho, women had been shy in their delivery of 'hardware' but had been more interested in 'software' delivery. E.g. out of approximately 2000 village health workers 80% were women, whereas only 20% of water minders or local latrine builders were women.

13. Mr SODERLUND replied that in the Kenyan Rural Water Supply Development Project women played a central role, and were involved from the beginning. The project recommended that at least 50% of members of well committees should be women. In addition these women were preferred as pump attnedants and were trained in their own environment to be self-reliant concerning their particular point source. The topics taught included water, health, sanitation, behaviour at the well and fund collection.

14. Mr RADHAKRISHNAN said that in his 12 years experience working as a Regional Water Engineer in Tanzania had shown that the community could be involved in village meetings, taking a population census, locating existing dug wells, determining the quality of water, clearing the jungle for hydrogeology, hydrology and topography surveys and water purification and pump maintenance. In fact with a little incentive the local community could be involved with the whole implementation.

15. Mr KABBA requested information on which strategies of promoting self-help in community participation were most appropriate in rural water supply. In addition he asked for delegates' opinions on the effects of health education prior to the construction of improved water and sanitation facilities on the level of community participation by women.

16. Professor MUJWAHUZI expressed the opinion that strategies used in Danida-supported projects in Tanzania were adequate; i.e. education of beneficiaries (prior to implementation) on the benefits to be obtained and the responsibilities/conditions associated with them. He thought that health education would not stimulate enthusiasm for participation by women but that the reduction in the work load associated with carrying water long distances would. Improved water quality is secondary to distance travelled and the quantity of water obtained: it does not mean that water quality is not valued.

17. Mr ELLIS quizzed Mr STUTTERHEIM on the rapid sand filters installed at Ambohitrolomahitsy village, Madagascar. He wished to know why rapid sand filtration was chosen instead of slow-sand filtration, where the sand was obtained and whether disinfection was implemented in the final stage.

18. In reply Mt STUTTERHEIM explained that rapid sand filtration was chosen to facilitate maintenance problems experienced during periods of high turbidity due to heavy rains. The filters are cleaned by successive backwashes operated by a simple valving system by village workers in charge of maintenance. Sand was obtained locally.

Chemicals for pre treatment prior to sedimentation are not readily available in Madagascar but the particle path length of 5 metres as well as the precipitates in the contact zone assist sedimentation.

With regard to disinfection, several processes were being considered but, to avoid the use of expensive chemicals, slow-sand filtration as a final stage was a possible intermediate solution.

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Kari Homanen and Kyber

Finnida activities concerning handpump applications in rural water supplies

FINNIDA ACTIVITIES CONCERNING HANDPUMP APPLICATIONS IN RURAL WATER SUPPLIES

General

The Government of Finland has assisted three countries in the development of their rural water sector. The oldest project is in the Mtwara and Lindi Regions in Tanzania, it started in 1972 and it is called the Mtwara-Lindi Rural Water Supply Project.

Projects of a similar type were started in Sri Lanka 1980 and in Kenya 1981.

Since the projects in Sri Lanka and Kenya are still in their early stages the following presentation concentrates on describing experiences gathered from Tanzania.

The total cost of Project implementation from 1978 to the end of 1984 was about 13 million US$. Of this about 42% has been spent on the construction of handpump wells.

Handpump Wells

The production of handpump wells has been about 250-300 wells/year totalling about 1780 wells and serving about 400,000 people.

Wells are either dug wells (dia 1.0 m) or tube wells (dia 6" or 8"). Dug wells are dug by tractor excavator or by hand. The water level is normally less than 4 metres.

Tube wells are drilled by the hand auger method. Water level is normally less than 8 m.

All wells are equipped with the Finnish made NIRA pumps.

The villagers are participating in the construction of hand pump wells as follows: the information on possible well sites is collected by interviewing the villagers during the survey. The villagers are informed about the well construction in village meetings. In machine dug and auger well production the villagers provide assisting labour.

Since July 1983 no payments have been made to the village for providing the labour. Earlier villagers were paid 500.- Tshs per well after completion. The change has caused some problems especially near those villages which have received payment before. Hand dug ring wells are constructed independently by villagers and the project provides only supervision (one foreman) and materials. After the construction has been completed, the whole responsibility for hand pump maintenance is gradually handed over to the village.

Operation and maintenance of handpump wells

The maintenance of handpump wells has been carried out from the beginning of the project until recently by mobile maintenance units. Every well has been visited on average three times a year. With this degree of maintenance 85-90% of the handpumps are always in a working order. The maintenance costs (Project overheads excluded) /well are about 45 US$ a year, of which about 20 US$ is used for spare parts.

The Project started in June 1983 to create a new village level maintenance system for the operation and maintenance of handpump wells. It consists of three levels:

- 1st level (the most important one) village well caretaker
- 2nd level district maintenance centre
- 3rd level regional maintenance centre

The village well caretaker is trained by the Project either in a one-week training camp (villages with existing wells) or together with construction and pump installation groups during construction of new wells. He or she is responsible for daily maintenance of the handpump, cleaning of surroundings of the well, repair of the handpump and collection of spare parts from the district maintenance centre. The district maintenance centre also gives technical assistance to the well caretaker, if needed. The regional maintenance centre acts as a coordinator and and distributes spare parts to district maintenance centres.

Villages have to buy the tool kit needed for the maintenance of the handpump, but spare parts are still provided free of charge by the Project.

The well caretaker is responsible to the village government when district and regional maintenance centres are within the Maji (Ministry of Water and Energy) organization.

The Project has already handed over the maintenance of the handpump wells in 70 villages, 4 district maintenance centres are functioning but the Project still acts as regional maintenance centre.

Judging from follow-up records, the village level maintenance system is functioning well. The number of broken handpumps has been only slightly higher than with the centralized system of maintenance.

There are still problems to be solved. The main problem has been inability or reluctance of the village governments to pay compensation to the well caretaker. However, we have a strong belief that the village level maintenance system will be the cheapest and also the most effective maintenance system for handpump wells, at least in our Project regions. Of course, a smooth system cannot be created in one or two years, the system will need careful follow-up, readiness for changes and strong support from both the Project and from the Government of Tanzania.

Development of handpump technology

The Project first became involved with the World Bank handpump test programme in March 1983. Since then there has been continuous discussion between the World Bank experts and the Project as well as within the Project staff concerning handpump technology.

As a result the Project started experimental work with a direct action handpump late in 1983. The aim was to develop a pump to be as simple as possible, to use as many local skills and materials as possible and that the maintenance can be done using as few tools as possible.

The actual dismantling work can be done solely by removing bolts from flange and cap. The cap can be opened, the inner pipe with wooden bushes can be taken away and the piston rod can be lifted up along with the piston.

The pumps have been made by skilled local workers using mainly imported materials and for the cylinder we have used the cylinder of the normal NIRA pump.

Six months of field testing have shown so far that the wearing of wooden bushes is fairly fast during the first weeks but after creating considerable clearance the rate of wearing is much slower. Villagers have agreed that the pump is heavy to use but has a good yield and so most users are satisfied.

The manufacturer of the NIRA pump has also developed a direct action pump, called NIRA AF-85. The stand pipe is made of mild steel, the hand and upper part of the pump rod of stainless steel and the rest of different kinds of plastic materials. The drop pipe and sealed pump rod are of high-density polyethene pipe and piston, foot valve, etc. are of polymer plastic. The pump is designed so that 70% of the work needed is used during the down stroke and 30% during the up stroke, and so pumping is quite easy down to 10 metres.

Health education and sanitation

The Project has prepared, in co-operation with local health authorities, a poster series and a booklet about water and health. Final decisions on how to continue have not yet been made but most obviously local organizations will take the leading role and the Project will provide only materials and general assistance.

Sanitation aspects had not been originally included in the Project. Last year at the request of FINNIDA a proposal was prepared by prof. Albert Wright for a sanitation programme. Final decisions have not yet been made, but it is likely that a pilot scale sanitation programme will be implemented in 1985 consisting of testing suitable latrine designs, testing construction methods, evaluating construction materials and the construction of demonstration latrines in some selected villages.

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Lister R E Kongola

Boreholes as a solution to water problems in Central Tanzania

ABSTRACT
This paper first establishes the potential for groundwater in Central Tanzania based on climate and geology. It then identifies the water problems in these areas. A mention is made of other possible solutions to water problems mainly dams and shallow wells. These being unsuccessful, an emphasis is placed on boreholes as the only viable and logical solution to water problems in Central Tanzania.

INTRODUCTION

Central Tanzania which covers Dodoma, Singida and parts of Tabora and Shinyanga regions is prone to water problems mainly due to low rainfall. The low runoff produces sandy ephemeral streams. The geology is made up mainly of syn-orogenic and migmatitic granites. The weathered and fractured zones of these rocks are potential for groundwater.

Water problems are well known and different solutions namely dams and shallow wells have been tried. These have not been successful. With growing population, emphasis on irrigation and industrial expansion, the demand for water keeps on increasing. The viable and logical solution to water problems in Central Tanzania is boreholes.

The initial costs which include drilling and submersible pump installation are very high. However, the maintenance costs especially where the energy source is cheap are low compared to other means. Looking at the experience and success of China where boreholes are a common site in rural areas, Central Tanzania can be made very productive if boreholes are given the emphasis and importance that they deserve.

GENERAL

Location

Central Tanzania is located between latitudes 4°S and 7°S and longitudes 32°E and 36°E (Fig. 1). It is an old plateau standing at an elevation varying between 2000 and 4000 ft above mean sea level (1).

Population

Central Tanzania has a total population of 5 m.people (2). Together with Mwanza region, this area has the highest concentration of livestock in the country; approximately 10 million. Most of the area can be transformed into very productive land if water for irrigation is made available and about 40 m. acres can be developed. With no policy on land, water and vegetation conservation coupled with the explosive population growth, Central Tanzania is slowly becoming wasteland.

Climate

Central Tanzania is semi-arid. The average annual rainfall is about 30 in. ranging between 20 and 40 in. (2). Within this range, the rainfall is very variable. The average temperature is over 70°F giving a potential evapotranspiration value of about 59 in. per year for Dodoma region (3).

Geology

Central Tanzania is part of the African shield made up of some of the oldest basement rocks which are up to 2.7 billion years (4). The Dodoman system found in the area is made up of schists, gneisses, quartzites, amphibolite and hornblende gneisses, acid gneisses and migmatites (Fig. 1).

Igneous rocks occupying most of the area are synorogenic granites of varying compositions and ages but mainly Archaean. Intrusive rocks are dolerite and pegmatite dikes and quartz veins.

Due to the semi-arid nature of the area, extremes of temperature, exceeding 30°F daily, produce a mechanism by which the granites undergo a very characteristic kind of weathering through jointing (1). This kind of weathering is partly responsible for the groundwater potential in the area.

Potential for Groundwater

Many boreholes have been drilled in Tanzania and the total figure is about 3700 boreholes. About half this number, 46% was drilled in the semi-arid areas alone (Table 1). This is because of the absence of permanent rivers as a result of little rainfall producing very low runoff; less than 10% of the rainfall for Dodoma (3). Most of Central Tanzania is covered with sandy soils whose infiltration capacities are high. This and the fact that most of the streams have beds of coarse sand, recharge to the groundwater reservoir is quite substantial. For Dodoma region, recharge occurs whenever the annual rainfall exceeds 16 inches (3).

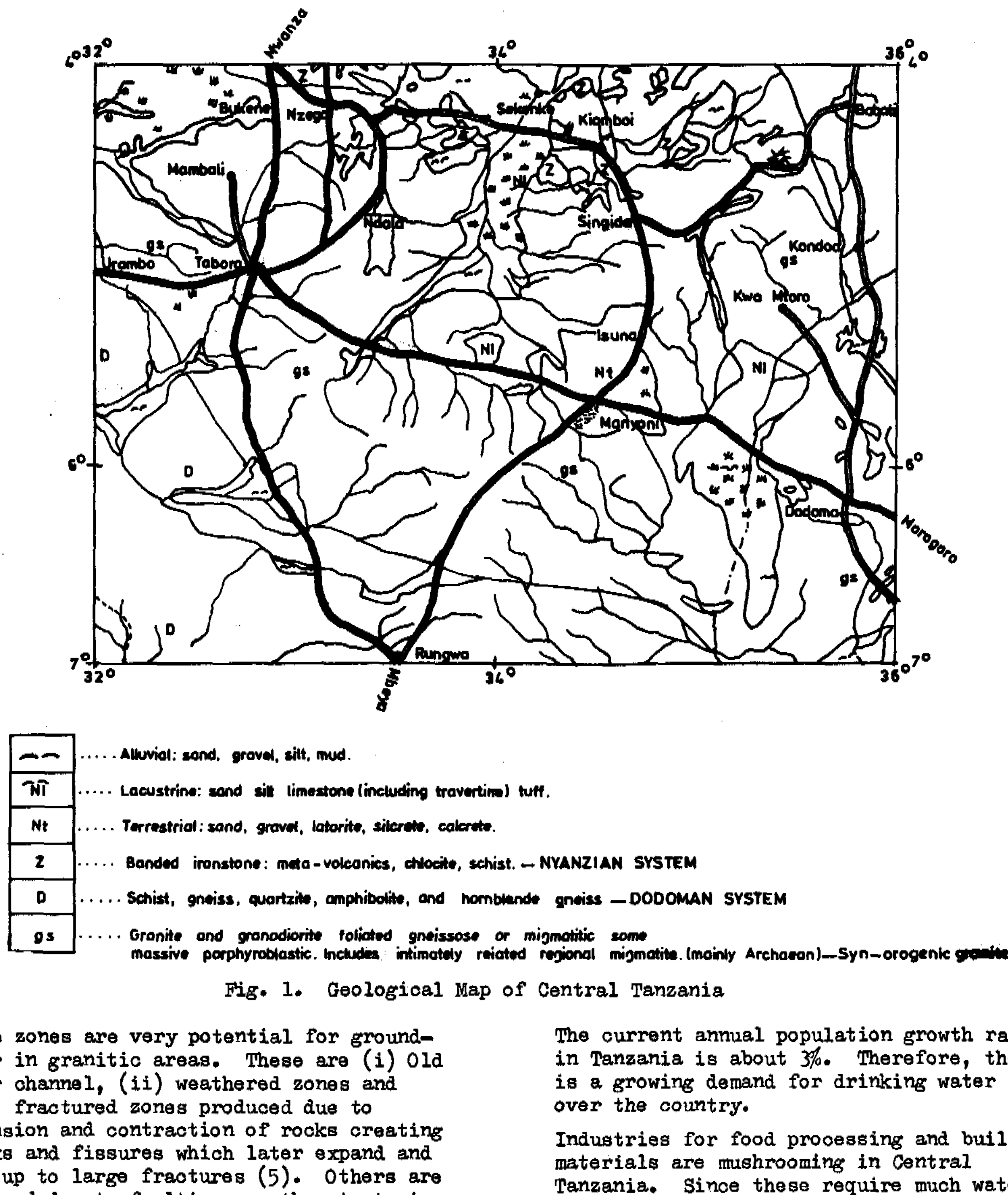

Fig. 1. Geological Map of Central Tanzania

Three zones are very potential for ground-water in granitic areas. These are (i) Old river channel, (ii) weathered zones and (iii) fractured zones produced due to expansion and contraction of rocks creating cracks and fissures which later expand and open up to large fractures (5). Others are produced due to faulting or other tectonic movements. Most boreholes yield their water from fractures as observed on borehole 119/75 in Dodoma (Table 1). Water derived from fractures is of very good quality.

The contacts between dolerite and pegmatite dikes and quartz veins with the country rock are other areas potential for groundwater.

WATER PROBLEMS

The problems to water are related to its use. Problems due to domestic use stem from the increasing human and livestock population.

The current annual population growth rate in Tanzania is about 3%. Therefore, there is a growing demand for drinking water all over the country.

Industries for food processing and building materials are mushrooming in Central Tanzania. Since these require much water, they put an extra stress on an already overstrained supply system.

The demand for water for irrigation purposes is to increase as a result of the new impetus now being placed on growing food crops. The drought that has adversely affected the production of food in these areas, has prompted new ways and means of agriculture to be sought.

REGION	ROCK TYPE Total No. of Bhs.	GRANITES Ave. Yield x 1000 gph	GRANITES Ave. Quality TDS, ppm	GNEISSES Ave. Yield x 1000 gph	GNEISSES Ave. Quality TDS, ppm	SCHISTS & PHYLLITES Ave. Yield x 1000 gph	SCHISTS & PHYLLITES Ave. Quality TDS, ppm	QUARTZITES Ave. Yield x 1000 gph	QUARTZITES Ave. Quality TDS, ppm	DOLERITE DIKES Ave. Yield x 1000 gph	DOLERITE DIKES Ave. Quality TDS, ppm
Arusha	191	4.3	-	1.4	1637	-	-	-	-	-	-
Coast	173	-	-	-	-	-	-	-	-	-	-
Dsm	90	-	-	-	-	-	-	-	-	-	-
Dodoma	742	3.3	978	2.5	648.8	-	-	1.8	916	1.2	850.9
Iringa	84	2.0	ND	ND	ND	-	-	-	-	-	-
Kagera	125	1.0	585	-	-	1.2	204.75	1.5	202	-	-
Kigoma	67	3.7	165	0.1	ND	-	-	0.5	ND	-	-
K'njaro	129	2.9	ND	1.5	769	-	-	-	-	-	-
Lindi	166	1.5	ND	1.0	ND	-	-	-	-	-	-
Mara	121	1.0	552.5	-	-	-	-	3.4	288.35	1.7	807.5
Morogoro	160	0.9	ND	1.1	1365	-	-	-	-	-	-
Mtwara	149	1.0	-	1.0	ND	-	-	-	-	-	-
Mwanza	179	1.3	490.9	-	-	-	-	-	-	1.4	ND
Rukwa	102	0.8	ND	0.7	ND	-	-	-	-	-	-
Ruvuma	27	-	-	0.9	518.3	-	-	-	-	-	-
Shinyanga	110	0.8	804	-	-	-	-	0.2	-	-	-
Singida	480	1.5	727	-	-	1.1	920	-	734	-	561
Mbeya	89	1.5	ND	0.6	ND	0.6	220	-	-	-	-
Tabora	192	0.9	898.52	-	-	0.5	618	1.5	655	-	-
Tanga	271	1.0	355.2	2.3	1831	-	-	-	-	-	-

ND = No Data   TDS = Total dissolved solids   ppm = Parts per million

Data on Bh 119/75 - Dodoma

Depth (ft)	SWL (ft)	Water strike (ft)	Yield (gph)	Drawdown (ft)	Aquifer	Quality TDS (ppm)
398.7	94	125	80,000	13	Weathered and fractured granite	1015

SOLUTION

The problems of water in Central Tanzania have been known for a long time and different solutions tried. Many dams have been built in the area to store water during the rainy season to be used during the dry season. Dams have not been very successful because of problems of siltation, low runoff resulting in empty or partially filled structures, high evaporation losses, and leakages due to loose foundations. Surface water requires complex treatment procedures before the water can be used for drinking.

Another very recent solution has been shallow wells. These have been tried in Shinyanga region with little success and there are ongoing extensive programmes in Mwanza, Morogoro, Mtwara and Lindi regions. Shallow wells are unsuitable in arid areas because of the great depths to the water table except in a few river alluvials where the depth might be shallow. Even then, the supply is unreliable, scanty and very localized. Shallow wells cannot serve large populations or irrigate large areas.

The only viable and logical solution therefore is boreholes. As mentioned above, Central Tanzania has potential for groundwater and already there exists an extensive network of boreholes from which a hydrogeological map can be prepared. This, together with other methods currently in use, can be used to locate other potential sites suitable for borehole drilling.

The best way to utilize the boreholes is by use of electric motor submersible pumps especially if cheap electricity is available. The Tanzania Electric Supply Company (TANESCO) can solve the energy problem by providing hydroelectric power through their expanding grid. Besides the TANESCO grid, small scale hydroelectric power stations could be set up on dams built across some of the rivers like the Bubu in Dodoma region to cater for small communities or small to medium scale farms. The Chinese have been very successful in this. The resilience of the submersible pumps far surpasses that of diesel, wind or solar pumps. Submersible pumps do not need regular maintenance like the other pumps. Although they cost more T Shs.150,000 (£7143 at T Shs. 21 to £1), after installation they are almost maintenance free.

Borehole water if not saline is usually of very good quality requiring no treatment at all. Aquifers being extensive formations assure a reliable, safe and sustained water supply for a long time unlike surface water which is adversely affected by drought and surface pollution.

CONCLUSION

Three things have to be done before the borehole solution can show any positive results in Central Tanzania. First, water has to be accorded highest priority in National Planning. Adequate funds have to be made available for the high surveys and drilling costs.

Second, a campaign has to be launched to educate the people on the value and importance of the expensive service being extended to them by the Government. Bylaws where necessary should be instituted to discourage vandalism and other kinds of irresponsibilities.

The third which goes with the second is the setting up of a National Policy on water, land and vegetation conservation. Once established, people have to be made to understand its objectives and a monitoring system worked out.

Once such a basis has been established, there is no reason why the borehole solution should not work in Central Tanzania or any other similar place.

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Sam Owusu

Operation and maintenance of rural handpump water supply systems in Ghana, West Africa

ABSTRACT

A brief outline is given of major rural handpump water supply projects undertaken in Ghana until year 1984. The present status of the operation and maintenance of the resulting water supply systems is given. Activities to be carried out to improve the maintenance set-ups in future, including plans to involve the well users in their operation and maintenance, are also discussed.

INTRODUCTION

In Ghana the provision of potable water for domestic purposes is the responsibility of the Ghana Water and Sewerage Corporation (GWSC). By policy water supply to rural communities (ie. those with population under 2000) is by means of boreholes fitted with handpumps at an approximate ration of 400 persons to one borehole.

For some 35 years now GWSC through its Drilling Unit has completed about 1000 wells and fitted them with handpumps across the country. In addition, various donor countries and agencies have sponsored a number of large-scale drilling programmes for some of the rural areas in Ghana during the last 15 years. Most significant of these have been the Upper Region Water Supply Project (URWSP) sponsored by the Canadian Government through CIDA (1974-81) and the 3000 Well Drilling Programme in Southern and Central Ghana funded by the Government of the Federal Republic of Germany (1978-84). The two projects resulted in the completion of 2300 and 3000 handpump wells respectively in seven administrative Regions of the country (see fig. 1).

MAINTENANCE PRACTICE OF GWSC

Maintenance services, like other aspects of GWSC's operations, have been traditionally administered by autonomous Regional Headquarters. Repairs of machinery and vehicles in the Regions are undertaken at workshops located at the Regional capitals.

Early in the 1970's the formation of District offices with workshops and stores attached was initiated in the Regions, to improve the maintenance facilities for the water supply of the rural areas. But the workshops and maintenance crews at the Districts have almost always been engaged in the maintenance and repair of pipe-borne water supply systems. The handpump systems completed by the Drilling Unit are therefore not maintained fully. As a result the handpumps are left unrepaired and the villagers go back to their old sources of water supply. The net result is that most of the GWSC handpump systems have fallen into disuse.

NEW MAINTENANCE SET-UPS

a. General

To forestall the non-maintenance of their systems, both the URWSP and 3000 Well Project introduced the setting up of well maintenance programmes as a major aspect of the Projects. The strategy involved the re-organisation and strengthening of existing GWSC facilities in the Regions to meet the increased maintenance needs related to the project's installations.

The basic concept of the maintenance programme for each project is for regular inspection and preventive maintenance of each pump with major repair or replacement on an as-required basis. Regular inspection was introduced to overcome communication and transport problems villagers face in reporting broken pumps.

For inspection and preventive maintenance, Inspectors riding motorcycles regularly visit each pump to ensure it is operating, liaise with villagers on site and pump maintenance and make necessary above-

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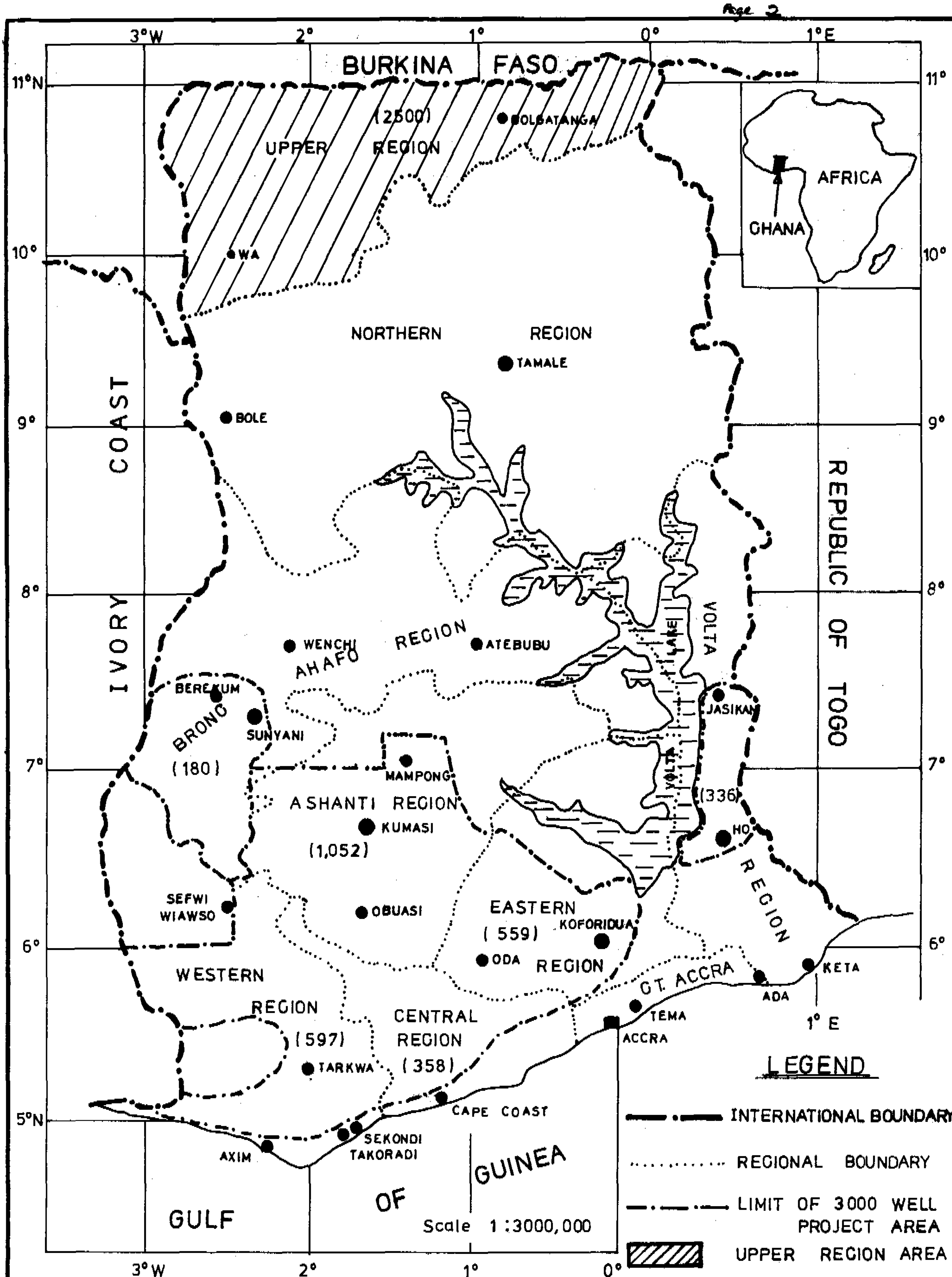

FIG:1 MAP OF GHANA SHOWING DISTRIBUTION OF EXISTING BOREHOLES BY REGIONS ground repairs. Service crews in trucks capable of complete field servicing of the pumps, fix pump the Inspector was unable to repair, either because he did not have the correct part with him or because the pump unit required removal from the well. The two separate functions by the pump Inspectors and the service crews are coordinated and operated as one.

b. URWSP

The URWSP maintenance organisation comprises of a Regional Workshop at Bolgatanga and District Workshops at five District Centres at Bawku, Bolga, Tumu, Laura and Wa. Each District Workshop has a supply of parts to support field operations. It also makes minor vehicle and pump repairs, welding, and metal fabrication. Major repairs from the District Workshops are referred to the Regional Workshop, which makes minor and major repairs on all equipment, pumps and vehicles in the Region.

A maintenance District Centre is headed by a District Engineer, Manager or Officer-In-Charge who is charged with the day-to-day responsibility of the Centre. The District Head reports to the Regional Manager of GWSC.

c. 3000 Well Drilling Programme

The organisation here comprises of 16 District Maintenance Centres equitably distributed throughout the project area (see fig. 1). There is a main Workshop at Kumasi, three medium-sized workshops at Ho, Nsawam and Takoradi, and smaller workshops at the remaining 12 District Centres. Each of the 12 smaller maintenance workshops has a supply of spare parts for pumps, and also repairs minor pump breakdown. Major pump repairs and repairs on vehicles are carried out at any of the three medium-sized workshops or at the Main Workshop in Kumasi. These four workshops are well stocked with tools and spares.

The 16 maintenance centres have been grouped into five and each group is headed for the time being by (an Expatriate) Consultant Supervisor. Each Supervisor is responsible for the running of the Centres in his Districts. Each centre has a crew comprising of a motorcycle Inspector and service crew personnel equipped with a cross-country vehicle.

d. Training of staff

Both maintenance organisations had the common aim of performing practical servicing and repairs of the handpumps, wells, and service vehicles, and training of Ghanaian personnel to undertake the maintenance on their own in future. The services of expatriate Consultants were used to achieve this aim. The Canadian Consultant's involvement on URWSP ended in 1981 and Ghanaian personnel have fully taken over the Unit's operations. The services of the Consultant on the 3000 Well Maintenance Unit will continue until the end of 1985.

The training of the local staff has been mainly through on-the-job sessions supplemented by short formalised classroom courses. The sessions are directed towards three groups: Regional/District Supervisory staff, field staff, and workshop staff. Topics taught include: preventive maintenance and repair procedures for handpumps, service trucks and motorcycles; management and supervision; mapreading; reporting; record keeping; safe working procedures and first aid.

e. Performance of maintenance set-ups

On the average 80% of all pumps have been operating at any given time on URWSP since 1976, with monthly performance typically ranging from 70 to 90%. On the 3000 Well Programme the respective figures are 85% and 75%-95% since January 1984.

COMMUNITY PARTICIPATION IN RURAL WATER SUPPLY MAINTENANCE

a. General

As part of the implementation of the handpump well systems on the two projects, it was proposed to involve the village well users in their maintenance. In the course of drilling of boreholes and installation of pumps therefore, village chiefs and village development committees were briefed on the work whenever possible. In some cases the villagers were involved in certain operations - for example with the back-filling of well-pads in the Upper Region. The villagers were also encouraged to select a "pumpman" or caretaker for each village, to be responsible for proper functioning of all handpumps in the village.

b. Training and role of "pumpman"/ caretaker

The use of village pumpman/caretaker is well under way in some Maintenance Districts. Following instructions of GWSC pump Maintenance Inspectors, the caretaker starts with minor jobs like lubricating and tightening of bolts and nuts on handpumps at his village. Later, a group of them is invited to the District Maintenance Centre for further training. Fields covered during the training include: sanitary aspects - cleaning of well pads and surroundings, provision of drainage for spilled water from pump and rain water; provision of watering troughs for animals; operating principle of pump installed in village; minor preventive maintenance procedures; reporting on major pump faults at the maintenance centre; eventual taking over of full preventive maintenance of pumps at a village.

Pump caretakers who have been trained as above are gradually taking full responsibility of preventive maintenance from the GWSC pump Inspectors, and will take over fully when they gain confidence in the task. This will not only save costs of running such systems, but will establish self-sufficiency and initiate a certain degree of independence of the villages.

c. Recommendations for Improvement

A serious omission that came to light on the two foreign-sponsored projects has been the lack of a proper"Responsibility and Educational Campaign" to involve the well users in the implementation of the programmes. Both projects planned to use other agencies - the Ministries of Health and Rural Development, Department of Community Development, and the Radio - to educate the people on the aims and objectives of the Programmes. For a number of reasons, however, educational programmes planned by these organisations were never implemented fully.

It may be safer to include such a campaign for future drilling programmes as part of the overall programme, to effectively involve the benefiting communities in the rural water supply implementation from the on-set, in such aspects as:-

- deciding on the location of boreholes in the community,
- some aspects of the construction phase, for example in site access clearance and borehole site clearance, well-pad construction, and back-filling around well pads,
- techniques of pump installation,
- a more significant role in the maintenance of the water supply systems,
- modalities for charging water rates for rural systems to pay for the emoluments of maintenance service personnel and the supply of spare parts for handpumps and service vehicles.

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

D F Williams

Community well digging in Zimbabwe

INTRODUCTION

Deep well digging has been practised in Zimbabwe for many years and many dug wells constructed in the early 1900s are still functioning. The last major government well digging programme occurred in the 1950s in Matabeleland South after which borehole drilling, using mainly cable tool rigs, was the usual method of exploiting ground water.

After independence in 1980, the Lutheran World Federation (LWF) started a well digging project in Matabeleland South (Ref. 1) initially employing some old workers who had gained experience during the Government Programme in the 1950s.

In 1982 UNICEF assisted the Government of Zimbabwe to establish a well digging programme in ten districts in Matabeleland adopting methods developed by LWF. This paper describes the programme.

INSTITUTIONAL ARRANGEMENTS

The Ministry with which UNICEF cooperates is the Ministry of Water Resources and Development (MWRD) now combined with the Ministry of Energy. This is mainly a technical Ministry without district level representation and whilst it carries out borehole drilling and previously well digging in the rural areas, this is usually on behalf of the District Development Fund (DDF) of the Ministry of Local Government and Town Planning (MLGTP). DDF has a workshop in each district and field officers responsible for maintenance of roads and water supplies for people and livestock. Water supplies to Government Institutions are the responsibility of MWRD. DDF is therefore responsible for hand-pump maintenance, but does not employ community workers and in the past communities were very often forced to engage in projects at the whim of the district commissioners.

The Ministry of Health does have a cadre of community workers, health assistants and now, in addition, village health workers. This Ministry has for many years been supporting community well protection but this has not involved blasting or very deep digging.

A pilot scheme was formulated by UNICEF which rather ambitiously involved the digging of four wells in each of ten districts in Matabeleland. Supervision at district level was to be the responsibility of the DDF field officers with community motivation carried out by district councillors and health assistants. Apart from the normal difficulty in trying to start a new programme or rather restart an old one, the DDF field officers had a great many other calls on their time and were unable or disinclined to spend much time on well digging. Boreholes, because of their higher technology, were also felt to be progressive and modern. It was also difficult for the two Ministries to work together at district level; each tended to concentrate on its own projects. In the event, only a few wells were completed during 1983.

However, further funds were made available by MWRD and in January 1984 a well sinking supervisor and foreman were employed through DDF in each district. The supervisors were given a one week training course in Bulawayo and then returned to their districts.

DISTRICT ORGANISATION

Zimbabwe is a country with a great deal of mining activity, so in most districts it was possible to find one or two unemployed ex-miners with blasting licences and sometimes well diggers whose licences had expired. One of these was recruited in each district as a foreman well sinker. Well sinkers were sometimes sent to other districts to learn from more experienced workers. Both the foreman and supervisor are paid monthly. The job of the supervisor is to generally supervise well digging in the district under the DDF field officer. In particular the job includes:

1. selecting priority areas in the districts in conjunction with the district councillors and community workers;
2. arranging for a well sinker to sign a contract form for each well site after checking if the site appears feasible;
3. measuring the work done by the well sinkers on a monthly basis and calculating the amount due on the well measurement forms;
4. keeping records of well sinking in the districts;

5. ensuring that well sinkers are kept supplied with equipment, explosives and cement, etc. and ordering equipment from Bulawayo;

6. ensuring that safety regulations are adhered to;

7. selecting trainee well sinkers and arranging with the Mining Inspector in Bulawayo for them to be tested for a restricted blasting licence.

The job of the foreman is to generally assist the supervisor but with special responsibility for training blasters and blasting wells where qualified well sinkers are not available. At the start of the programme sufficient licensed well sinkers were not available and one well sinker often contracted for several wells at a time. This often caused problems as the well sinkers were then not inclined to do much physical work except setting the explosives. As more licensed sinkers became available, this practice has decreased and, in general, one licensed sinker works on one well at a time.

Licences are also required for purchase, transport and storage of explosives and the Government regulations have to be adhered to.

No special transport was provided for the project. The existing DDF transport fleet is used and refunded through a MWRD vote at a standard rate per kilometer.

COMMUNITY PARTICIPATION

The community are invited to participate in the programme in the following ways:

1. form a small committee, which should consist of four people at least two of whom should be women, at each place a well is required;

2. select a site for the well;

3. start digging the well, after the site has been approved, to a depth of four metres or until rock is reached whichever comes first;

4. provide food and accommodation for the sinker and his team;

5. provide clean broken stone and sand for the concrete lining, cattle trough, etc., if available locally;

6. witness the removal of water to check that 100 kibbles are removed on each of two successive days;

7. provide a layer of stones around the well to protect against erosion;

8. construct a fence around the well;

9. look after the well, handpump and surround and ensure that the handpump is properly used;

10. transport the windlass and other well sinking equipment to the next site;

Community motivation and participation has varied greatly from district to district and has depended largely on the enthusiasm of the district councillors for the programme.

WELL SITING

Over about 80% of Zimbabwe, the water table is within 15 m of the surface. Much of the country is composed of igneous rock, granites, greenstone, and basalt and water is contained in fractures and in the decomposed layers.

Selection of the well sites is left entirely to the community. In theory, the supervisors have the power to veto unsuitable sites but as their period of training was so short in practice they often had little more idea of a good site than the rural people.

Site selection however has not been a problem. In only one district has the failure rate exceeded 10% and, as the year progressed, it was evident that better sites were being selected. People are learning by experience. In any case, the cost of a geophysical survey is comparable with the labour cost of digging a well. The yield sought is also relatively low.

As a guide wells were not to be sited closer than 2 km to another protected source but this has not always been observed.

WELL DESIGN

In non-collapsing formations, wells are dug unsupported. Very often the soil cover is only a metre or so. The well is dug with a diameter of 1.5 m reducing to 1.2 m in hard formations. The upper portion is lined with in situ unreinforced concrete with an internal diameter of 1.3 m to 0.5 m above ground level. Wells are covered with a split reinforced concrete cover slab 80 or 100 mm thick.

In collapsing formations plain ended precast concrete rings are used 1.2 m external diameter by 1 m high by 0.075 m thick and reinforced with chicken wire.

The average depth is about 15 m but wells over 35 m have been dug. 30 m is the advised maximum and windlasses are normally supplied with 30 m of 10 mm wire rope.

As dewatering is done manually, dug wells cannot yield much more than 5 cubic meters per day, unless they are quite shallow.

This is sufficient for about 100 people or ten kraals.

WELL DIGGING AND CONSTRUCTION TECHNIQUES

A well digging team usually consists of a well sinker and three labourers. The team is presently paid Z$20 (Z$1 = £0.58 16/2/85) per metre for digging in any material and Z$38 per metre for blasting. The first four metres are dug voluntarily by the community. The rates are increased by 50% when the well is producing more than 1¼ cubic metres of water per day. Water is removed using a 50 litre kibble and a simple steel windlass, also used during digging. A well is considered to be adequate when it is producing more than 5 cubic metres or 100 kibbles per day. For each kibble of water removed the well sinker places a stone to one side for subsequent checking by the supervisor. Removing 5 cubic metres of water from a deep well can take 5 or 6 hours of hard work.

Holes for blasting are drilled by hand, normally using tungsten carbide tipped solid hexagonal drill steels with 27 mm tip and 22 mm shank and 4 lb hammers. Sometimes untipped drill steels are used which can be sharpened by village blacksmiths. Well sinkers, however, prefer the tipped steels the top end of which wears down before the carbide tip becomes blunt. Short steels are used for starting the holes which should be at least 650 mm deep. Ammon gelignite 60% in 25 x 200 mm sticks is generally used for blasting. It has good water resistance, good blasting strength, and is very safe to handle. Factory made connector capped fuses with No. 6 strength detonators are used. These tend to be more reliable and waterproof than on site fuse-detonator connections. Slow burning igniter cord connects the fuses together and is either lit down the well or at the surface. The latter is recommended but many well sinkers prefer the former method. Good well sinkers can achieve 0.5 metres per blast. Some well sinkers use ammon nitrate/diesel mixture as an explosive. This is considerably cheaper but needs a stronger detonator and is not water resistant.

Trainee well sinkers have to work for at least three months under a licensed sinker before they are able to take the blasting test. If they pass, they are issued with a restricted blasting licence by the Mining Inspector of the Ministry of Mines. Knowledge of the safety regulations and how to deal with misfires are important aspects of the test. For each successful test, the well sinker who was responsible for the training receives a bonus. To date 57 licensed well sinkers are working on the programme.

The well sinking team also receives payment of Z$12 per metre for lining the well with concrete. Steel shutters 1 m high by 1.3m external diameter are used for this together with a wooden or steel platform suspended by ropes from the legs of the windlass. Occasionally the well sinkers make the cover slabs but it has been found preferable, from a quality control point of view, to have these made centrally at the DDF yards.

HANDPUMPS

Two types of handpumps are used on the wells. For deeper wells, a modified version of a handpump developed in Zimbabwe in the 1930s by Mergatroyd is used. The main features of the pump are a large wooden bearing block and generally simple but sturdy construction. The pump stand is concreted in beside the well. Conventional down hole components are used consisting of 50 mm brass foot valve, 75 mm brass cylinder, 12 mm galvanised pump rods and 40 mm galvanised steel pipe all locally produced. The present cost of the pump for a depth of 30 m is about Z$ 540.

For shallow wells, down to 12 m, a direct action pump called the Nsimbi is used. This was developed by Jellema of LWF in Bulawayo based on work he did in Malawi. Above ground components are painted steel with PVC used below ground. The pump rod is 32 mm Class 16 PVC pipe and the riser pipe 50 mm PVC pipe either Class 10 or Class 16. The 50 mm Class 16 PVC cylinder is fitted with a brass foot valve and the piston is a standard rubber piston used in hydraulic machinery and has to be imported. The piston is drilled and fitted with a rubber valve. The pump is not yet available commercially but at present costs Z$146 for a depth of 12 m compared with about Z$ 360 for the deep well pump. The Nsimbi pump is much simpler to install and repair and has proved to be reliable.

For both pumps, most problems have been caused by incorrect installation. Installation and repair is carried out by DDF workers who have received little or no training. This aspect is now receiving attention.

PROGRESS

Progress from January to December 1984 is as follows:

Wells completed and fitted with handpumps:	132
Wells completed but awaiting handpumps:	82
Wells in progress under contract:	201
Abandoned wells: (48 in one district which at present has no blasting capability)	60

Completed wells are costing on average about Z$1,500 each including handpumps.

One of the major constraints has been due to the fact that whilst DDF is the main operating agency for the project UNICEF is officially co-operating with MWRD. Consequently DDF has not yet fully adopted the programme and it tends to be sacrificed, for instance when there is a conflict over transport. In addition, because well digging is not part of MWRD's normal activities, supporting staff has not been readily available.

Lack of very effective community motivation has also been a problem. This has largely been due to the shortage of health assistants soon to be rectified and has sometimes resulted in DDF undertaking tasks which should be done by the community.

Progress has also been hampered by the security situation which has very often made it necessary for Government vehicles to carry armed military escorts.

CONCLUSIONS

It is estimated in Zimbabwe that from purely hydrogeological consideration well digging would be more effective than borehole drilling in about 40% of cases. In these sites the depth of decomposed rock is insufficient to provide adequate inflow to a borehole whereas the larger diameter of a dug well provides storage and therefore allows inflow to occur over a longer period.

In addition it is considered that a well digging programme has the following advantages:

1. no high technology equipment requiring imported spares or expertise is required;
2. considerably lower cost; in Zimbabwe a dug well costs about one-quarter the cost of a borehole;
3. well digging is labour intensive and thereby provides a positive transfer of resources to the rural areas;
4. by providing jobs and skills training in the rural areas, rural self sufficiency is enhanced and the drift to the urban areas in a small way reduced;
5. more scope for community participation;
6. as the skill remains in the community, dug wells can be deepened and cleaned if necessary without resorting to complicated machinery;
7. by training people in well digging, private well digging is encouraged;
8. water can still be obtained from a well using a bucket even if the handpump is broken;
9. well digging, being community based and with no tempting machinery, provides less target for dissident activity.

Paying well diggers on a piece work basis, although contrary to Government practice, has proved to be effective. Well digging is hard and unpleasant work and little progress can be expected if workers are paid monthly. By paying the well diggers for work done, supervision, notoriously difficult in remote rural areas, becomes easier. If the well diggers are not working, they are not being paid. Conversely, if the supervisor is not doing his job, the well diggers are soon out for his blood.

In general, the programme has been well accepted by the people and government workers at district level where the advantages are self evident. The LWF programme, on which this Government programme is based, executed with freedom of action of an NGO, continues to make very good progress.

No explosive related accident has been reported in the Government programme and only one accident of any kind. All workers are supplied with locally made safety helmets.

The programme does depend on a well organised Ministry of Mines and availability of explosives. It is perhaps curious that a simple technology such as deep well digging may be more appropriate in a country with a relatively well developed infrastructure than in less well organised countries.

In conclusion, it is suggested that, whilst this type of programme may not be replicable in every country in Africa, it does have a major role to play in achieving the goals of the IDWSSD in Zimbabwe.

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11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

C. Ruxton and L K Biwott

Rural water supply development and handpump use in Kwale District, Kenya

The Government of Kenya has made considerable development of water resources with the aim of improving the living conditions of its urban and rural populations. In the late '70s, it was noted that simple technologies, and in particular, the handpump offer advantages in the development of relatively shallow groundwater for rural populations due to its low capital investment and running costs. The development of groundwater using simple methods is widespread in Kenya and is being implemented by the Government, non governmental organisations, donors and other institutions. All these activities depend on community participation to a large extent. Kenya is well known for her traditional community "Harambee" efforts in all spheres of development.

This paper gives details of a handpump project on the coast of Kenya, which aims by its approach to provide a water supply that is maintainable in the long term. Basic features of the project are community ownership of pumps and hence community responsibility for maintenance, and the development of a locally manufactured pump that can be maintained at village level.

The South Coast Handpumps Project in Kwale

In 1981, preparation of this project was initiated as part of the Government participation in the 'International Drinking Water Supply and Sanitation Decade'. On initiating this project, the main objective was a simple yet dependable water supply system incorporating the support and involvement of the community to be served in its execution. The other objective was to field-test about eight types of handpumps and identify those that are suitable as shown by the users; and as a follow-up, to establish local manufacture with designs incorporating the community ideas.

The South Coast area of Kwale was chosen because it has a shallow water table, usually less than 50 m, and due to the need arising out of widespread health problems related to waterborne diseases notably bilharzia, cholera and typhoid. Walking distances of one to two kilometres are commonly found in the area.

Actual drilling operations began in earnest in September 1983. With its two small, cable-tool rigs, the project has constructed sixty boreholes fitted with handpumps. In addition, ten open well have been protected and fitted with handpumps. All these are distributed in an area of 300 km^2 with a population of about 50,000.

This project is implemented by the Ministry of Water Development which also meets about 35% of its cost. The Swedish International Development Authority provide the other finances, channelled through UNDP. The UNDP/World Bank Rural Water Supply Handpumps Project provides management support while a local NGO (Kenya Water for Health Organisation) undertakes community liaison and training.

The direct cost for one water point (borehole) calculates slightly above US $1,000. Other indirect costs such as operation and maintenance, staff costs and community contribution in labour and materials are about twice as much. Each water point serves on average about 200 people.

Project Approach and Activities

Before actual work began, a water resource survey was carried out to collect and analyse relevant hydrological, hydrogeological, population and population distribution data. Existing water sources were identified, including about 100 open wells. The water table was found to be generally less than 30m. below ground level in the project area. Water samples were collected for both bacteriological and chemical tests. The results showed water of generally favourable mineral constituents although often contaminated. The need for protection was therefore real. New sites for borehole drilling were identified with sufficient care being given to water conservation measures and coiding chemically unacceptable or possible polluted sources. In most cases the sites were such that the villagers had easy access to the water source.

Community Involvement

Initially there was understandable reluctance from the community as some believed (some few still do) that the end result would be failure as was the case with similar handpump projects in the past. A socio-cultural study was initialted when this was realised. The study involved:

a) Present status of water supply and sanitation in the area.

b) Community organisation and participation in self-help programmes with special emphasis on self-help groups.

As the project progressed, the community became the centre of nearly all activities. In this way, major obstacles were overcome, including issues such as land ownership, community institutions for managing the waterpoint, handpump ownership and responsibility for pump maintenance. The activities which secure the water point may be summarised thus:

a) An extension worker who is constantly in touch with the local community receuves and forwards their request.

b) The liaison officer together with the siting geologist then approach the community which may be an existing organised grouo or one with no definite organisational structure. In the latter case, a committee is formed.

c) The villagers (committee) are requested to identify the site with the hydrogeologist assisting.

 site on public utility land - OK
 site on private land - the community decides.

Once decided by the community with the consent of the landowner, the project takes up the issue with relevant authorities to see that such an agreement is embodies in the landowner title deed. This arrangement is seen to be the most practical and satisfying to the community and landowner because, by a community decision, the community gains right of access to the well and the landowner gains a nearby water source.

Construction Stage

Once the site has been agreed upon, the drilling which is done by a specialised crew commences. The drilling which is carried out through sands, coral limestone and sandstones with clays is done carefully, formation samples being collected and its characteristics recorded. Once the required depth is reached (normally between 30 and 50 m), completion casing is set in place and then well graded sand of the required quality is inserted. When this is done properly, the borehole is certainly sand free ensuring the well's long life and prolonged pump life. The well is then developed as necessary and tested for its productivity. At the end of the test, water samples are collected for chemical and bacteriological analyses. All these activities take about two weeks.

During this period, the community may have done some or all of the following:

a) Clearing access to the well location.

b) Providing water for drilling.

c) Collecting construction materials e.g. sand, stones, etc.

When acceptable results of the water analyses have been obtained, the pump pedestal, washing basins and drainage system are constructed and the handpump installed.

Other Community Activities

During this time, other government community workers, e.g. Public Health Technicians, Community Development Assistants together with Project extension workers are organising communities to:

a) Be aware of the benefits of clean water to health, hygiene and general well-bing (as a metter of fact, some villages have reported improved health among their children since they got the water point).

b) Prepare small vegetable gardens which will use the waste water.

c) Prepare and organise themselves to keep the pump surrounding clean and remove stagnant water pools.

d) Raise a modest financial contribution (normally contributed on a weekly or monthly basis at about US $0.25 per month per family). Contribution among twenty villages begun in Spetember last year amounted to more than US $400 (see below) by end of February 1985.

Planning for Maintenance

As mentioned earlier, operation and maintenance require substantial inputs and the success of rural water supplies will depend largely on how well this is prioritised. The project has taken the following steps:

(i) Every water committee is being encouraged to collect funds on a regular basis so that the funds will be abailable for hire of artisans and purchase of spare parts in case of pump failure. The response has been fair, about 50-60% of the eleigible contributors actually contribute without any external duress.

(ii) The project at its start employed local people to install handpumps and carry out above ground construction. This team has developed complete skills in handpump installation, removal, repair and maintenance. The project intends to provide these men with repair tools and pump manuals so that the local community can hire them when the project team has left.

(iii) Several local companies are now manufacturing pumps and pump components. Some of these are institutions aided by Government to spur industrialisation, for example Kenya Industrial Estates and some regional Institutes of Technology. Large scale production and a proper distribution network have not yet been established and this certainly is a major challenge for this year.

(iv) The project is formulating an effective training programme. It has not yet been possible to introduce some of its aspects due to the diverse nature of pumps and the handpump testing programme; nevertheless training of trainers who will then carry out training at the village level is now under way. Also villagers have generally been called upon to observe and sometimes participate during pump installation and removal for repairs.

(v) All the different types of handpumps installed are routinely monitored by the UNV (UNDP/World Bank) handpumps engineer for their performance, durability and acceptability by the target users. Data is being compiled on repairs carried out on each type of handpump, the frequency of fialure and which part actually failed. Our results show that out of twenty five (25) pumps installed a year or so ago, seven have not had any breakdown, while a maximum of three repairs were carried out on the others. This monitoring, together with developments in local pump manufacture, should allow selection of the most suitable pump and standardisation to one type of handpump in the near future.

It is necessary to emphasize that the problems of operation and maintenance may not be overcome easily. The ideal handpump may probably never materialise because of the conflicting requirements - a cheap sturdy long-lasting easily-maintained piece of equipment! The deciding factors may be:

a) Acceptability by the users and easy maintenance.

b) Local manufacture.

c) Constant source of spare parts and an effective distribution network.

d) Sufficient training and motivation of maintenance crew at the village level.

The above aspects require action in a vigorous manner if the handpump is to succeed.

Future Plans

Though the present project had a lot of flaws in its initial approach and some still exist, a reasonable acceptance by the target community has been generated. Its success and the degree of community participation have opened up chances of its extension to other areas of Kwale District where need for water is greater. A programme is now planned which will be district based, in line with recent Government policy of delegating more authority to the districts for rural development. The districts have been strengthened with the necessary manpower and facilities to cope with these enlarged activities. The District Focus for Rural Development policy rightly sees long term rural development success depending on the participation of local populations and concentrates on the fact that there is a high degree of cooperation among and between all people involved in development in any one particular district. The strategy is based on the principle of complementary relationship between ministries with their sector approach towards development and the district with its integrated approach to addressing local needs.

The proposed Kwale District Community Water Supply and Sanitation Programme will centre around community based participation and will involve target communities that have expressed desire and shown commitment to participate in the programme's activities. It is proposed that this commitment will be formalised in terms of Community 'Water and Health Groups', registered with Government, which will be responsible for the water points and sanitation facilities installed under the Programme. It is felt that this approach will increase the chances of achieving one of the basic aims of all water supply and sanitation projects: long term and sustainability.

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SESSION D **CHAIRMAN:-** **Mr. Len Hutton**
WEDC Centre
Loughborough University of Technology U.K.

Discussion

1. Mr LINDEYER stated that for the successful development of VLOM-procedures it is imperative that a competitive market is developed for spare parts. He wished to know if a similar experience had occurred in Africa and, if yes, how this was achieved or, if no, what were the reasons.

2. Mr GREY responded saying that, as far as he was aware, there was no large scale experience in Africa of a competitive spare parts market for hand pumps as unlike in Asia, hand pump manufacture was on a relatively small scale. However there were clear benefits from getting the handpump into the market place so that individuals and communities could buy and sell pumps and spares.

3. Dr NYUMBU requested comments on experiences or problems of collecting rates levied for meeting the cost of operating and maintaining village water supply systems.

4. Mr GREY replied that for community-organised rather than utility-run water supplies there is much discussion on the benefits of cash collection for operation and maintenance of community water points, but that there is only limited experience. However in some projects, in Kenya and Sudan, he was aware of most successful efforts by water committees to collect such money on a regular basis.

5. Ms KYBER said that in the Mtwara-Lindi Water Supply Project collection of rates from individuals was not recommended as a general development tax was already collected to provide communal services. Consequently operation and maintenance costs have to be estimated on a yearly basis and budgeted for by district councils.

6. Mr VUORI added that in the Development Project in Kenya revenue recovery had been good. In the past year 75% of the total repair costs had been paid by the well committees, who had lists of recommended prices provided by the project. All of the 450 wells completed over an 18 month period had well committees.

7. Mr MAMBALI asked that, as operation and maintenance has proved to be the cause for failure of many existing water projects, and as continuity of operation of installed hand pumps requires replacement of parts or even whole pumps, were there plans to assist the developing countries to manufacture the pumps locally. He applauded highly the comment by the World Bank Representative (Mr GREY) that pumps should be made locally.

8. Mr GREY replied that, whilst it is probable that hand pump programmes will only succeed in the long term if hand pumps are made locally (to ensure spare part availability), in many countries the shortage of raw materials and possibly poor quality control may jeopardise the sustainability of such programmes.

9. Dr MATONDO observed that in the slides Zimbabwean wells appeared to be open, he wished to know if they were polluted during the rainy seasons or if any pretreatment was used.

10. Mr WILLIAMS replied that all dug wells are fitted with cover slabs and either a deep well or a shallow well pump. A 3 metre long discharge pipe takes water from the well head.

11. Mr BROWN asked for opinions, in light of experiences with problems of salinity and wells drying up in the dry season, on the option of combining well programmes with improved rainwater harvesting at the community level. He recommended integration of sanitation programmes into well water projects right from the start.

12. Ms KYBER informed delegates that in the Mtwara-Lindi region certain areas had traditions in rainwater collection which were encouraged by the provision of tank-building materials to institutions such as schools and hospitals. In this region, the sanitation component had been started but, unfortunately, late in the scheme.

13. Dr. MUGONDO referring to a slide showing a hand pump in use in the immediate vicinity of a put latrine, a potential source of pollutants, wished to know if failure to resite the latrine was the result of unwillingness by the owner or community.

14. In answering Ms KYBER explained that the choice of well site was a compromise of

the community's choice and the survey team's findings. She agreed that, ideally, latrines should not be sited nearer than 100 metres from the well, a rule explained when wells were constructed.

15. At the end of the session Mr MUGA suggested that there should be a joint committee for international bodies and the Tanzanian Government to establish a special design of handpump to serve in all parts of the country. This would eliminate problems of differences in spare parts and avoid marketability of different types of hand pumps. There would be the possibility of opening a factory in the country to manufacture the hand pumps.

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Ingvar and Carolyn Hannan-Andersson

An alternative approach - small-scale improvements to existing sources

1. RURAL WATER SUPPLIES IN TANZANIA

1.1. The target

In 1971 a 20 year programme for the rural water supply sector was prepared, with the target to supply adequate water (piped supplies) to all Tanzanians by 1991. However following the villagisation programme in the early 70s, the government was compelled to accelerate the improved water supply programme. Thus a second objective was formulated in 1975 as the provision of each village with at least one adequate source of water by 1981.

1.2. The progress

Given the magnitude of the task and the limited resources available, it is not surprising that the 1981 objective has not been attained, and that achievement of the 1991 goal does not seem probable. It is very difficult to assess just what has been achieved in the rural water supply sector in Tanzania to date. Government figures (1983) state that 39% of the rural population have access to safe water.[1.] However there are all indications that this figure is far too high, as it is necessary to distinguish between potential capacity of the schemes constructed and the actual service provided. Many schemes constructed are not functioning to capacity or not at all. In addition, even when schemes are functioning the intended consumers may not utilize them. The aspect of utilization is crucial as the non-utilization of operational schemes lowers the percent of population actually benefiting from improved supplies even further. There has been no reliable assessment of the actual impact of the improvements to date. However it is believed to be slight since the percent of the population actually benefiting from improved water supply may be as low as 5% in many regions, which ironically is the same figure given for early post-independence.

1.3. The problems and proposed solutions

The poor performance in the rural water supply sector can be attributed to

a) inappropriate technology choice
b) neglect of operation/maintenance and rehabilitation aspects
c) lack of community participation

The failures in these areas have been recognized by government and outside donors and some steps have been taken to rectify the problems. Thus the ILO study (1982) [2.] commends *"recent Governmental changes in orientation"* which were a growing enphasis on rehabilitation and operation/maintenance, and a move towards a simpler technology.

The technology type which has been emphasised in Tanzania in recent years is shallow wells with hand or foot pumps. The move towards this technology type is usually motivated by the financial gains, i.e. that the per capita development cost is 80 Tanzanian shillings as opposed to 250 for diesel powered surface supplies. [3.] In addition there is an increasing belief that, theoretically at least, the simpler the technology the greater the potential for community involvement and the less complicated the operation/maintenance infrastructure required.

The shallow wells with handpumps technology has been implemented on a relatively wide scale in Tanzania. However it would appear that the actual impact of this strategy has been very slight. The most appropriate level of technology has not been reached- i.e. a level which will allow for maximum attainment of impact.

2. LIMITATIONS OF THE SHALLOW WELLS WITH HANDPUMPS STRATEGY

2.1. Inadequate density of supply points

If any benefits are to be attained from a shallow wells with handpumps programme, there must be a sufficient number of supply points in each village. The normal criteria for Tanzania is to estimate one well for 250 people. However the political and economic realities influence the actual performance in implementation. A serious constraint can be identified in the goal to reach all villages with at least some form of improved supply. The scarce financial resources must, for political reasons, be equally divided between districts, wards and villages. As a result there is usually a very low density of supply points in individual villages. Very few villages, if any, receive adequate coverage and the impact can thus often be said to be non-existent. [4.] It is simply not economically feasible to envisage constructing the number of wells which would be necessary in each village to give the density essential for any real impact.

2.2. Inadequate accessibility

Far too often the shallow wells with hand pumps which are installed in the villages cannot compete with the traditional sources with regard to accessibility. This obviously has implications for the actual utilization of the wells, which is in turn related to the level of impact. Good accessibility is a crucial factor for both increased convenience and the attainment of health benefits. There is increasing evidence that the most important criteria for the women water-carriers is, for very practical reasons, improved accessibility. Unless an improved supply is definitely closer than all other alternative sources in all seasons, experience from Shinyanga region shows that the households will continue to use the traditional sources, at least in the rainy season. [5.] Similarly it was revealed in Singida region that households using the improved supplies did not always completely abandon the traditional sources. [6.] Obviously the non-abandonment of unimproved, polluted sources negates the health benefits of the improved supplies.

2.3. Problems of reliability

With regard to reliability, handpumps are certainly better than pumped supplies which rely on supplies of diesel. However break-downs of handpumps are common, and mainten-ance is far from adequate, If hundreds of hand pumps are dispersed over a whole region, the problems of maintenance become enormous for a central organization. To date the maintenance infrastructure has proven inadequate, as evidenced by the long delays experienced in Shinyanga and Singida regions to get handpumps repaired. [7.] The solution often proposed - to hand over responsibility for maintenance to the village - is not in itself a simple solution. Even given adequate training inputs, the problems of spare parts for so many wells is daunting.

2.4. What conclusions can be drawn?

The results of surveys in Shinyanga and Singida regions showed the impact of the shallow wells with handpumps programme to be negligable. [8.] Those actually using the improved sources were only a small percentage of the total population, since so few improved supplies had been constructed. In addition, the problems of breakdowns negated the benefits to these few households. The limited impact must be related to the problems of reliability and accessibility (i.e. density and location of supply points) In order to achieve the expected benefits of improved health and increased convenience, the improved supplies must be able to compete with the traditional sources in terms of both these factors. Nowhere have these conditions been met and it seems unlikely that there can be any improvement in the immediate future, given the constraints operating at present, in particular the economic realities. What is needed is an alternative strategy which can guarantee accessibility and reliability, optimum operation and utilization, and optimum impact.

3. AN ALTERNATIVE PROPOSED: IMPROVEMENT OF TRADITIONAL SOURCES

Given the economic situation and political goals on one hand, and the necessity to improve the water supplies for all members of the community on the other, it would appear that a more appropriate strategy would be the improvement of existing traditional sources. The starting point for such improvements would be an inventory of traditional sources already in use. Implementation would be concerned with establishing how many of these can be improved to give water supplies of better quality, quantity and reliability.Improve-ments could be of many different types - deepening and lining wells, installing aprons, and where absolutely necessary installing hand or foot pumps.

Each community has developed a traditional user-choice system which is adapted to the physical, social and economic context in which is exists. Any improvement of water supplies should therefore begin with an investigation of the system already funct-ioning. An improved system should be based on an understanding of water-use, water organization and water values and thus an understanding of the environment, its uses and the users'perceptions is an essential starting point.

3.1. Motivation for such a strategy

Experiences in Singida region on the accept-ance of change in rural communities seemed to indicate certain essential criteria for the diffusion of innovations: [9.]

- the innovation should not upset the exist-ing traditional structures too much
- it must involve advantages for the communities (as understood by themselves)
- it should not involve too many costs in terms of money, time or energy
- it should be comprehensible to the community
- efforts should be directed in particular to the homestead/household level

The strategy of improving traditional sources would appear to be in keeping with these criteria. Other reasons which indicate it would be a realistic and appropriate strategy are discussed below.

a) Only way to achieve impact
The improvement of traditional sources guarantees that accessibility will not be worsened, while quality, quantity and reliability can be improved by varying degrees. There is a greater chance that the improvements will be accepted and that benefits will be achieved.

b) In keeping with traditional practices
By building on something already existing, and making small, comprehensible changes, there is more likelihood of the acceptance of the improvement and its success. Many traditional water-use systems are multi-source, in response to no single source being adequate to all needs. It would therefore appear advantageous to consider improving the water supply from all sources rather than planning to construct one completely new supply.

c) A least-cost technology
This strategy is in keeping with the economic realities since the economic requirements are relatively modest. Sources can be improved by quite simple means and local materials and know-how utilized to a greater extent than at present. A complicated and expensive maintenance infrastructure would not be necessary and the present problems of spare parts could be lessened.

d) Facilitates community involvement - especially of women
Such a strategy involving a minimum of resources and limited input from outside lends itself to community participation and the "user-choice" approach. The problems of trying to make the women accept and identify with the improved supplies are not relevent since their links with the sources are already well established. Thus their participation in planning, implementation, operation/maintenance and evaluation can be facilitated. In this respect the reduced capacity for high-level technology may prove positive for women in terms of increasing their involvement in community affairs. [10].

e) Possibility to improve sources for non-domestic uses
An advantage, likely to be appreciated by many rural communities, is the possibility to improve those sources which are rejected for domestic use, for non-domestic purposes such as watering livestock or irrigating small vegetable gardens.

f) Facilitates diffusion to other communities
The chances of meeting felt needs and achieving benefits are enhanced. Impact could be achieved at a faster rate since delays in implementation could be shortened. Success in one village could encourage other villages to seek assistance- the elusive "felt need" . Diffusion would be facilitated if women are actively involved.

3.2. How realistic a proposal?

Such a strategy would doubtless meet with much hesitancy and opposition initially - from both planners/administrators and the consumers. There has already been a lowering of expectations from piped supplies to wells with handpumps, and now it is suggested that there should be a further lowering of technical standards to improvements to traditional sources.It requires a basic change in attitudes at all levels. It is nevertheless considered the only feasible strategy for Tanzania at this point in time- the only way a reasonable level of service can be provided and maintained. However, before it can succeed a lot of attention has to be given to aspects of practical implementation.

3.3. Practical implementation of the strategy

The starting point should be to assess the suitability of the source from the point of view of accessibility for domestic uses. If ease of access is acceptable, the next consideration is chemical standards of water quality. If the water quality is chemically suitable the reliability of the source is investigated. Given adequate yield the bacteriological standards are assessed. If the source meets all these criteria it can be considered for water for domestic uses.

If the source fails to meet the conditions for acceptable accessibility or chemical standards and is thus ruled out for domestic purposes , it can be considered for non-domestic uses, such as watering livestock. Where reliability is a problem it may be possible to improve it for domestic use, using a variety of measures. Or it may be accepted as a seasonal source of drinking water. Where bacteriological standards are not met it is necessary to determine the cause of the pollution and the possibilities for eliminating it. If no protection can be assured the source can be considered for purposes other than drinking and cooking, eg for washing clothes or bathing. In some cases the sources may have to be rejected for all uses.

3.4. Some areas for further investigation

a) Need for adequate planning
Even though the methods of improving the supplies are often simple, the whole operation must be well planned to avoid as many difficulties as possible. Costs must be worked out beforehand - financial as well as labour and material contributions - so that the communities are well informed and well prepared for what is expected of them right from the start. Aspects which must be thoroughly investigated are procedures for community participation, priority, felt-needs and ownership.

b) Flexible organizational set-up
The organizational set-up and management system proposed must be flexible enough to take into account the varying conditions in the communities. Especially in terms of procedures for community participation there must be emphasis on flexibility and experimentation.

c) Management and maintenance aspects
It is easy to presume that since the improvements to traditional sources are relatively simple and do not require great numbers of staff, expensive equipment, complicated maintenance infra-structure, etc, that the improved sources will function without problems. On the contrary there are bound to be problems, and some inputs may be required resulting in cost and effort on the part of the communities. There must be a well-thought-out proposal for regular inspections, reporting of problems, cleaning operations, etc. More complicated maintenance systems will have to be established if hand pumps have been installed.

d) Integration with health education/ sanitation inputs
These aspects will require much thought and effort. Since the water quality can only be improved to a limited extent - through measures such as spring protection, lining of wells, construction of barriers for animals, etc - there is a greater need to ensure adequate health education. An integral part of any programme to improve traditional sources must be a health education/sanitation component, and this must be based on a very sound understanding of local customs and beliefs relating to health/hygiene/sanitation. It can be argued that inputs in these areas would have a very good chance of succeeding if the level of participation anticipated can be achieved. It is, however, a big challenge to work out an adequate programme, given the "deafness" which has developed among the consumers to the usual advice and regulations regarding hygiene, handling of drinking water and sanitation. [11].

e) Need for an adequate knowledge base on local conditions
Much of the failure of improvements to water supplies can be attributed to a lack of knowledge of the details of everyday life in rural societies, knowledge which should be the starting point for planning improvements to living standards. An adequate knowledge base on such areas as traditional beliefs and practices regarding health, hygiene, nutrition, child-rearing, etc is absolutely essential if meaningful inputs are to be made in rural societies, and if there is any chance of these inputs being accepted and assimilated. A strategy for improving traditional sources will not succeed unless based on a sound knowledge of how rural people, especially women, actually live- their activities, beliefs, attitudes/values and expectations.

4. CONCLUSIONS

The seriousness of the situation within the rural water supply sector calls for an alternative approach. Improvement of traditional sources would appear to be the only feasible solution at this point in time, given the economic constraints. In spite of the inevitable initial negative response to such a strategy, it is anticipated that the consumers could come to accept it as the only way possible to obtain a reasonable level of reliable improvement to the water supply situation. The implications for community involvement and responsibility, especially of women, and for health education and sanitation inputs are positive, given adequate attention to planning and aspects of organization and management. [12].

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The pretreatment of turbid surface water prior to slow sand filtration

There are several important advantages in the employment of slow sand filtration, for the treatment of potable water supplies in the developing world which include simplicity of design, the possibility of using local materials in the construction, the relatively low technical level required for operation and, particularly, the high bacteriological quality of the produced filtrate. There is however, one important drawback that has inhibited the wider adoption of this process and that is the difficulty which occurs when attempting to continually filter water of a high turbidity. High turbidities of the raw waters fed to slow sand filters result in short filtration runs and necessitate frequent cleaning which adds appreciably to the problems and cost of operation as well as requiring larger installed filter surfaces.

Maximum turbidities in the raw water, over prolonged periods, of between 10 and 50 turbidity units [1] have been quoted although it is normally accepted that higher turbidities of perhaps 50 T.U. to 120 T.U. can be tolerated for one or two days without major increases in the head-loss [1]. Throughout much of the tropical world surface waters have very high turbidities during at least part of the year which corresponds with the rainy, or monsoon season. This, again, is a major reason that slow sand filters have not been more widely adopted in regions where, apart from the difficulties of high turbidities, they could be most advantageously employed.

AVAILABLE TECHNIQUES FOR TURBIDITY REDUCTION

Techniques are available for the pre-treatment of highly turbid raw water to bring down the initial turbidity to a level suitable for continual slow filtration (less than 30 T.U.). These available techniques can be listed as:

- Infiltration wells and galleries
- Storage
- Plain sedimentation
- Rapid roughing filters (vertical flow)
- Horizontal-flow gravel filters
- Chemical pre-treatment
- Rapid sand filters (gravity, upflow, pressure)
- Coarse filtration at the river bed

INFILTRATION WELLS AND GALLERIES

Infiltration wells and galleries are employed widely in the Indian sub-continent and occasionally in other parts of the world. They can be extremely effective either for the partial treatment of high-turbidity waters or for the total treatment of less turbid waters. Large diameter shallow wells situated on the river bank may be employed so that the water abstracted from the river must percolate through the silt of the river bottom and the gravel of the river bed to reach the well from which it may then be pumped directly to the slow sand filters. More sophisticated arrangements have infiltration galleries running from the river-side well. These may be laid either in the bank, parallel to the flow, or under the river.

CHEMICAL PRE-TREATMENT

Chemical pre-treatment for the coagulation and flocculation of finely divided suspended material, followed by sedimentation, may be employed prior to slow sand filtration in a manner identical to that operated prior to rapid gravity sand filtration. This is effective but removes, for much of the world, two of the major advantages of slow sand filtration - those of simplicity and low operational costs.

PLAIN SEDIMENTATION

Plain sedimentation prior to slow sand filters has been attempted but it is only of appreciable efficacy if the suspended solids to be removed from the feed water are of sufficient size to settle readily within a few hours.

LONG PERIOD STORAGE

The long term storage of water prior to filtration can bring about a major improvement in water quality. This is practiced in many places and notably in London. Over a long period all the readily settleable material is removed. There is also some coalescing and settlement of finer suspended materials. In addition a continuing degradation of biodegradable organic material occurs and, importantly, there is a major die-off of potentially harmful microorganisms. Long term storage is used for this purpose on a village scale in several locations in Thailand [2]. There is however, a disadvantage associated with the technique and that is the potential, particularly in hot countries, for blooms of algae to occur.

COARSE-MEDIA GRAVITY FILTERS

Coarse-media gravity filters have been suggested [3,4] as pre-treatment techniques for slow filtration. The medium employed is normally rock or pebbles. Coarse filtration in the river bed at the point of abstraction has also been used. This filter may be in the form of a basket of pebbles through which the water must be extracted. For a shallow stream a more reliable method may be to lay a perforated abstraction pipe on the river bed, across the flow, and just on the upstream side of a low weir. This pipe is then covered with gravel on which the stream itself deposits a layer of silt. The abstracted water must then be pulled through both a layer of silt and a depth of gravel. This will reduce effectively the initial turbidity. The gravel/silt pre-filter is held in position by the weir and the flow of the stream continually washes off the top layer of silt and replaces it with fresh material.

RAPID SAND FILTRATION

For larger more sophisticated situations where there are turbidity problems with the raw water, conventional rapid sand filtration has been effectively employed [5]. The rapid sand filters can be either conventional gravity filters or upflow sand filters or even pressure-filters. They are normally operated without chemical pre-treatment. All these techniques are widely employed in the UK where rapid gravity filters are installed prior to slow sand filters at several sites.

HORIZONTAL-FLOW GRAVEL FILTRATION

The use of horizontal flow gravel filtration as a pre-treatment technique prior to slow sand filters is not a new technique. It was employed for many decades at the old Fobney treatment in England. It has also been used in Germany [6].

Some German gravel pre-filters are quite sizeable, being between 50 m and 70 m long, and filled with 0.4 m depth of 5-12 mm gravel on top of a layer of 30-70 mm gravel. The flow rate is 10 m/h to 20 m/h [4,7]. The suspended solids content of the river water rises to 270 mg/l in spate conditions and can be reduced through the horizontal filter by 75%, but to achieve this the treatment rate has to be dropped to 8 m/h.

A complete run with these German filters is expected to take between five and six years because of the very high storage capacity for removed silt. Certainly at Aesch (Switzerland) [7], where the horizontal flow gravel filter of 15 m length operated at an average rate of 5 m/h (8 m/h maximum), it had not been cleaned for four years and the following slow sand filter had not been cleaned for three years.

INVESTIGATIONAL WORK IN THAILAND

Much work has been carried out in Thailand at the Asian Institute of Technology into the operation of horizontal-flow gravel filters. Initially the work was carried out on a laboratory scale. The laboratory-scale model was 1.2 m long with four consecutive 300 mm compartments containing 9.1 mm crushed stone, 6.4 mm, 2.8 mm and finally 9.1 mm [8]. The rate of treatment was 14.4 m/day and the raw water employed for both laboratory-scale and pilot-scale investigations varied normally between 24 to 50 JTU although this increased to as high as 114 JTU during rainy periods. On average the turbidity was reduced by between 60% to 64% and, interestingly, this was accompanied by a 70% to 75% removal of coliform bacteria for an inlet water count which varied between 1100 and 2400/100 ml.

Following the laboratory-scale work at the AIT, a pilot-scale horizontal-filter 6 m long by 1.5 m wide by 1.0 m deep was constructed [8] and filled with vertical layers of 15.7 mm, 6.8 mm, 4.5 mm, 3.5 mm, 3.4 mm, 4.5 mm and 15.7 mm crushed stone which was again operated at 14.4 m/d. The removal of turbidity was 63% following an early maturation period of 20 days. It was perhaps strange that a maturation period was necessary for a process in which, it would be expected, most of the turbidity removal was brought about by sedimentation.

RESEARCH IN TANZANIA

Early experiments [9,10] carried out on a small scale demonstrated that smaller aggregates in horizontal flow pre-filters were superior to larger aggregates. These experiments also demonstrated that turbidity removals declined markedly at flow-rates greater than 2 m/h.

The later work by the University of Dar es Salaam [9] was carried out at village sites. One of the pre-filters, 9 m long, consisted of three compartments in series containing, in the first, 16 mm to 32 mm gravel then 8 mm to 16 mm gravel and in the last 4 mm to 8 mm gravel. Using this pre-filter the turbidity was reduced from 115 NTU to 30 NTU at a flow rate of 0.5 m/h. from 48 NTU to 10 NTU at 0.75 m/h and from 38 NTU to 17 NTU at 1.5 m/h. The reference slow sand filter (Effective Size 0.24 mm) for this stage of the investigation, receiving water which had not been pre-filtered, blocked after three days of operation at a rate of 0.2 m/h while the slow sand filter receiving pre-filtered water and operating at the very appreciable rate of 0.4 m/h continued for seven days. A longer pre-filter containing four 4 m compartments in series, with 16-32 mm gravel in the first, 8 mm to 16 mm in the second, 4 mm to 8 mm in the third and 2 mm to 4 mm in the fourth, was able to reduce the inlet water turbidity from 92 NTU to 39 NTU at a flow rate of 0.5 m/h and from 69 NTU to 34 NTU at a flow rate of 1.0 m/h.

RESEARCH IN THE UK AND PERU

Further investigation into the operation of horizontal-flow pre-filters were carried out at the University of Surrey [11]. These involved three filters each, 2.5 m long by 0.3 m by 0.3 m one of which contained 10 mm graded gravel, another 20 mm graded gravel, and the third 40 mm graded gravel. When the filters were operated in parallel at flow rates of between 0.5 m/h and 2.0 m/h it was found that performance was consistently inversely proportional to gravel size, with the 10 mm gravel filter removing up to 90% of the faecal coliforms and up to 75% of the turbidity. Collaborative work by the Panamericano de Ingeneria y Ciencias de Ambiente (CEPHIS-PAH of WHO) demonstrated that larger gravel is more useful for reducing gross suspended solids when influent turbidities were in the range of 200 to 2000 NTU. Further investigations by the Surrey team with the three filters in series in the order 40 mm gravel then 20 mm and then 10 mm, with influent water turbidities of only between 2 NTU and 20 NTU, achieved a removal of faecal coliforms of up to 96% and a turbidity removal of between 60% and 75%. Long term improvements in filter operation were also observed. This indicated again the need for an appreciable maturation period before full efficiency is achieved and confirmed the similar findings in Thailand and Tanzania.

RECENT WORK IN SWITZERLAND

The results from various investigations carried out into the operation of horizontal-flow gravel filters have certainly been encouraging but until recently it could not be accepted that adequate guidelines for design had been evolved. The work carried out by Dr Bolter at the EAWAG laboratories in Switzerland [12] has now, however, carried the work forward considerably.

During this research, which was carried out using suspensions of kaolin in water, a number of parameters were investigated including size and type of filter media, filter length, filtration rates, filter loading, filter efficiencies and headlosses. The variation of filter efficiency (per unit filter length) with particle size of the suspended kaolin, filter grain size and filtration rate (m/h) was demonstrated. A semi-empirical filtration model was then developed for horizontal-flow filters in which the effluent quality and final filter resistance are the two main criteria. The actual reduction of suspended solids in the water passing through the filter is described in terms of filter efficiency as a function of rate of filtration, type of suspension, filter loading and sizes of the filter media. This filtration model can be employed to simulate horizontal-flow operations.

This investigation also revealed that as the solids are removed by gravity settling they form loose agglomerates of several mm height on top of the media grains. The height and shape of these agglomerates depend upon their slope stability and, once this is exceeded, the deposited material moves downwards within coarse media but the movement is prevented if the medium is smaller than 4 mm. This gradual downward movement restores the retention capacity of the upper regions of the filter medium and helps maintain the filtration efficiency long into the run. It also leads, obviously, to the collection of the removed solids at the filter bottom and enhances the effect of filter drainage in restoring removal capacity.

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Experiences with slow sand filters in Tanzania

1. INTRODUCTION

The use of groundwater to meet domestic demands in most developing countries is generally limited to areas with potential aquifers only if that type of water requires minimum or no treatment at all. Where suitable water bearing aquifers are absent, consumers will have to rely on surface waters whose quality is usually not good enough for consumption without treatment. Slow Sand Filtration (SSF), if properly applied, is one of the most appropriate processes for treatment of surface waters in developing countries. However, the quality of most tropical surface waters limits the applicability of SSF alone and often they have to be preceeded by some form of pretreatment.

Although it has been a common practise to characterize the suitability of water for SSF with turbidity, one should not forget the fact that clogging of filter beds is brought about by solid and organic matters which are responsible for physical blocking of the interstices. Turbidity is measured by photo-metric principles which allow determination of the intensity of light scattered and absorbed by suspended matter in water. One has to bear in mind that, scattering of light is on the one hand a function of number, shape, size and refractive index of particles in water and on the other of its wavelength spectrum.

It has been experimentally established (ref. 4) that, total suspended solids concentration and filtrability can characterize more accurately the suitability of water for SSF. In practise, a correlation of the former to turbidity can be developed over the linear range for the sake of estimating the levels of suspended solids in water indirectly from records of turbidity kept.

2. BACKGROUND HISTORY

The initial application of Slow Sand Filtration (SSF) as a water treatment process in Tanzania during the early seventies has had an unpleasant history. Most of the schemes which were designed to apply SSF faced operational difficulties due to the extremely short filter runs experienced with them. For example, (ref. 1) reported that SSF constructed in about five villages in Tabora region were already inoperational hardly two years after commissioning. In (ref. 2), similar operational problems with SSF were reported in a number of provinces in Kenya.

Besides hindering the development of biological activities, the short filter runs led to abandonment of some of the treatment plants with SSF due to the heavy burden of cleaning the filter beds frequently. There were two likely causes of these problems, one of which might have been improper operation of the pretreatment units say by application of very high overflow rates. The other main cause was feeding of raw waters with high contents of impurities directly into the SSF.

3. RESEARCH IN PRETREATMENT OF SSF

In a bid to alleviate some of the problems mentioned in the foregoing chapter, research work aimed at ultimate development of an appropriate bio-physical pretreatment process for SSF was initiated at the University of Dar es Salaam (UDSM) early in 1979. To this effect, the following activities were done:

3.1 Water quality survey

The survey and statistical analysis of water quality data for surface waters in Tanzania showed the prevalence of relatively high suspended solids concentration characterized by remarkable seasonal fluctuations as shown on table 1. below. The results proved the necessity of pretreatment of most raw surface waters prior to SSF.

3.2 Laboratory tests at UDSM

Investigations on perfomance of a number of bio-physical pretreatment methods showed that Vertical Flow Roughing Filters and Horizontal Flow Roughing Filters (HRF) had equal treatment efficiency but the latter were preferred to the former on basis of economic, operational and technical merits.

3.3 Field tests

In order to check the validity of laboratory findings in the field, a number of similar tests were carried out at Handeni, Wanging'ombe and Iringa urban water treatment plant sites during the period of 1980/81. In between 1981 and 1983, extensive field tests were carried out with the bigger pilot plant constructed at Iringa in order to have more data for production of design guidelines for HRF in Tanzania.

3.4 Companion research work

Since February 1982, a companion research programme in HRF was undertaken by the International Reference Centre for Wastes Disposal (IRCWD) in Switzerland. The objective of this work was to provide detailed explanations about the prime factors responsible for purification in HRF and as a result, towards the end of the year 1984 a filtration model for HRF was developed.

3.5 Results

- The field tests results were in very close conformity with the laboratory investigations in terms of treatment efficiency of HRF.
- Pretreatment of raw water with HRF prolongs the filter runs of SSF to acceptable durations (i.e. more than four weeks).
- Average turbidity removals of 50% and maximum removals of 80% were observed during the research period. Higher removals were attained at relatively low filtration rates.
- After a ripening period of about three weeks, HRF could remove 50 - 75% of E.Coli and Total Coliform bacteria from a raw water with less than 1000 Total Coliform counts per 100ml after 24 hours of incubation.
- The following design guidelines should be observed for HRF:
  - In general, filtration rates should be kept less than or equal to 2.0 m/hr. The best way of getting the optimum rate is by carrying out pilot tests with the raw water to be treated.
  - HRF should be designed with filter runs of at least six months.

Table 1. Surface water quality

PARAMETER	Average X			67% limit: $(X+\sigma)$	
	Wet season	Dry season	Annual	Wet season	Dry season
Turbidity (NTU)	41	28	35	105	61
Colour (mg Pt./l)	79	55	67	162	116
Suspended solids (mg/l)	96	42	69	271	92

(σ : Standard deviation)

- The diameter of filter media to be used (usually gravel) should range from 4 to 50mm and only three or four fractions should be provided.
- The net total length of filter media should lie in the range of 10 to 20 metres.

4. WORKING CONDITIONS OF W/S SCHEMES WITH SSF IN TANZANIA

The following observations were made during the site visits to w/s schemes having SSF in different areas of Tanzania during the year 1983, see (ref. 5).

4.1 Pretreatment units operation

In many cases, improper operation of pretreatment units result in very short filter runs of SSF. For example, the poor settling efficiencies of sedimentation tanks are usually a result of application of high overflow rates. However, this can be alleviated by either installation of weirs or simply by construction of additional units. For some chemically assisted pretreatment units, shortage of chemicals, non-existence of rapid mixing facilities at the dosing points, and unreliable analyses of optimal doses of Aluminium Sulphate (Alum) contribute to poor settling efficiencies experienced.

4.2 Cleaning of filter beds of SSF

In extreme cases, the filter bed is washed within the SSF box by filling it with water and after thoroughly mixing up the contents, dirt is flushed off through the overflow pipe. However, such a practise is not recommended at all because it disturbs the purification mechanism of the SSF to a great extent and allows penetration of impurities deep in the sand bed.

The most common practise is to scrape off the top one to three centimetres of sand from SSF bed after clogging and to refill it after washing. In any case, the application of this technique should have some technical and economic justification. Thus it has to be clearly established that the cost of refilling fresh sand stored at the site or brought in from nearby sand quarries is much higher than the cost of washing it after scraping if unsieved sand is used.

4.3 Background knowledge of the plant operators

The background knowledge of the plant attendants about operation and maintenance of SSF is completely insufficient. In order to ensure that they at least have the minimum understanding, some theoretical and practical instructions should be conducted for them, prefarably in Swahili language. The pilot plant at Iringa is available for such a training to start with and the Department of Civil Engineering of UDSM could organize such workshops upon request from the responsible ministry on specific terms of reference.

4.4 Control of filtration rates

For reasons already mentioned in item 4.3 above, most of the attendants are not even able to check the filtration rates of SSF at any time during normal operation of the plants. In order to have a more reliable control of filtration rates, devices which can indicate them visually should be made use of. Such a device can be installed in the outlet box of the SSF as a floating structure just before the weir itself, see (ref. 3).

4.5 Design of SSF

The design of inlet and outlet structures of some of the SSF are completely unacceptable and in many cases, the latter is not properly provided for, thus allowing the occurence of negative pressures in the filter beds and hence resulting in premature filter runs due to the subsequent air binding.

5. SSF RESEARCH WORK IN PROGRESS AT UDSM

The following research activities in the field of SSF are in progress at the University of Dar es Salaam.

5.1 To check whether or not refilling of washed or unused sand on top of the SSF bed after scraping has any effect on the duration of full rejuvenation of biological activities on the filter bed.

5.2 Comparison of treatment efficiency of SSF beds with sieved and unsieved sand complying with SSF bed specifications recommended in literature.

5.3 Continuation of research with HRF - SSF systems in Tanzania.

6. CONCLUSIONS

6.1 Slow Sand Filtration is an appropriate and reliable treatment process for surface waters in rural areas of tropical developing countries if carefully implemented.

6.2 The component of training to be plant operators should not be overlooked during the stage of planning execution of new w/s schemes with SSF.

6.3 HRF can be very conveniently applied as pretreatment prior to SSF in schemes which have high bacterial pollution loads and considerable amounts of settleable suspended matter.

ABBREVIATIONS USED

SSF	Slow Sand Filtration or Filter
HRF	Horizontal Flow Roughing Filter
UDSM	The University of Dar es Salaam
IRCWD.......	International Reference Centre for Waste Disposal
ref.	reference number
w/s	water supply
σ	Standard deviation

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L G Msimbe - T N Lipangile to present paper

Wooden and bamboo materials in the implementation of water for all Tanzanians by 1991

ABSTRACT

Lack of foreign money, ill concieved and undefined levels of service, adverse global economics of the 80's and embezzlement of funds and dishonesty on the part of the implementing authorities are but a few of the snags that hindered implementation of a resolution by the ruling party; then TANU, of 1971 which stipulated water for all Tanzanian by 1991 within a distance of short walk, defined as 400 m.
A government sponsored project to investigate on use of locally available materials; wood and bamboo as water conduits was started by T.N.Lipangile in 1974. Results of this research and their possible impact in the implementation of the rural water supply programme are discussed in this paper.

INTRODUCTION

Ten years before launching the International Water and Sanitation Decade, the Tanzanian government embarked on a twenty year program of safe water for all Tanzanians by the year 1991.
At 1971 prices it was estimated that the government would be spending not less than 260 million TAS (Tanzanian shillings) annually of which 80% was expected to be acquired from foreign sources in form of materials, transport equipment and training of staff.
No sooner than the program took off, following problems that hindered smooth implementation became apparent:

a) Scarcity of foreign money
b) Adverse global economic conditions also affected those countries which would have contributed to the success of the program
c) Although rarely put onto records, funds embezzlement and dishonesty on the part of the implementing authorities, misuse and mismanagement of resources are also significant factors that contributed adversely towards the programmes progress.
d) Increased costs of projects due to general rise in cost of industrial products.
e) Desirable levelsof service were ill concieved by water experts and were not defined. As a result unnecessarily stringent conditions governed selection and development of water sources leading to enormous investments benefitting only few people. It is only at present that government is thinking to alter the existing adopted technological mix in favour of less expensive technologies. Shallow wells should serve 50% of the rural population in stead of the origanally planned 9% (ref.1). However even with shallow wells constituting 50% of the technological mix for rural water supply, government would be required to invest not less than TAS 1030 million annually (100 TAS = 4.87 Pound Sterling).This represents about 15% of the entire 1984 National Budget if the 1991 target is to be met. From the previous money supply records (ref.2) it seems unlikely though that government will, in the near future be in a position to afford such massive investment in the rural water sector. The previous annual financial inputs are shown in figure 1.

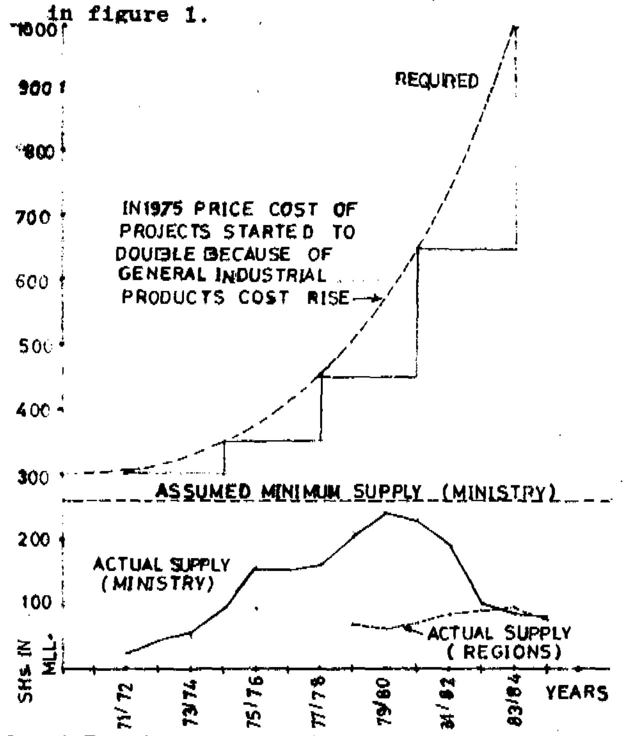

fig.1 Required, assumed and actual annual financial input for rural water supply

From the foregoing it is apparent that little success has been recorded so far in implementing the programme and the future of the programme remains gloomy. Improvement of this situation calls for:

- More elaborate definition of levels of service in short and long terms i.e. desirable combinations of availability, dependability quality and quantity of water to be supplied at different development stages.
- Simpler and cheaper technlogies in the de-

velopment of sources and distribution of supplies.
- Increased beneficiaries participation in realization, implementation, operation and maintenance of supply systems.
- Enhancing education; as benefits of safe water supply are a bit obscure compared to those of health service and education, com munity participation in water supply has not been as pronounced as in those other two sectors.
- Less dependance on external inputs as the number of external supporters has been invariably decreasing. Water expert's attitude should reflect more of the national policy of self reliance.

BAMBOO PIPES

Bamboos, belonging to the family of the grasses, vary greatly in appearance from small thin species to species with stems as thick as 30 cm and as high as 30 m. All are however characterized by hollow stems with solid partitions at intermediate distances. This pro perty makes them attractive for use as water conduits (after removing of the partitions). Although there are many varieties of bamboo, those extensively used by the project include Arundinaria alpina, also known as the green African mountain bamboo, and Bambusa vulgaris (a green striped yellow bamboo). Whereas the former is an indigenous specie, the latter was introduced by the Germans from Asia. Both species are found in millions in a number of places in Tanzania.

Physical and mechanical properties

Bamboos reach their full length in the first year of growth and become only thicker after that. The culm of a mature bamboo starting from one metre to five metres above ground is more or less of uniform size and thickness. Variation of average bore size and the difference in pipe diameters between the two ends within those four metres is as shown in table 1

table 1: The average bore size and the difference in diameter

average bore size	38	50	63	75	mm
difference in diam.	3	3	1	nil	mm

From the table it is apparent that the smaller the bore size, the larger is the difference in diameter at the two ends.
Bamboo fibres are longitudial and are more or less glued together by pectins with few inter connections.This gives bamboos a low shear strength. Experiments carried out to ascertain pressures that bamboos can withstand revealed the following:
- For Bambusa vulgaris instantaneous pressures as high as 10 bars were recorded
- For Arundinaria alpina instntaneous pressures of 6 bars were recorded

It has to be mentioned however, that pressure bearing capability differs from bamboo stem to bamboo stem and that maximum values drop considerably when the stem is exposed to those pressures for longer times. Parameters affecting pressure capability are yet to be established. From field experience it has been concluded that working pressures of Arundinaria alpina and Bambusa vulgaris should not exceed respectively 1.5 and 3.0 bars. The lower working pressures compared to instantaneous pressures are thought to be due to water hammer effects and possibly less-effective tightening of the reinforcement wires onto the bamboo in a field situation. The higher pressure bearing capability of Bambusa is probably due to its shorter internode distances and thicker walls.

Hydraulic properties

Discharge-pressure measurements were conducted by the Hydraulics laboratory, University of Dar es Salaam. The variation of friction factor (λ) as determined by Darcy-Weisbach equation with Reynolds number (Re) is plotted as shown on the Moody diagram (fig 2)(ref 3).

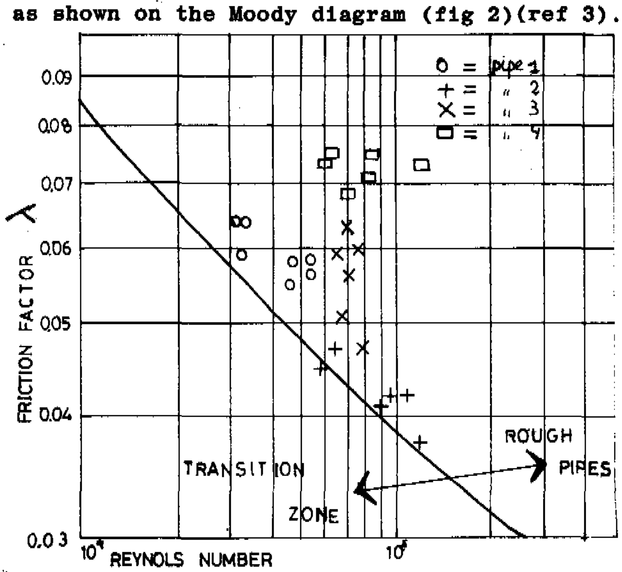

fig 2: friction factor λ of tested pipes on Moody diagram

The diagram clearly depicts that the values plotted in the turbulent flow zone where λ is governed by the relative surface roughness of the pipes. Consequently the use of the exponential formular for the flow through the pipes is justified. The average values of Manning's (n) and Hazen-William's (C) roughness coefficient were determined and found to vary between 0.013 - 0.016 and 75 - 90 respectively. The lower n-value and the higher C-value correspond to good node removal. For design purpose the project adopts a value of C between 70 - 75. This is because presently pipes are not centrally processed which makes control of quality unreliable.

Economics of bamboo pipes

With the assumptions made in SIDA's evaluation mission report (ref 4), bamboo pipes of sizes 63 - 75 mm are found to be price competitive to polythene pipes both in terms of financial and economic annualized costs. In terms of present expenditure however, bamboo pipes are several times cheaper both in finan cial and economic costs (ref 5). The economic costs in table 2 are based on CCA - a copper, chrome, arsenic preservative - treaetment of the pipes to enhance their durability.

Table 2: Economic cost comparison between bamboo pipes and plastic pipes.

	ECONOMIC COST TAS/MTR		
	Arund.	Bambusa	PE 63mm
manufacture of bamboo	13.80	16.45	-
purchase of poly	-	-	46.45
transport, installat.	20.85	20.85	42.30
SUB - TOTAL	34.65	37.30	88.75
maintenance	1.60	1.60	-
ANNUALIZED COST	7.35	7.85	12.85

Remarks:
- transport cost based on weigthed average distances to construction site
- for calculations a shadow exchange rate of 200% of the fixed rate of March 1983 is used (all calc. based on March 83 level)
- overhead expenses for bamboo are 50% of manufacturing cost and non for PE
- bamboo pipes are depriciated in 10 years, PE pipes assumed to have a residual value of 50% after 10 years

From the analysis transport costs is seen to be a major contributor to the costs of bamboo pipes. It is hoped that once the research on preservation gives positive results, transport costs can be significantly reduced by encouraging wide spread growth of bamboo all over the country.
Depending on what size of a polythene pipe a bamboo pipe is going to replace, the economic advantage of using bamboo pipes as a function of hydraulic gradient and discharge is depicted in fig 3.

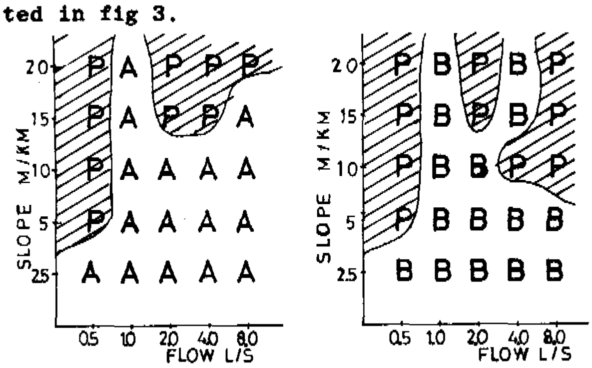

fig 3: least cost comparison of Arundinaria alpina (A) // Bambusa vulgaris (B) and PE pipe as a function of gradient and flow

It is generally observed from the figures that at low gradients, say up to 10 m/km, a system of bamboo pipes will convey increased flows with economic advantage. This is because manufacture costs of bamboo are not dependant on the size of the pipe unlike purchase of polyethene pipes.
The gradient difference shown for the two species is due to the fact that wire reinforcement on Bambusa vulgaris was then considered not effective in enhancing the pressure withstanding capability. Recently however, it was discovered that it was the mode of wire tigthening which rendered reinforcement non-effective on Bambusa vulgaris.
It is unlikely though that at any discharge a system of bamboo pipes would be of economic advantage at increased gradients. This is because at higher gradients bamboo schemes require more break pressure chambers while also more closely spaced wire reinforcement is needed.
An added potential advantage of using bamboo pipes is the possibility of community participation by encouraging people to grow their own bamboo. This will make construction and maintenance more village orientated.

Preservation of bamboos

Being organic in nature, upon its death bamboo is bound to undergo biological decay caused by bacteria and fungi and termite attack. Thus without protection a bamboo pipe would not last long in the soil environment which normally harbours all these decaying organisms.
Present practise involves a combination of preservation procedures which include:
- External coating of the pipes by boiling them for a short time in tar
- trench treatment with aldrin
- intermittent chlorination of systems

The ideal solution would be the impregnation of the bamboo culm itself with a preservative which is both insecticide and fungicide. However experiments conducted so far, failed to quarantee the non-leaching of these chemi cals into the drinking water.

WOODSTAVE MATERIALS

Introduction

The present woodstave technology started developing in the United States of America in the 1860's. Although Wood/Bamboo project adop ted this technology, it has nevertheless car ried out investigations to ascertain actual carrying capacity for the locally manufactured staves and safety of water carried through or stored in woodstave structures treated with the toxic preservative CCA. Presently the project is also involved in investigations leading to use of staves inpressurized flow conduits. Todate woodstaves have been success

fully used in the construction of tanks, irri gation channels and culverts. It is envisaged that woodstave technology will also find use in construction of silos for grain storage and sewarage pipes.
Although there are numerous types of trees available in the country, present efforts are mainly restricted to the use of soft wood (pine). This is because pine is abundantly available, cheap compared to other wood species, easily workable and can be treated to enhance its life-time.

Engineering properties

As a building material, mechanical properties are well known. The project carried out investigations to establish hydraulic performance of wooden pipes. Results from experiments carried out at Hydraulic's laboratory, University of Dae es Salaam, indicate minimum and maximum Hazen-William's C - values of 70 and 115 respectively (ref 3). Although earlier work by Scobey (1916) gave higher C - values of 120 (ref 6), the hydraulics laboratory recommended a value of 85 for hydraulic calculations. The experiments further showed that with the normal thickness of staves used there was excessive sweating at pressures above 0.5 atm. Recent trials however showed that sweating can be reduced considerably by using thicker staves or by coating the staves with tar or bitumastic paint. Pressures as high as 5 atm were reached without experiencing sweating.
A known additional advantage of timber pipes is its non-corrosive nature; unlike concrete and metallic pipes in which corrosion is a problem especially when used in chemical industries and sewarage systems.

Economics of investment

At present the Wood/Bamboo project buys ready made staves from the factory and assembles them on site. As it is apparent from fig. 4 ground level tanks are very cost competitive with the more conventional materials; steel and concrete.

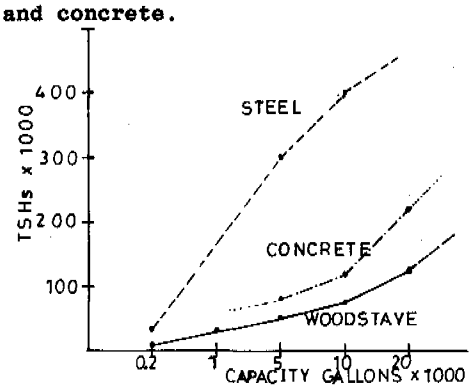

fig.4: construction cost for ground level water tanks

A recently constructed irrigation pipeline of 600 mm diameter and 365 m length costed 420,000 TAS whereasthe same would have costed 630,000 TAS and 1,125,000 TAS had it been constructed of respectively concrete or steel (ref.7).

Preservation and durability

Impregnation of chemicals into pine timber to preserve it, has been successfully practiced. Records on CCA preservation of pine wood in direct contact with the soil, show that the timber will last for at least 20 years (ref.8).
As all preservatives are however more or less poisonous,a careful selection of the preservative should be made when the treated timber is to be used in water conveying structures.Fixation characteristics of the preservative and intended use of the water are important parameters to count with.
At present CCA has been used in all water tanks and open flow pipes. Investigations showed that the leaching of the chemical compounds does not pose a health hazard when storage does not exceed 10 days (ref.9).

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SESSION E

Discussion

CHAIRMAN:- Mr. R. Andersson
UNICEF
Dar es Salaam Tanzania

1. Mr HARTUNG informed delegates that his associates had very good experiences with slow sand filters although the turbidity values were much higher than those mentioned by other authors. He queried the sufficiency of turbidity (measured in NTU) for monitoring raw water and suggested the need to define a parameter related to the time when the water has reached its half turbidity; this value gives some information about particle distribution.

2. Mr MBWETTE agreed that turbidity measured by NTU was not sufficient as it is not directly correlated to filter clogging. He suggested that it would be better to establish a correlation of turbidity with suspended solids and monitor raw water using this relationship. Filtrability is another option for defining suitability of water for slow sand filtration but it is not as realistic as suspended solids.

3. Mr HARTUNG warned against river bed prefiltration unless the river is known thoroughly and the prefilter placed carefully; otherwise it would be washed away.
With regard to horizontal gravel filters, he saw two problems: a) obtaining the gravel and b) the need for two pumps if this method was used for prefiltration.

4. Mr MBWETTE stated that hand/mechanically crushed gravel could be used as long as the material was inert to water. He explained that only one pump is necessary if the river is below the level of roughing filters since headlosses are minimal. Alternatively gravity flow could be adopted if the relief allowed.

5. Mr Van SCHAIK wished to know if any delegates had experience with gravity filters for roughing purposes as pretreatment to slow sand filtration for larger rural water supply schemes. (Using sand as medium).

6. Mr MBWETTE replied that rapid horizontal flow roughing filters with coarse sand were not recommended as studies had shown that with diameters less than 4 mm the mechanism of collapse of silt deposits due to stability is greatly hindered. For larger schemes such pretreatment units are not recommended as they involve prohibitive rates of backwashing. Similarly vertical roughing filters with fine grains were not economically or technically feasible.

7. Professor KILAMA asked if the antifungal treatment also protected the bamboo pipes against termites. He also wished to know what chemicals was used and if acute/chronic toxicity tests had been performed (in mammals).

8. Mr MSIMBE replied that the effect of the treatment depended on the chemical/preservative used. This may be an insecticide, a fungicide or a combination of the two. Protection against termites was not achieved by treating the bamboo itself, but through spraying the trench with 0.5% aldrin solution.
Analyses carried out at the Tropical Pesticide Research Institute at Arusha and at the University of Delft, Netherlands showed that there was no leaching of the aldrin from the soil, through the bamboo and into the water in the pipes.

9. Dr MTEY asked if any of the delegates had used wide-bore (yellow) bamboo as the vent pipe for VIP latrines.

10. Mr MSIMBE, on the basis of the importance of the diameter of ventpipes for VIP latrines, thought that the use of bamboo would depend on the design criteria. Yellow bamboo is available in diameters up to 125 mm, and providing this fits the design criteria, there should be no problem using it for the vent pipes.

11. Mr RAY posed three questions relating to the use of bamboo pipes. These were:-

(1) How was the clean bore achieved inside the pipes?
(2) What was the life span of bamboo or wooden pipes reinforced externally by wires?

and

(3) What was the maximum working pressure that had so far been tried in this kind of pipe in Tanzania?

12. Mr MSIMBE replied:-

(1) Nodes were removed by bits sharply pointed at the leading end with the cutting edges enlarged to the diameter of the pipe.
(2) The main concern of the research was to establish the lifespan of the main material, i.e. the wires should be

galvanised to minimise corrosion. Once the lifespan of treated bamboo is established the service life will be determined by the material with the shortest lifespan.

(3) Presently there is no way of knowing before hand the pressures that can be withstood by bamboo. However data collected indicated that green and yellow bamboo were capable of withstanding pressures of 5 and 20 m, respectively, in their natural conditions.

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

Robert R Bannerman

Organisation and participation in rural water supplies programme in Ghana

ABSTRACT - Borehole water supplies have been popularised in some rural communities. Success is achievable where effective operation and maintenance of the schemes can be demonstrated to the local people; who in turn will identify activities in which they can meaningfully participate. Better returns on the investments is aimed at through adoption of national maintenance programme and rehabilitation of old schemes.

INTRODUCTION

Organisation and participation in borehole water supply schemes in Ghana have passed through various phases during the past few decades. A brief review, illustrated by selected schemes, is presented and participation by the beneficiaries at the village level is also highlighted.

Government sponsored schemes such as well sinking, pond digging, construction of infiltration galleries and collector wells, were first embarked on, as rural water development, in the colonial period through the Geological Survey Department. Sites were selected by geologists, as part of their routine reconnaissance and the schemes were carried out by community participation, equipment were sometimes provided.

With the attainment of Independence in 1957, a Water Supplies Division (WSD) was established under the Ministry of Works and Housing, and an active borehole drilling unit was set up. Several thousand boreholes were constructed, and equipped with mechanical and hand pumps, for community water supplies.

The old time well sinking teams were however retained, but with the glamour of newly introduced boreholes, which were more quickly completed and easier to operate, interest dwindled in the well sinking programme.

Based on a report on water resources sector studies in 1970, it became government policy that it is more economical to provide all rural communities with boreholes equipped with hand pumps. Since then many more schemes have been carried out by the Ghana Water and Sewerage Corporation (GWSC) under national development programme.

It is a sad commentary however to find most of these schemes malfuction or have fallen into disuse. This is mainly due to lack of spare parts, non-provision of fuel and lubricants, inadequate operation and absence of maintenance. Trained operators have left their posts and management attitude is luke-warm.

Still faced with enormous rural water supply problems and realising that government efforts alone could not yield any meaningful impact, foreign financial and technical assistance was sought in the realisation of two regional drilling programmes; this time incorporating full scale maintenance facilities.

A water utilisation component was added on to the programmes to assess the impact of the new schemes on the socio-economic lives of the rural people.

No doubt, these programmes have been successful and five years after their completion, over 90% of the pumps are working in the field. Borehole supplies have become popular in the rural areas. Effective operation and maintenance have resulted in less breakdown time.

In the past few years, a number of church organisations, private institutions and individuals have sponsored a number of boreholes, in different parts of the country.

<u>Borehole and handpump maintenance</u>

In view of the various schemes implemented by different organisations, it has been necessary to adopt a national maintenance programme within the GWSC. Nevertheless, one church organisation, which installed 300 boreholes in four widely separated regions has opted to set up their own maintenance system.

This idea became immediately controversial in that the church organisation felt that, with a burden on the GWSC, and therefore on government, their boreholes will not be adequately servied. On the other hand, the GWSC felt that as a matter of national responsibility (if not for sentimental reasons) they were better equipped and sufficiently experienced to add on these few hundred boreholes to the thousands that are being maintained by them.

The GWSC might be right in a sense too, that in view of past experience with local authorities, which could not cope with the maintenance of their own schemes, they would be forced by government to eventually go to their aid.

Rehabilitation of existing schemes

Indeed a number of old schemes malfunction or have fallen into disuse. It was time a national survey was carried out to determine the state of affairs and what measures were possible. For it is very disturbing whilst one is on a new programme, to come across existing boreholes with apparently minor problems, which if remedied would save a whole new investment.

Some attempt has been made in recent years, to include the rehabilitation of such boreholes in on-going programmes. The GWSC have recently rehabilitated some few boreholes, not on programme basis, but rather at times when they had less new development jobs on their hands or only as a means of redeploying idle men and equipment.

Local participation in programmes

It is desirable that the local people who benefit from projects should be involved in policy making, implementation, operation and maintenance of the schemes. This theme is often harped on, without clearly defining the nature of participation expected of the people.

In Ghana, today, where by policy the drilled hole is preferred against the dug well, the local people are automatically precluded from participating in the drilling and constructional phase of borehole schemes, due to the sheer technical nature of the operation.

With time the people themselves have identified activities in which they can effectively participate. In the church sponsored projects, foreign cost components are borne by the church and the community bears all local costs. The initial commitment to have a borehole is made by the whole village. Discussions as to the number of boreholes required, population to be served and distribution of boreholes in the village are generally left in the hands of the local chief, elders and opinion leaders in the community.

A water committee is formed - usually insisting on the inclusion of women. In some communities, adult population census is first taken from which is derived the economic status of each household. Rates to be paid by individual households are determined and the committee is charged with mobilisation of the local funds. For example brewers of local beer and those who use a lot of water are made to pay commercial rates.

The committee also fixes hours of operation for different sections of the village. They appoint pump caretakers and supervise the proper use of the sites by organising periodic site maintenance and development.

Initially the villagers only volunteered to provide materials and labour for backfilling of areas around the pumps.

Through adult education and community campaigns, they participated in the construction of extended concrete pads around the boreholes heads to improve sanitation. Later the exercise was extended to include the relocation of animal water holes away from the pumps.

Sometimes inputs were provided under the government sponsored water utilisation programme, which was designed to ensure that the burden of maintenance of handpumps could be passed to the villagers themselves. Hence the people were trained to carry out simple hand pump maintenance and repairs.

The stage is now reached where the local people are now aware of the benefits of good water supply in promoting personal hygiene and good health. Some of them now use groundwater in supporting livestock production and in some cases dry season vegetable gardening.

Till now government sponsored schemes are free of charge to the people. Only recently has there been a draft legislation to consider monthly rates to be charged for the maintenance of schemes.

The ability of the local people to participate in their own schemes is now clearly demonstrated. They are now ready to make sacrifices towards project implementation. However it is only in cases where it is difficult to raise the initial capital, that the local authority or the church comes to their aid.

There is the case of a community which had already contributed and paid money for a borehole to the GWSC, for over three years; and when asked to contribute new funds for a borehole for which the drilling equipment was on site, they refused to contribute any more money, but reprimanded the water committee and asked them to retrieve the bad debt.

There is the other case of a community which just could not afford the cost of a borehole and therefore proposed an instalment plan. Meanwhile in another community the people had pledged their farm produce to the local commercial bank to raise money.

CONCLUSION

Nothing more clearly indicated the awareness of the local people in organising and participating in their own water supply than to be invited to the commissioning ceremony of a borehole water supply project and to see the hand pumps under different kinds of locking mechanisms - sometimes with fence walls - all in effort to safeguard the new investment.

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Jan Davis

'Luwero Triangle' emergency water programme, Uganda

INTRODUCTION

In recent years the rising toll of world disasters has increased alarmingly. Tragically, the trend continues. This paper describes an emergency water programme in Uganda in order to share the experience gained which it is hoped may be of value in similar relief programmes in the future.

BACKGROUND

The emergency

In September 1983 the Government of Uganda launched an international appeal for assistance in the disturbed areas immediately north of Kampala of Luwero, Mpigi and Mubende Districts (referred to as the "Luwero Triangle" after more than a year of armed conflict in the region. Over 75,000 people (rising later to 100,000) had been displaced into makeshift camps after losing most of their belongings. It was estimated that 25% of the affected population were young children accompanied mostly by women. Children and adults alike suffered from malnutrition, measles, diarrhoea, malaria and skin diseases. Consequently the needs were for food, water, shelter and medical services.

Co-ordination of the programme

From the outset co-ordination of the relief effort was very good and, although co-ordination meetings took up valuable time, they proved useful and constructive resulting in positive co-operation between agencies. The Government of Uganda designated the Office of the Prime Minister to be responsible for the co-ordination and administration of the relief supplies under a Relief Administrator.

The need for improved water supplies

At the beginning of the relief operation it was apparent that mortality and morbidity was caused by inadequate water supplies. Due, in part, to the recent history of Uganda, rural water supplies in many regions of the country are inadequate and in need of rehabilitation. For the displaced people this need was further increased and seen as an emergency for the following reasons:

i) Concentrations of large numbers of people in makeshift camps. The camps tended to be based on existing villages or small towns which at the onset had poor water supplies. These supplies became overused and totally inadequate for the ever increasing numbers of people.

ii) The generally poor state of health of people arriving at the camps and worsening on arrival due to the high prevalence of water related diseases such as diarrhoea, dysentery, scabies, etc.

iii) The relative neglect of the region due to insecurity over previous years which resulted in a continued deterioration of existing water supplies.

iv) The urgent need for provision of water at health centres, hospitals and the supplementary feeding centres.

Complementary to the need for improved water supplies was the need to improve sanitation. The ICRC (Red Cross) took responsibility for the digging of pit latrines, control of rodents and insect vectors and health education in the camps, in addition to supporting the water programme.

THE OVERALL PROGRAMME

Borehole rehabilitation

The Uganda Water Development Department (WDD) supported by UNICEF were and still are involved in a national programme of borehole rehabilitation. Boreholes that had been drilled from the late 1940's onwards had been fitted with hand pumps that had performed well but had been neglected in more recent years. A decision had been made to replace these pumps with the India Mk II hand pump (renamed in Uganda the U-Two Pump) At the beginning of the emergency operation the process of pump replacement had just started. A Save the Children Fund engineer was appointed to work alongside the Drilling Section based in Kampala to hasten the repair and rehabilitation of existing boreholes nearby camps, health centres and the hospitals. This involved the deployment of a Dando 200 percussion servicing rig mounted on a Bedford lorry. The procedure was to dismantle what was left of the old pump and plinth, clear the borehole, install the pump pedestal, cast the borehole surround, run-off and soak pit before returning later to install the pump and commission. This proved a very satisfactory method of rapid rehabilitation. One borehole could be rehabilitated over a period of about 10 days.

Springs and wells

Not all camps and emergency centres, however, had a borehole conveniently located nearby. In the absence of equipment to drill new boreholes attention was turned to springs and wells.

The local conditions did not give rise to many springs and where they did they were not always accessible to the camp residents. However, over the years some springs had been protected and there did exist a structure through which requests for spring protection was passed to the District Health Inspector (DHI). The DHI employed a spring fundi or mason whose job it was to provide the skilled labour required for the "masonry" work. Due to the conflict in the area much of that structure had been disrupted but as an additional aid to longer term rehabilitation it was a policy to work through existing structures where possible, however fragile, and to utilise local skills and expertise. To this end, supervising technicians were recruited within WDD and the spring fundi for Luwero District located. In normal times the procedure would have been to organise self-help labour through the village chief and the DHI or his appointed health assistant. In the camps this was organised through the camp chairman and where villlage communities still held together, through the village chief. Men would normally provide the labour for digging, mixing concrete, collecting and puddling clay. Women and children would often collect and carry hard core.

Where springs were protected they proved effective and popular. They are easily maintained and they are relatively quick as an emergency measure with the advantage of a considerable life byond the emergency.

Where there were no boreholes and no convenient springs to protect, then the solution was a hand dug well. Being an emergency programme, the siting of the wells had to be such that the well could be sunk and adequately protected quickly. This usually meant choosing a site close to a swamp, reaching the water table, on average, about 1.5 metres below ground level. It may be argued that this was not sufficient to prevent pollution from surface water percolation but it was felt in the circumstances that quickly obtained improved quantities of water of improved quality but not necessarily to WHO standard was the best strategy to adopt. As a consequence the wells were relatively shallow of 4m to 8m depth. At most sites the soil conditions dictated the use of precast concrete well lining rings to caisson into the water table. Due to the security situation it was not possible to cast the rings on site, which would have been the ideal. A casting section was therefore established in Kampala to cast reinforced concrete rings of 1m internal diameter and 1m depth. The reinforcement was necessary only to improve strength during handling and transportation to site. As is often the case with hand dug well construction, the main problem encountered was keeping the well rings vertical as they were sunk. It was quickly appreciated that the slightest misalignment had to be immediately corrected.

Where it was possible to complete the work, the wells were finished with a concrete apron shaped to fall to a drain and soakaway. Two wells were capped with a reinforced concrete slab through which a Pulsa 3 hand pump was installed. The other wells were left for drawing of water by rope and bucket. Whilst this did not afford the best sanitary arrangement, it did maintain the policy of providing water quantity albeit at diminished water quality. These wells were still a vast improvement on the grossly polluted waterholes.

Rainwater catchment

Rainwater catchment schemes were only viable at a few sites. Whilst many of the buildings in the area once had good galvanised steel roofing unfortunately buildings had been partly destroyed and many of the corrugated steel roofing sheets looted. It had been customary, where people could afford it, to collect rainwater in corrugated galvanised steel water tanks. However, many of these had fallen into disrepair or had also been looted. The collection of rainwater could in any case only have been a supplementary water source in most situations.

Only at the two hospitals was rainwater catchment seriously considered. In Kampala there were thriving small industries fabricating gutters and tanks from imported galvanised steel sheet. These were purchased locally and installed at the hospitals. Local semi-skilled labour was hired to lay foundations and plinths for the tanks.

Water tanker

UNICEF provided a Bedford lorry mounted with a 6000 l steel tank for the transport of Kampala mains water to the camps. Due to the geographical distribution of the forty or so camps the tanker could normally make only one delivery per day. If drinking water consumption is calculated at 3l/person/day, the tanker could supply 2,000 people a day with drinking water. It was decided to deliver to five main centres a week where there were supplementary feeding centres for moderately and severely malnourished children. UNICEF also supplied plastic collapsible water tanks of 5000 l capacity for each centre. The water from the tanks had to be used sparingly and rationed for use in making up oral rehydration solutions etc. The tanker played a vital part in the programme but it can be seen that it was totally unrealistic to use a tanker for the supply of all the camps except for the special cases.

Pumping schemes

Motor driven pumps were avoided wherever possible. In the special circumstances of the emergency, the insecurity, looting, and the difficulties in servicing and refuelling, even the medium term running of motor-driven pumps would have been erratic and unreliable. The only sites where it was possible to consider pumping schemes were at the hospitals where staff could run and service them.

At Nakaseke the original scheme pumped water from a valley tank situated about 1.5 km from the hospital. It passed through a pressure sand filter to a storage tank of approximately 36,000 l capacity. Prior to the hostilities the hospital received electricty but the supply had been disrupted. In addition, the pump electric motors together with all the switchgear and cabling had been looted. It was decided to install a diesel drive for one of the two Blake double-acting piston pumps which still remained. Both pumps were overhauled, a diesel installed and the pump house repaired and secured. Holes in the backwash storage tank were plugged and the main tank at the hospital cleaned and bitumen coated internally.

However, as an example of unexpected events regularly encountered in the programme, the day of re-commissioning was a big disappointment. The route of the rising main passed through an army detachment. It was common practice for each detachment to dig fox-holes for cover around their base and in this digging the rising main had been ruptured in five different places. This was not noticed, however, until pumping re-started and the first fox-hole was flooded. Great diplomacy was required that day and the pvc pipe was eventually repaired.

Nakaseke hospital had been completely looted. This included taps, wash basins, pipes and other sanitary ware. Full credit should go to the WDD team who re-plumbed the hospital which allowed the flushing of toilets and the use of washing facilities.

The next problem was the fear of flooding due to drain blockages. This was a common problem at both hospitals. Unfamiliarity with flush toilets and blockages due to consolidation of sediment over the years necessitated control over the use of toilets and a concerted effort to throughly clear all drains.

Water quality and yield

Attempts were made to analyse water samples but it was not possible to compile comprehensive records. The field test kit for bacteriological tests utilised the "membrane filtration method" which necessitated incubation at a set temperature. Unfortunately, the kit was unable to maintain the critical steady temperature and hence the results were unsatisfactory.

As an aid to rapid assessment on site, test strips for the identification and semi-quantitative determination of nitrate ions were used. These dip sticks indicated nitrate levels in protected springs of from 0-20mg/l. In one case a well was condemned when it was found to have a nitrate level approaching 45 mg/l which was due to bad siting of pit latrines.

Yields were fairly academic since any improvement was never enough. To give some indication, typical yields were as follows:

Springs	5 - 14 l/min
Wells	10 - 25 l/min

Insecurity

Insecurity was a major problem. At the beginning it had been hoped the camps would be gradually disbanded, people would be able to go back to their shambas and the nature of the programme would change from emergency to rehabilitation. However, insecurity continued throughout the programme and the manner in which to approach the relief work was under constant re-assessment. The relief effort was regularly interrupted by events which necessitated the temporary halting of travel within the area.

For a time Nakaseke and Kiboga hospitals were used as bases which considerably reduced travelling times. The period spent on site was vital because very often it was the only time work was actually done. Although labour was supplied from within the camp, residents had other tasks to carry out. The skilled work of lining a well or constructing a spring wall also required a supervisory presence. These factors contributed to the many delays experienced on the programme.

Costs

The programme was supported by a number of agencies, each of which had ongoing programmes elsewhere in the country and therefore the apportioning of overheads is fairly arbitrary. However, the direct costs of typical units can be estimated to give some indication of the expenditure involved. The estimates for a typical spring and well are given in the table. In normal circumstances the provision of sand, aggregate and hard core might be wholly or partly contributed by the local community. In the camps it was often impossible for people to be free enough to collect hard core and in any case it would have been adding to the people's burden rather than aiding their situation to urge more involvement than it was sensible to request. The emergency nature of the work also meant that any time spent in organising community labour, where this was possible, could have delayed the improvement of water supplies. Self-help community labour has got to be kept in realistic perspective. Therefore, after initial trials of predominantly self-help labour the work became mostly paid at an appropriate local rate.

Decline of the programme

During April and May 1984 relief was limited to just several "transit centres" close to the main roads. The majority of the camps were being disbanded. From July to September the scope of the relief effort became considerably limited because of the deteriorating security situation. Work was carried out only at sites on the main roads. Additional sites were identified closer to Kampala of a non-emergency nature in order to maintain the momentum of the work and keep a team together capable of reacting to a change in circumstances within the "Triangle". However, hostilities returned to the level of a year and a half previously; the situation had come full circle.

It was therefore decided to cease OXFAM's involvement in the water programme and since OXFAM had assumed the role of lead agency this meant the termination of the majority of the water relief programme. At the end of the programme, all three remaining transit centres had adequate water supplies; there were no longer, to OXFAM's knowledge, any concentrations of displaced people in camps; the insecurity in the region would have made any continued relief effort hazardous.

CONCLUSION

Lasting effects

Over the period of the emergency water programme 76 boreholes were rehabilitated, each fitted with a U-Two hand pump; 21 wells were dug; and 19 springs protected. In addition, extensive work was carried out on the water supply, internal plumbing and drainage of the two hospitals at Nakaseke and Kiboga. During this period the borehole maintenance section had maintained and repaired hand pumps which had suffered heavy useage. The WDD borehole teams were available to continue this repair work, if they judged the situation safe, and through a scheme funded by UNICEF a "Luwero bonus" for work in the disturbed areas was continued.

The sinking of hand dug wells prior to the emergency was relatively rare and there is now the knowhow and capability within WDD to recommence this work in the "Triangle" when possible, and to continue in more settled areas.

It is to be hoped the region can soon return to normal and benefit from longer term development projects such as the UNICEF/WDD national water development programme.

Table of summarised direct construction costs.

A typical 5m deep hand dug well:	
Materials for 6 No. 1m dia x 1m deep, 1:2:4 mix concrete rings plus apron surround, filter and drain.	£206
Labour (Supervisor, mason, diggers)	£120
Fuel (2 Bedford trips to site)	£ 45
Total	£371
A typical 2-pipe outlet protected spring:	
Materials for floor slab, spring wall, access steps, filter and pipes.	£210
Labour (Supervisor, masons, assistants)	£ 90
Fuel (4 Bedford trips to site)	£ 90
Total	£390

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

A Horsfield

Village water supply scheme - Senegal

INTRODUCTION

The paper describes the study which commenced in 1983 for the water supply to 24 village areas for human, animal and agricultural purposes in Senegal. Both the study and the construction work is being implemented using local counterpart staff and local labour to ensure satisfactory operation and maintenance

The study included a considerable input to ensure that the social and economic environment of the country and of the villages was fully understood and taken into account.

The proposals have been put forward based on experience gained from a previous project constructed in the neighbouring country of Mali 9 years ago.

PREVIOUS PROJECT

In the early 1970's my firm, Balfours Consulting Engineers of London, were employed on a major water supply sector study for the World Health Organisation for the Republic of Mali. The study recommended a priority list of practical water supply projects for both towns and villages. The top priority town was Sikasso, the chief town of the 6th Sector. The proposal to construct the works by direct labour was originally made because of the remoteness of Sikasso and the lack of experience of local contracting firms in this type of work.

The involvement of local engineers and labour enabled them to have a much better understanding of the design and construction and consequently the project has continued to operate satisfactorily.

The main problem has been the occasional lack of fuel for the pumping station. The money for the fuel should be provided by Energie du Mali but the funds provided have sometimes been either too small or too late. The local operations manager has no access to funds raised by the provision of water.

SENEGALESE VILLAGE WATER SUPPLY SCHEME

Study Team

The study is funded by the Overseas Development Administration and our proposal was submitted in March 1983. The team arrived in Senegal early in May 1983 and completed their studies in September of that year. Following the submission of a draft report in English and subsequently in French the report was approved in January 1984.

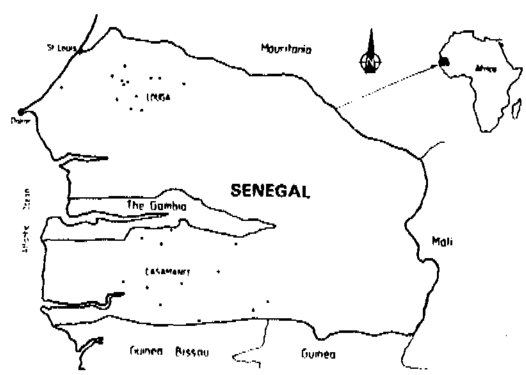
Whilst in Senegal our engineering staff worked closely with local counterparts whose knowledge of the area and the customs of the peoples was most helpful.

The study team in Senegal comprised a co-ordinating leader who was a Civil Engineer supported by two engineers, one Civil and a Mechnical and Electrical; an economist and a social anthropologist. Hydrological input was supplied by two specialists who visited for short periods and a borehole pumping test supervisor.

Topography

Senegal is situated in the extreme west of Africa on the Atlantic coast between latitudes 12° and 16° north. It is bordered by Mauritania, Mali, Guinea and Guinea Bissau. Senegal has a population of about 5 million and an area of 197 000 sq.kms.

Figure 1 - General Map



Study areas indicated thus •

The rainfall varies between 300mm and 1 200mm per annum. The number of dry months varies between 6 and 9.

The rock strata beneath Northern, Central and South-West Senegal form part of the large Mauritania, Senegalese, Guinea Basin of Secondary and Tertiary sediments which overlay ancient basement which is exposed in the South-East. Within the sedimentary piles there are several aquifers of which the Maestrichtian sands are of particular significance. These sands under-lie a large part of Senegal, are generally medium to coarse grained, of moderate transmissivity 1-2 x 10^{-2} m^2/s and receive considerable re-charge from river infiltration. The quality of contained water is only moderate with total dissolved solids of 700-1500mg/l being typical.

The economy of Senegal is largely based on agricultural production and the rearing of livestock. The number of cattle, sheep and goats being more than the overall population with some areas having a very high cattle production.

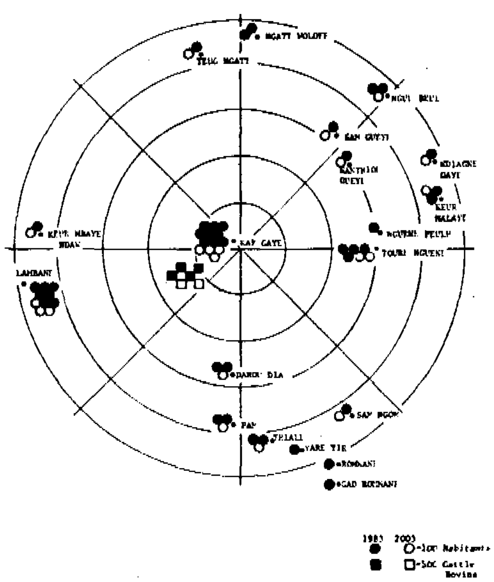
Investigations

In Senegal all work of water supply comes under the Ministère de l'Hydraulique with village water supplies coming under the Direction de l'Hydraulique - Rurale (DHR) which has several regional offices responsible for construction, operation and maintenance.

The villages studied were 12 villages in the semi arid northern Louga area and 12 further villages south of the Gambia River in the open forests of the Casamance area. Water supplies are from underground aquifers.

A village area was defined as the area within a 5 km radius of the main village or the borehole.

Figure 2 - Typical village plan - showing distribution of population and livestock.



The villages to be studied had been previously agreed between the British and Senegalese Governments. No suitable maps existed and there was difficulty in locating some of the village areas. The first task was to locate the village and produce a 'map' which indicated the relative positions of all houses and relative population distribution - Fig. 2 shows a typical 'target' plan for Kab Gaye. Whilst the positions were located using a four wheel vehicle the economist and the social anthropologist completed questionnaire based enquiries with the help of the local administration, the village chiefs and elders and also the men and women of the village. These meetings provided sufficient information on which to base human and livestock water requirements and to provide sufficient design information on which to estimate the future volume demand required. It also provided sufficient information on which to base economic comparisons of various alternative engineering solutions.

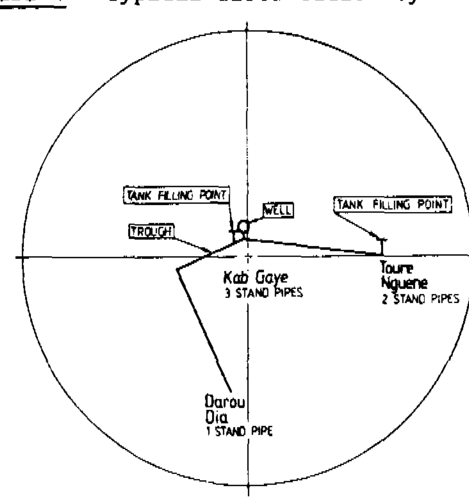
Figure 3 - Typical water demand summary

GLOBAL WATER DEMAND : BESOIN EN EAU GLOBAL				
Group Groupe	Max. 1983	 2003	Min. 1983	 2003
Human/Humain	130.3	186.1	86.9	124.1
Sheep & Goats/ Ovins/caprins	24.7	54.0	24.7	54.0
Cattle Troughs/ Abrevoirs	104.9	155.5	86.3	127.9
TOTAL	259.9	395.6	197.9	306.0

NOTES:
1. Volumes in m^3/d (en m^3/jour)

After many alternative proposals had been compared, we finally recommended that eighteen village areas be supplied with a limited distribution system, comprising a borehole equiped with a diesel driven axial drive pump, a sectional steel water tank of $250m^3$ capacity mounted on a 30m tower and trunk distribution mains discharging through standpipes and cattle troughs and tank filling points.

Figure 4 - Typical distribution system



Social and Economic Considerations

Although the study team were provided with a significant amount of data which formed a useful framework and background, the team found a considerable difference in the customs, habits and requirements of each village area.

The main ethnic groups were the Wolof (74%), Peulh (19%).

The variations in the circumstances of 24 villages made it impossible to generalise on the existing availability of water. It is readily available throughout the rainy season in some village communities but at other times there are substantial migrations of cattle and humans caused by complete lack. Particularly in the Louga area many womens hands are deformed by the continual raising of water from depths up to 100 metres.

To obtain comparable data village by village, a comprehensive questionnaire was drawn up. We were thus able to identify the villages which fall into the 5 km catchment area, their population and an assessment of the livestock population, and to review the agricultural patterns and any particular topographic or socio-economic features for comparison.

The following is an example of the population structure of a village in the Louga region.

Males	14 - 65 years	227
Females	14 - 65 years	80
Male children		60
Female children		27
Over 65 years		3
		397

Much individual research was done on the structure of each village and family unit. The population forecasts for the Louga and Casamance areas are summarised as follows:-

Village	Human Population 1983	Human Population 2003	Cattle 1983	Cattle 2003	Sheep & Goats 1983	Sheep & Goats 2003
Louga	56 965	79 855	79 890	118 770	82 610	177 470
Casamance	34 400	49 275	66 845	120 710	40 580	123 955
Total	91 360	129 130	146 735	238 480	123 190	301 425

In order to forecast per capita consumption the following figures were used.

Population	Per Capita Consumption (litres/days) High	Low
Human	30	20
Cattle	40	30
Sheet & Goats	5	5

Using this data, detailed design figures were prepared equating the estimated well outputs with the present and future requirements for humans, animals and agriculture. The sizes of pumps, distribution pipes and power or fuel requirements were also calculated.

LIII 6 KAB GAYE

Water demand 2003	= $306m^3/d$	Water available	= $1500m^3$/ 10 hrs
Water tower:			
Water tower volume	= $250m^3$	Regulating volume	= $66.9m^3$
Standby volume	= $183.1m^3$	Irrigation volume	= $120m^3$
Height to bottom water level	= 30m	Height of base above borehole	= 10m
Distance from borehole	= 500m		
Inlet connection	= 100m dia.	Outlet connection	= 150mm dia.
Outlet connection	= 200m dia.	Washout connection	= 100mm dia.
Special fittings	: Cascade aerator		
Pumping Equipment Water Demand 1983	= $198m^3/d$	Initial pumping rate	= $25m^3/hr$
Borehole static level	= 35m	Lowest dynamic level	= 55m
Pump setting level	= 60m		
Total head	= 110.6m		
Pump type	: Mono BH 250D	Pump speed	= 700 rpm
Pump absorbed power	= 12.5 kW		
Engine type	: Lister diesel HRW2	Engine speed	=1500 rpm
Site derated engine output power	= 15.3 kW		
Fuel consumption	= 3.57 l/hr		
30 day fuel consumption @ 10 hrs/day	= 1701 l/30 days		
Lubricating oil consumption	= 12 l/30 days		
Water Outlets:			
Drinking troughs	= 1 x 2 No. troughs	$86.3m^3$	throughput/day
Bornes Fontaines	= 6 No.	$41m^3$	throughput/day
Tank Filling points	= 3 No.	$70.6m^3$	throughput/day

After much research, it was considered unreasonable to expect villagers to contribute more than 5 per cent of cash incomes to water supply costs. This was the basis on which the level of service and recharge rates were calculated.

Implementation

In view of the location of the villages and the level of technology applied we reasoned that the proposals would not attract serious international competitive tenders. We therefore recommended standardisation of equipment, materials and structures and all works being carried out by local labour under our supervision. We considered that this would provide local jobs, a better understanding by the locals of the works and a better performance of operating and maintenance tasks. In addition all the plant and equipment required during construction would be handed over to the Senegalese at the end of work possibly enabling further schemes at relatively low cost.

The construction will be undertaken in sequence so that certain key construction workers can be moved from village to village and so that instruction on operation and maintenance can be given over an extended period.

Unfortunately I cannot yet report on actual construction progress as the orders for plant and equipment for other than survey purposes have not yet been made.

Acknowledgements

I should like to express many thanks to the Ministry of Overseas Development, The DHR and Balfours Consulting Engineers of London and Sheffield for permission to write this paper and for their assistance.

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A Windram, R Faulkner, Dr M Bell, N Roberts, P Hotchkiss and R Lambert

The use of dambos in small scale rural development

INTRODUCTION

Dambos (or vleis) are treeless headwater depressions with groundwater close to the surface. They are found throughout the plateau savannas of the tropics and have a core area in central southern Africa. Similar features are recorded for Tanzania, Northern Nigeria and parts of Latin America. Previous studies of dambos have investigated their geomorphology, hydrology and vegetation (refs. 1-4). With the exception of Russell's (ref. 5) work in Malawi, little research has been carried out into their potential role in rural development. Their use for small-scale irrigation in Zimbabwe was discouraged during the colonial period because of the threat of soil erosion. However, attention has recently been drawn in the scientific press to the underused potential of these small water sources (ref. 6). As a result, the Overseas Development Administration (ODA) of the British Government are funding a project run jointly by the Water and Waste Engineering for Developing Countries (WEDC) group at Loughborough University of Technology and the Department of Civil Engineering, University of Zimbabwe. The fieldwork commenced in 1984 in Zimbabawe. It is intended that some comparative studies will also be carried out in neighbouring countries.

BACKGROUND

Large scale irrigation projects which seek to redress the growing imbalance between population and food supply have a restricted potential in many African countries in view of the shortage of suitable land in the vicinity of adequate, exploitable water sources. However, limited amounts of water appropriate for small scale irrigation may often be found in dambos. In Zimbabwe these features occupy a substantial proportion of the highveld. They are saturated with water in the wet season while during the dry season the water table drops to a metre or so below the surface. This annual fluctuation is most apparent at the upper dambo margins where the vegetation changes from grass to shrubs.

While the unrestricted development of dambos could pose a severe threat of erosion and perhaps even alter the precarious ecological balance on their margins in particular, cultivation may be encouraged with appropriate conservation practices. Although these areas are unsuitable for any single large-scale project, collectively they constitute a valuable asset in the development of indigenous agriculture.

Small-scale irrigation development has many advantages over large-scale projects. For example, the current capital development costs for sprinkler and flood irrigation systems in Zimbabwe range from $2,000 to $6,000/ha (Z$0.6 = £) depending on conditions. In comparison, small-scale developments using handpumps can be implemented for less than $500/ha - and hand-watered gardens for a good deal less.

Potential sites for large-scale irrigation developments often do not occur in areas with high population densities and may require relocation of would-be cultivators. Conversely, rural settlements are normally sited close to small water sources which could be exploited, thus bringing irrigation directly to the people. Existing extension staff could be trained to implement and advise upon the most appropriate low cost technology associated with small scale irrigation, eliminating the need for large consultancy and management contracts. In addition, the risk factor would be spread over a large number of mutually exclusive projects, instead of being carried by a single large project heavily dependent on management inputs.

The main constraint on small-scale irrigation is that it is normally necessary to lift relatively large quantities of water to an elevation high enough for it to command the areas to be irrigated. A number of handpumps capable of delivering sufficient water to irrigate up to one hectare have been developed. The pumps have the advantage of being cheap and rely on a renewable energy resource, namely manpower. In general they are limited to operational heads of under 6m.

In Zimbabwe, large areas of vegetable gardens are irrigated by hand, in spite of the substantial logistical problems. Typically, water is drawn from a shallow wide-body well (in reality just a hole in the ground) tapping a dambo or perched water table. Water is then carried to adjacent vegetable plots in 1-20 litre containers. Given an adequate supply of water and assuming a reasonable standard of cultivation, a plot of 1,000m^2 of irrigated vegetables would ensure a more than adequate supply for a Zimbabwean family of between six and eight. Hence a one hectare block, if cultivated by an extended family or on a communal basis could cater for 60-80 people.

However, a 1,000m^2 family plot will require a gross of 3-7.5m^3 /water /day depending on the time of year. This represents 35-90 minutes pumping on a handpump delivering 4 litres per stroke at a rate of 20 strokes per minute or a total of 150 to 375 roundtrips hand watering with a 20 litre can. While both, especially hand watering, are onerous tasks, they are within the physical capabilities of an average family unit.

PRESENT CULTIVATION

Figure 1 shows a number of dambo sites which have been investigated. Despite three years of drought (1984), the water table in these dambos was rarely more than 3m below the ground surface and more typically between 1 and 2m. Variation in water level is partly related to substrate which varies from swelling clay to coarse sand. The level of the underlying rock (granitic gneiss) also varies considerably and gives rise to local perched water tables. The upper horizon of the dambo soil is typically black and relatively rich in organic matter.

All the dambo sites under investigation had some cultivation both in winter (July) and summer (December 1984). Typically these were small garden plots (0.2 hect.) with hand methods used to raise the shallow well water. In the case of dambos within 100 kms of Harare and hence with a market for produce, notably Domboshawa in Chinamora district, commercially orientated operations were evident. Cultivated plots extending over an area of 1 - 2 hectares were not uncommon with diesel pumps used to lift water. A common method of providing irrigation water within dambo gardens is by the construction of a small dam involving the excavation of material from below the mean phreatic level to form a bund (1.5-2m high) on the downslope side. Water then collects behind the bund and is released via a simple pipe through the bund itself to irrigate the land downslope. Both in July and December most of these dams were dry due to the drought.

Dambos are used extensively for communal grazing with the result that cultivated gardens must be fenced as a protection. Cattle tend to water at the base of the dambo where a small seasonal stream or open water surface exists. This may rapidly lead to gully erosion extending upstream. Field evidence suggests that uncontrolled cattle grazing on dambo sites pose a greater threat to the delicate ecology of these areas than well-managed cultivation. It has been found in certain areas that the constant passage to and from a water source constitutes an erosion hazard, particularly if the course is a perennial stream.

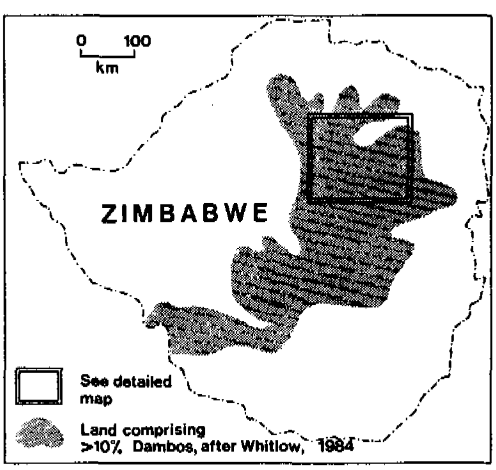

Figure 1a Dambo distribution in Zimbabwe

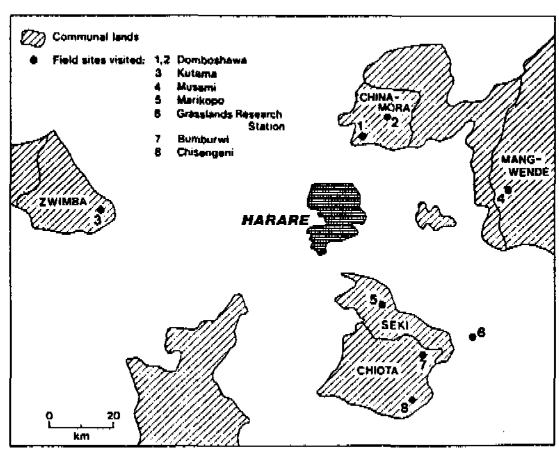

Figure 1b Dambo sites investigated

ENVIRONMENTAL ASPECTS

The hydrology of dambos is complex. Instrumentation is being developed to analyse the parameters of rainfall, evapotranspiration, runoff, infiltration and deep percolation. One objective is to establish the contributions of surface runoff and groundwater flow from the higher adjacent land to the dambo itself. Qualitative evidence suggests that both may be substantial. Work carried out so far indicates that not only is the variation from one dambo to another, but within a single dambo the variation in depth to underlying rock (0 to >3m) complicates the groundwater movement. Figure 2 schematically illustrates the profile of a dambo.

It has been argued (ref. 7) that dambo utilisation is harmful since the evapotranspiration from cultivated vegetables and crops in the dry season is much larger than that which could occur from natural grass vegetation (which is also sometimes burnt in the dry season). This then detracts from the 'sponge effect' of the dambo by which water is released slowly to downstream watercourses. The extent to which this is true will depend upon the intensity of cultivation. It has also been argued that cultivation leads to degradation and erosion since the soil is washed out of the dambo as silt. This in turn detrimentally affects the downstream watercourses while leaving the dambo itself gullied and degraded (ref. 8). Good water and land management is needed to avoid this.

Nutrients used by crops from the organic upper horizon of hydromorphic dambo soils must be replaced by manure and fertiliser; if not, breakdown of the fragile soil structure will result with subsequent abandonment of the land. However, good agricultural practice including contour furrowing can ensure that these soils remain fertile and productive. The evidence suggests that it is gully rather than sheet action which causes erosion as a result of cattle trampling in the seasonally saturated ground. Overgrazing leads to a reduction in vegetation cover and compaction of the soil surface, which lowers infiltration capacities. The resulting increase in surface runoff causes headward extension of the gully formation and hence dambo desiccation.

SOCIAL BENEFITS

Current legislation in Zimbabwe severely restricts cultivation on wetlands (which include dambos) and within 30m of a water course. These restrictions have their origins in laws passed in 1927 and 1952 when the colonial government was concerned to prevent streambank erosion and reductions in streamflow. A tradition extending over centuries of dambo cultivation as part of indigenous agricultural patterns was thereby interrupted, evidence for which remains in the remnants of former field systems. Information from recent aerial photographs suggests, however, that in spite of the legal restrictions, cultivation has greatly increased since independence with substantial social and economic benefits to the communities involved. These include the nutritional value of the vegetable crops grown which enhance the staple diet based on maize, notably during the dry season when, with simple technology, irrigated cultivation is possible. In sites close to population concentrations, and to Harare in particular, the market value of vegetable production can be considerable providing an important additional source of income to rural households (in some cases Z$ 5-600 per month).

In contrast to large scale, centrally managed agricultural schemes, dambo cultivation does not conflict with traditional agricultural practices and social

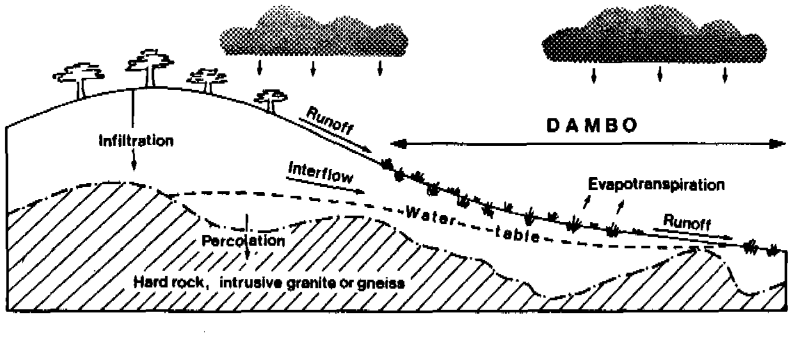

Figure 2 Schematic diagram showing dambo hydrology

organisation. However, irrigation practices are often wasteful in terms of water use while little assistance is provided by government extension services. Irrigation technology is also at present highly labour intensive and inefficient in terms of labour effort. If attempts are to be made to reconcile the advantages of dambo use with the possible social and environmental conflicts which may arise from an increase in the area under cultivation, questions concerning access to land and water resources and to the use of labour must be better understood.

CONCLUSION

Considerable benefits can accrue to rural populations by utilising dambos for small scale cultivation, based on irrigation, particularly during the dry season. However, the environmental and social forces conditioning their use must be clearly understood and evaluated in order that ground rules may be drawn up to ensure that the land remains fertile and degradation does not take place.

ACKNOWLEDGEMENTS

We should like to thank the Overseas Development Administration for their financial support for this project No. R3869.

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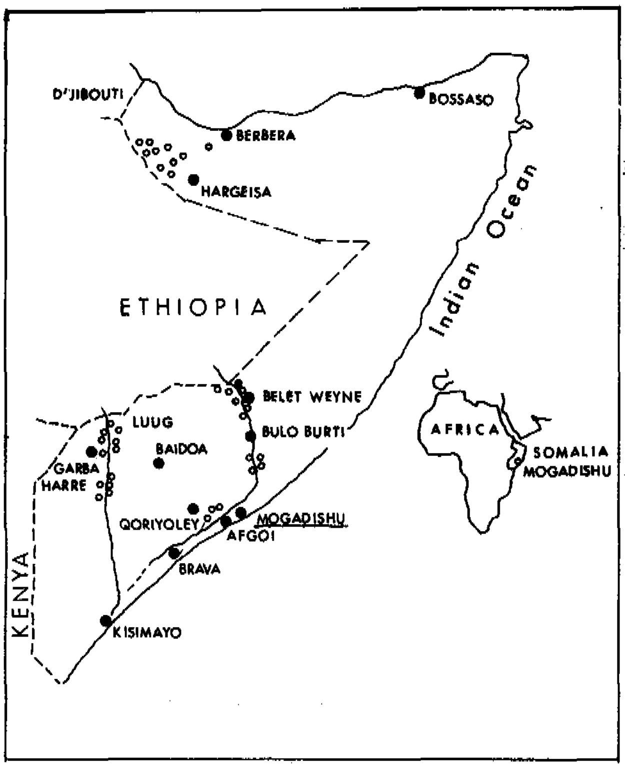
WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

Hans Hartung

Appropriate water technology in Somalia's refugee camps

GENERAL SITUATION

There are appr. 500,000 refugees from Ethiopia living in Southern Somalia for more than 4 years. They live in 28 refugee camps situated close to the rivers Juba and Shabelle. New camps are currently being set up to accomodate the recent influx of more refugees.



Refugee camps in Somalia

WATER SUPPLY

Suitable ground water has been found only in a few camps. Most camps rely on purified river water. The purification system in use when the author arrived in Somalia in the middle of 1983 was set up within an emergency phase. It was dependent on considerable amounts of chemicals (for flocculation and desinfection). One of the basic objectives of the refugee water supply is to reduce the dependency on continued external inputs such as chemicals and fuel. Three efforts to achieve this goal are presented in this paper.

- pumping of water with stream powered pump
- prefiltering of river water
- introducing easy and fast to erect slow sandfilters (Oxfam Treatment Package).

STREAM POWERED PUMP

Since the refugee camps in Southern Somalia are situated near the river and rely on river water, it seems only logical to make use of the energy of this river.

Concept

A relatively simple concept was put into practise: an easy-to-fabricate propeller is driven by the river current. The energy thus produced in used to pump water with a 3 piston pump. Propeller and pump are both installed on a float in order to follow seasonal differences of discharge of the river. They are working below the water level and cannot be seen during operation. For maintenance or servicing, the whole assembly can easily be brought above water level.

Stream powered pump being serviced

Experience

The pump has been in operation for one year. At high water levels of the river, branches and other floating material got cought at the pump and had to be removed almost daily.

The connecting rod bearings of the piston pump had to be replaced twice. They showed increased wear due to the high sediment load of the river. This led to a complety changed concept: a centrifugal pump has replaced the piston pump. It is connected by a planetary gear to the propeller. Model tests with the new pump are very encouraging and at the days of this conference, the new pump is tested out on a river in Europe.
After careful examination, it was decided not to incorporate the stream powered pump into the Refugee Water Supply. The main reason was, that the river Juba is between 2 and 5 months too low for the stream powered pump to operate. A stand-by diesel pump does not comply with our overall concept of only one standardized pump for one water supply plant. But a great potential has been identified to use this pump for irrigation purposes.

PREFILTERING

Concept

Riverbed sand can be used as a filter medium in the purification of river water. Methods as used when dewatering construction sites are taken and applied to the exploration and installation of prefilter systems.

Exploration

For the exploration of the underground, test holes are jetted into the ground. The material actually around the tip of the jetting pipe is washed up to the surface and can easily be examined. If a thick and sufficiently extended layer of sand in hydraulic continuity with the river has been found, a test filter is installed in one of the test holes to get information on quality and quantity of water.

Installation

The installation of the prefilter system is adapted to the conditions at the specific site, taking into consideration

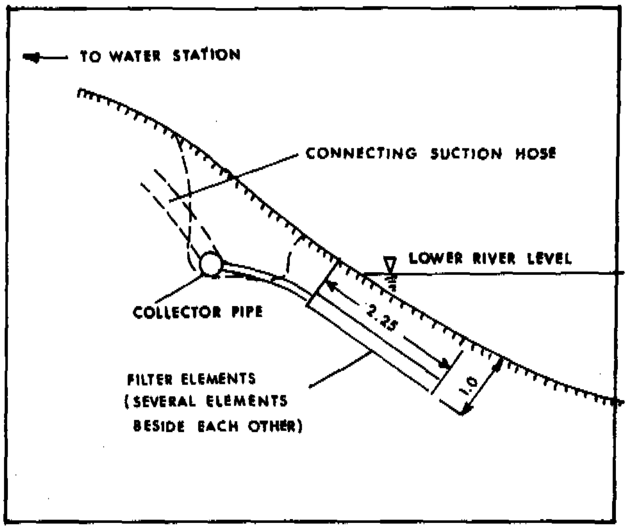
- permeable layers of sand, their thickness, extension and permeability
- location of the prefilter system with regard to river bank and riverbed (and its possible shifting) and the existing water station in the camp
- the encountered water quality (we found quite often salty water in the Juba sandbeds).

The installation can take place only at low river levels.

Components

The main components of the prefilter system are

- drainfilters, consisting of flexible drainage pipe 1 3/4" and covered with filter fabric or slotted, self jetting 2" filters
- collector pipes, connected to the drainfilters by flexible suction hoses
- self sucking pump which gets its water through drainfilters and collector pipes



Prefilter system in the river bank

Conclusions

The main purpose of the prefilter system is to supply sufficiently clean water for further treatment. This purpose has been achieved and could be demonstrated by a considerable reduction of water turbidity.
Reduction of coliform bacteria depends on the distance the river water has to travel through the

sand. At some places coliform bacteria were completely eliminated so that drinking water quality had been achieved.
The installation site plays the most important role. Many prefilter systems were destroyed, when the river was high and the riverbed sand shifted considerably. Therefore careful observation of the river and choosing a site which will not move (as e.g inner bend, stable bank) are absolutely necessary.
The system is universal and can be adapted to different situations:
- it is especially suitable as an easy and fast-to-erect water system in emergencies, if the prefiltered water is carefully treated and monitored
- it has been used to replace an insufficient borehole near the river bank
- it can be used to tap shallow groundwater resources.

SLOW SANDFILTER

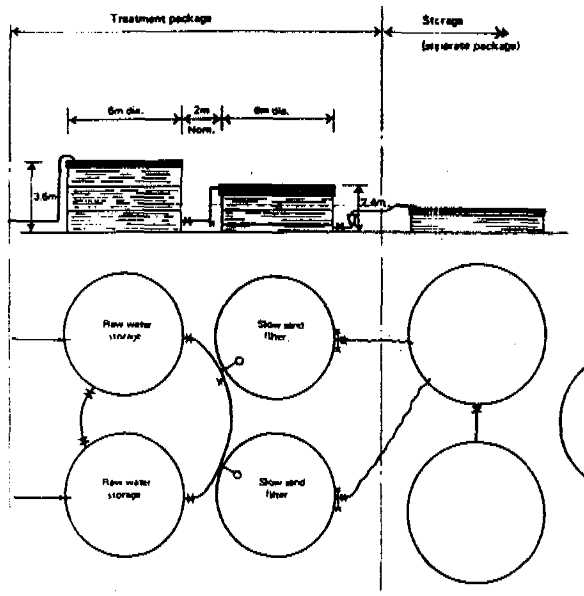
Task

As mentioned at the beginning, a simple chemical purification system was used in the camps as drinking water supply. It was erected as an emergency measure to be used for half a year. But in the meantime it was-and partly is-in use for more than 4 years.
It had to be replaced by a system meeting the criteria
- use no chemicals
- easy to erect
- inexpensive
- medium term solution. At least major components should be movable to be operated at new locations if refugees are shifted.

Solution

The ideal system to meet these criteria was found in the Oxfam Treatment Package. It is a slow sandfiltration system consisting of a basic unit of
- 2 raw water storage tanks, allowing a continuous inflow into the sandfilter tanks and serving as settling tanks at the same time
- 2 slow sandfilter tanks
- 2 clear water tanks as storage of the drinking water .

All the tanks consist of corrugated steel sheets that are bolted together and lined with a flexible butyl rubber membrane.



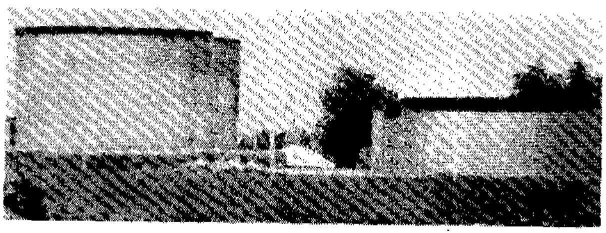
General arrangement of slow sandfiltration system

The slow sandfilter tanks are filled with around 30 cu.m of sand meeting specific criteria. The riverbed sand of the Juba was found suitable but had to be washed to eliminate sediments. On top of the sand, a filtermat is placed.
The underdrainage of the sandfilter has been changed from the original plastic slotted pipes to synthetic fabric covered drainpipes as used for prefiltering. Thus no gravel has to be used which simplifies the installation considerably. The link pipe work was adapted to the piping system in use within the water project.
The design capacity of the basic unit is 115 cu.m/d corresponding to a filter velocity of appr. 0.08m/s.

Experience

Sand for the slow sandfilter is taken from the sand banks in the river at low water level.
Installation time of the plant depends a lot on local conditions, available transportation and proper supervision. One unit with 2 raw water tanks and 2 sandfilter tanks was erected in one month. Two engineers, two local mechanics and 8

helpers were involved.
Prefiltering of the river water was found not necessary, although the turbidity of the Juba varies between 30 and 110 NTU.
Cleaning intervals average 3 months with water intake directly from the river. Filter speed appr. 0.05 m/h.
The cleaning consists of washing the filtermat (located on top of the filtersand) and scraping off a thin layer (appr. 3mm) of sediments on the sand surface.
Operation of the plant is extremely simple. Problems with our staff arose to operate the sandfilter plants continuously. They all worked before with chemical purification, which was a discontinuous process.
Water quality checks show no total coliform bacteria in the purified water when the plant is operated correctly.
The slow sandfilter plants have met the expectations so far i.e. after being in use for 9 months maximum.
4 plants are operating to date, 11 more will be installed to replace all chemical purification units.



Raw water and sandfilter tanks in Qorioley II refugee camp.

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

H S Mangat

Kyeni - rehabilitation of a rural water supply

1. BACKGROUND

In the last twenty years great emphasis has been placed by the public and Government in Kenya on development of Rural and Urban Water Supply Projects. A large number of schemes have been completed by Departmental Design and construction by direct labour or by use of Consultants for Design and Contractors for construction. During the same period action has been taken to train Technical and Administrative manpower for design, construction and maintenance of schemes. It is now possible to look back and carry out critical analysis of design, construction and maintenance procedures used and the operational aspects of various schemes. The Author had the opportunity to deal with Kyeni Water Supply Project in this context.

2. KYENI

Kyeni is a rural area located on the eastern slopes of Mount Kenya approximately 30 km from Embu, the Provincial Headquarter for Eastern Province. The water supply system was installed in 1972 to serve an area of 130 km^2. The area is 26 km in length with average width of 5 km situated between the valleys of Itembogo and Thuchi Rivers. The altitude of the area varies from 1100 metres to 1800 metres above MSL.

Kyeni is situate in the high and medium potential agricultural zone suitable for Tea, Coffee and Dairy Farming.

3. WATER SUPPLY SCHEME

The original scheme was designed to provide water to the population in Kyeni from communal water points situated at approx. 2 km intervals i.e. based on average of 1 km walking distances.

The design criteria used for calculation of demand was as follows:

"Water demand was calculated on basis of 450 litres/farm for number of farms existing at time of design (i.e. 1970 - 72). No allowance was made for water demand for Institutions, Trading Centres etc."

As the ground water potential of area is low and the rivers originating from Mount Kenya have perennial flow the supply is based on run of river abstraction. The water has been abstracted from the rivers outside the settled areas near the forest boundaries. The water is not treated prior to distribution.

The scheme is divided into two parts as follows:

1) High level zone with intake from Siangomo River at 1844m A.O.D. - 370 M^3/Day.
2) Low level zone with intake from Thuchi River at 1822m A.O.D. - 1130 M^3/Day.

4. REHABILITATION STUDY

After some years of operation many short-comings were noticed and there has been pressure from users for the improvement and rehabilitation of the scheme. The Government of Kenya with assistance from SIDA commissioned a detailed study to determine the shortcomings and improvements required.

5. EXISTING CONDITIONS

5.1. Details of scheme

The existing water supply scheme comprises of 49.5 km of uPVC water mains varying in size from 12mm to 150mm dia. and 12 No. storage tanks.

The tanks have been sited to work as break pressure tanks and also for balancing peak flows thus ensuring economy in pipe sizes. The scheme is provided with 160 communal water points out of which 2 are operational.

In practice it has been found that communal water point system has not worked.

At present there are 1800 individual connections and demand is increasing.

5.2. Population

The population of the area in 1979 was 21,427 and in 1983 it was 35,475. It is estimated that on the basis of growth rates of 3.7% (the growth rate assessed from 1969 and 1979 census figures amount to 3.65%) the year 2001 population will be 66,871. The current national annual population growth rate is around 4%.

5.3. Operational problems

The scheme as designed and built is not adequate to supply the demand in the area. There are large fluctuations in water pressure in the system and water does not reach some of the areas at times of peak demand. The operators have to ration water by turning on supply on a zonal basis. Farmers in the area have installed individual 5 to 10 M^3 corrugated iron steel tanks to ensure availability of water. There are frequent blockages in the distribution system. Pipes get blocked with silt, grass, roots etc. Water intakes on the rivers allow passage of silt and floating matter into pipes.

6. INVESTIGATIONS

6.1. Check on survey and preparation of plans

It was noted that the original longitudinal profile drawings for all the mains were drawn to scales of 1:24000 horizontal and 1:2400 vertical. These scales are very small and the design profile does not show all the high and low points occuring along the route of the mains thus resulting in omission of air valves and washouts at relevant points.

Site investigation also shows discrepancies between construction on site and the design drawings.

The pipelines in many places donot follow the ground profile. In certain places mains have been laid so that high points have been introduced while the ground itself may be falling or is flat.

The engineering survey for the pipelines was done to determine exact position of pipelines and the actual profiles so that a comparison could be made between the actual flows, design flows and maximum allowable flow in the pipelines, which could only be determined if the exact pipeline profile was known.

The new plans have been drawn to following scales:

Layout: Scale 1:25000

Longitudinal Sections: Horizontal 1:2000
Vertical 1:200

Trial holes were dug where necessary to determine exact positions and levels of the mains.

This work was started in January 1981 and completed by April 1981.

6.2. Design criteria

The design criteria used in the design of existing scheme was checked and compared with latest criteria established by the Ministry, after experience in operation of various schemes, and also compared with actual demands in the scheme area.

The existing water supply scheme had been designed for a capacity of 1500 M^3/Day. From the water demand calculations (section 6) it can be seen that the present water demand, based on the MOWD design criteria, is 2000 M^3/Day and the ultimate demand is 4326 M^3/Day in year 2001.

It was established that the current average consumption is 1300 litres per day per connection. This high consumption was partly attributed to loss of water through open taps; leaking taps; irrigation; storage of water in earth ponds; and generally unscrupulous use of water due to the fact that connections were unmetered.

The upper Kyeni intake on River Siangomo had been designed to supply 370 M^3/Day. This source has very low dry weather flow and therefore during some months of the year it cannot supply enough water to meet the present demand for upper Kyeni. Hydrological analysis of suitable sources was carried out to ensure that 98% probability safe yields are adequate to meet the estimated demand.

6.3. Operation

Operational aspects for the existing scheme were monitored under actual operating conditions. Each water supply zone has been studied over a period of 1 week under varying operating conditions to determine the following aspects:

1) Water pressures in the system.
2) Maximum daily flows in various parts.
3) Operating problems and their effects on the flow.
4) Design and construction defects.
5) Assessment of water demand.

Flow monitoring: In order to determine the operating characteristics of the existing scheme a flow monitoring study was carried out.

The locations of water meters and pressure gauges were pre-determined on a layout plan of the distribution system. Meters were sited in strategic positions so that water demand for each branch line could be determined and flow rates into and out of storage tanks established. It was also possible to determine hourly demand pattern for the consumers and thus establish peak flow requirements. Water meters were installed at the start of distribution mains and at storage tank outlets.

Pressure gauges were sited at start, middle and end of distribution mains or at existing air valve positions.

Flow monitoring was carried out under following conditions:

1st day - normal flow - no rationing

2nd day - normal flow - no rationing

3rd day - rationing

4th day - rationing

5th day - flow in main lines

6th day - flow in main lines

7th day - flow in one part only.

Pressure gauges and water meters were read every hour between 6.00 a.m. and 10.00 p.m. Field recording work was carried out by school leavers and 'O' level students at local schools under supervision of Consultants staff.

Typical flow monitoring record is shown in Fig. 1.

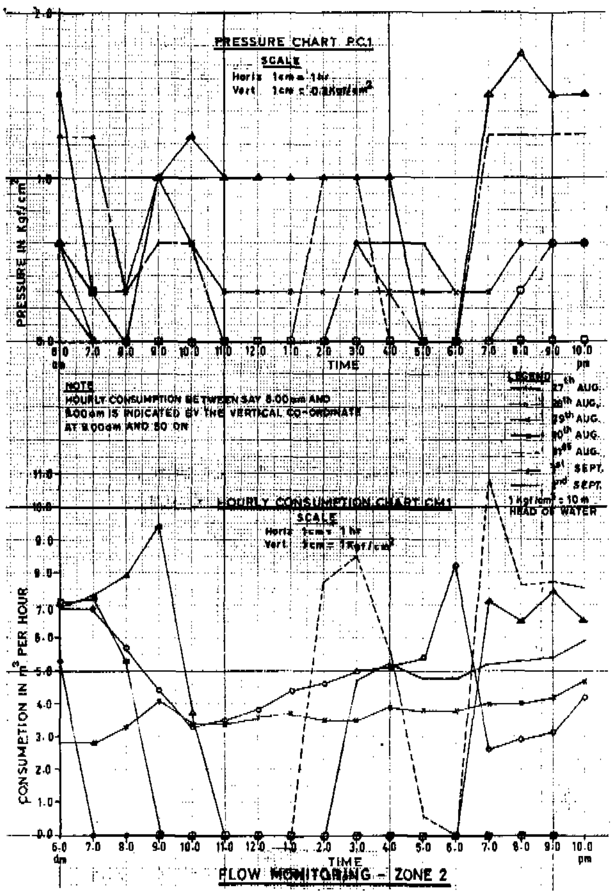


FIG. 1

6.4. Maintenance

The maintenance arrangements made by the Provincial Water Officer and the constraints of staff, plant, vehicles, spares etc. were studied.

6.5. Economic potential and future growth

The information relating to economic potential of the area and future growth was compiled and its effect on water supply system analysed.

7. WATER DEMAND

7.1. Land carrying capacity

In assessing the ultimate water demand for the area it is necessary to establish the total "land carrying capacity".

The number of people that can reasonably live in an area depends on agricultural potential of the area and the income level. The nature of development and type of farming at any particular time depends on market prices of produce, industrial and economic development in the country, political and socio-economic policies, training and incentives given to farmers and availability of farming inputs. It is therefore not possible to assume or adopt a specific model for future development of an area. The calculations in Table 1 indicate an average situation which is likely to arise and has already materialised in some parts.

Ministry of Agriculture has carried out studies to determine the minimum size of farm to provide subsistence level income for a typical family.

The water demand has been assessed assuming that 100% population will be served by individual connections and livestock units based on zero grazing.

It has been considered that a family with a gross margin of Shs. 2,500/= can live at subsistence level. The size of the farm required for this purpose is 0.6 Ha. for high potential zone which comprises of two thirds of the area of Kyeni.

For medium potential zone the farm size required for subsistence living is estimated at 2.4 Ha.

For cash earning farmers living above subsistence level additional area has been allowed on the basis of 0.6 Ha. and 2.4 Ha. respectively.

It has been assessed that at the stage when population of the area reaches the land carrying capacity 70% of farm land will be used by farmers for subsistence living and 30% by farmers having cash income in addition to subsistence living.

Details of calculation for land carrying capacity are as follows:

Table 1

Calculations for land carrying capacity - population

Total area of Kyeni	9,990 Ha.
Area of high potential zone	6,660 Ha.
Area of low potential zone	3,330 Ha.
a) High potential zone	
Area of the zone	6,660 Ha.
Less land area that cannot be used for farming - 10%	660 Ha.
	5,994 Ha.

70% of the land at subsistence level

when land carrying capacity is reached
Thus, number of farms = 0.7 x 5994 ÷ 0.6
= 6,993

30% of the land cash income level when land carrying capacity is reached
Thus, number of farms = 0.3 x 5994 ÷ 1.2
= 1,499

Thus, total number of farms in high potential zone = 6,993 + 1,499
= 8,492 farms

Population supported by 8,492 farms at 7 persons per farm family
= 7 x 8,492 = 59,444 people

b) Low potential zone

(The calculation as for high potential zone is repeated)

Area		3,330 Ha.
Less	10%	333 Ha.
Thus, farming area		2,997 Ha.

Farms at subsistence level
= 0.7 x 2997 ÷ 2.4 = 874

Farms at cash income earning level
= 0.3 x 2997 ÷ 4.8 = 187

Total number of farms in low potential zone = 874 + 187 = 1,061

Population = 7 x 1061 = 7,427 people

Total population of Kyeni when land carrying capacity is reached
= 59,444 + 7,427 = 66,871 people

This population for Kyeni will be reached in the year 2001.

The ultimate water demand for the area is given in Table 2.

Table 2

Water Demand

People		
100% population on individual connections		
66,871 people @ 50 l/h/d		3,344.0 m^3/d
Schools		
Primary - 17,272 pupils @ 12.5 l/h/d		215.9 m^3/d
Secondary - 7,402 pupils @ 35 l/h/d		259.0 m^3/d
Medical Centres		
2,900 out-patients @ 20 l/h/d		58.0 m^3/d
473 in patients @ 100 l/h/d		47.3 m^3/d
Trading Centres		
220 premises -		
25% @ 200 l/d	11.0 m^3/d	
75% @ 50 l/d	8.3 m^3/d	19.3 m^3/d
Extra demand for resident staff in institutions (Schools, Hospitals etc.) 2x241x7x25		84.3 m^3/d
		4,027.7 m^3/d

8. REHABILITATION PROPOSALS

The flow monitoring study together with the engineering survey has enabled the determination of the capacity of distribution system to transmit water in sufficient quantities and with adequate residual pressures. It has also been possible to determine the pattern of water consumption in the area. After completion of engineering survey it was possible to assess the design capacity of the scheme and identify sections of lines requiring vertical and horizontal realignments.

The rehabilitation proposals covered the following aspects:

1) Repairing, renovating and rectifying defects in existing scheme.
2) Augmentation of existing scheme to meet increased present and ultimate demands.
3) Setting up an operations and maintenance organisation with adequate personnel, equipment, offices and supporting services.

The proposal under 8(1) above covered installation of new air valves, washouts, realignment of defective lines, cleaning of existing mains, installation of screening and silt removal facilities at intakes, re-arrangement of distribution system from each intake to suit safe yield from the source, repairs to storage tanks and ancillary works. This work was estimated to cost KShs. 5.5 million (Stg. £1 = KShs. 18.9 - February 1985).

The complete rehabilitation and augmentation scheme was estimated to cost KShs. 28 million.

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SESSION F

CHAIRMAN:- Dr. Margaret Ince
WEDC Centre
Loughborough University of Technology U.K.

Discussion

1. Mr MBWETTE put forward the following questions relating to paper F5 (Appro- water Technology in Somalia's refugee camps).
(i) How is corrosion protection provided for the stee- containers (either inside or out)?
(ii) What is the pore size of the aritificial mats put on the slow sand filter beds?
(iii) What was the author's experience with regard to cleaning and refilling after scraping as opposed to the practice of cleaning without refilling?
(iv) What was the detention time of water in the storage units and the quality of improvement of the effluent?

2. Mr HARTUNG responded as follows:
(i) Water does not come into contact with the galvanised iron sheets. Somalia has a very dry climate so that few problems are expected, provided leakages in the link pipework are avoided.
(ii) The filter used is of a synthetic fibre with air conditioners. The pore size was not known.
(iii) As the amount of sand scraped off of the surface of the filter beds is so small it is not considered worthwhile washing it and refilling with it. However it was stored and could be washed and reused after some years when the sand was at its minimum.
(iv) The detention time is about 24 hours. One of the transparencies showed that the turbidity values (NTU) for raw water at the intake and outlet were 170-200 and 70 (while pumping into the raw water tank) or 20 (20 hours after ending pumping).

3. Mr ELLIS expressed interest in the use of synthetic membrane to replace the natural schmutzdecke and simplify the cleaning procedure. However the thought that the two-stage cleaning process indicated that the membrane had failed. He requested comments on this, plus indications of the amount and type of dirt removed from the membrane and the total coliform count of the water entering the membrane.

4. Mr HARTUNG explained that, although one definite advantage of the membrane was at cleaning, they were unsure of its full advantages. Future yield trials may determine the functions of the fabric. On cleaning the fabric contained river sediments and dead algae.
The faecal coliform count at the sand filter intake was approximately 500/100 mL.

5. Mr KONGOLA asked what was the cause of salinity in the gr-undwater and whether the salinity was localised or equally distributed throughout the country. He also wondered if the option of constructing a dam had been considered.

6. Mr HARTUNG said that salinity is a problem almost all over the country although there are areas of good groundwater too. The salinity is attributable to large gypsum deposits.
Dams have been built in Northern Somalia, a mountainous area; in addition subsurface dams in wadis to store run-off water underground have been successful.

7. Mr GREY informed delegates that much work on the hydrology and hydrogeology of dambos had been carried out in Malawi over the last five years. Experience showed that if there was mineralisation in the basement rocks generally associated with dambo development then there was often concentration of evaporites in the dambo - even to the point where gypsum deposits may be exploitable - and the groundwater was very saline. He wished to know if this had been observed in Zimbabwe.
In addition, he explained that 'Dimba' cultivation occurred on the margins of many dambos. This was commonly associated with incision and headward gulley erosion, presumed to be because reduced dambo area results in increased velocities of overland flow to a point where gulley formation starts. There was evidence of gulley sealing in areas where people moved out e.g. in National Parks. He concluded that the risks of dambo cultivation are therefore very real.

8. Dr. WINDRAM replied that salinity was not a problem in true dambos in Zimbabwe. However salinity in pans on sodic soil, predominantly in the middle and low velds, is often observed in areas of perched water tables.
Cultivation can result in erosion but it

is considered that appropriate conservation measures can easily control this and that unrestricted cattle grazing constitutes more of a problem.

9. Mr Van SCHAIK asked if any delegates had experience with using communal gardens to raise maintenance funds for communal water supplies.

10. Dr WINDRAM said that returns from market gardens given access to markets, fertilizers, fungicides and pesticides can be considerable. The most successful ones usually involve entrepreneurs, either individually or in groups.

11. Mr WILLIAMS commented on Paper F.3. (A.HORSFIELD) said that the dug wells shown wn the slides appeared to be of an appropriate design. He asked if the author had evidence that the diesel engine scheme proposed would be maintained and fuel supplied, bearing in mind problems experience elsewhere.

12. Mr HORSFIELD confirmed that the concrete lined wells with pulley blocks shown in the slides were of adequate construction. The problem in Senegal was that the groundwater level has been falling and shallow wells were drying up. As a short-term measure the shallow wells are often deepened in search of water. To ensure a reliable supply it is essential that the deep-lying aquifers of the Miocene and Maestriction sands be exploited by drilling boreholes 100-300 metres deep.
On the question of operation and maintenance of mechanised boreholes, he explained that a sub-division of the Ministere de l'hydraulique with specific responsibility for operation and maintenance of equipped boreholes was formed in 1949, and that it now maintained some 200 boreholes. The main workshop at Longa was adequately equipped to carry out routine servicing jobs. A quantity of spares and tools for Longa and a (new) workshop at Kolda was included in the project. However villagers themselves would be responsible for day-to-day running of the boreholes. They would have a trained 'Gardien' to check oil levels, fuel the pumps, check for oil leaks etc. Ideally the 'Gardien' would also help with the construction work in the village. In the event of a major breakdown a technician would bring necessary parts from one of the Central workshops.

The irregular supply of fuel was a major problem. Villagers agreed to voluntarily contribute about 5% of their average cash income, equivalent to 25-30% of running costs, with the government providing the balance. This type of system has operated satisfactorily in Senegal for some considerable time.

13. Mr WILLIAMS queried the introduction of British engines and pumps into a Francophone country where presumably French equipment predominates. He wondered if this would decrease standardisation and increase problems of spare parts and maintenance.

14. Mr HORSFIELD replied that the Senegalese had particularly requested British Lister diesel engines and that they were more than happy with the choice of Mono pumps. As the Senegalese were familiar with both these items of equipment there should be no increase in the problems of spare parts and maintenance.

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N C McHalle

A critical review of the water and sanitation Decade in Tanzania

Way back in 1971, the Tanzanian government adopted a twenty year programme (1971-1991) the primary objective of which was to provide potable water to all by the year 1991. This programme was further reinforced by the launching of the Water and Sanitation Decade (1981-1991) by the United Nations.

At the time of launching the twenty year programme, it was estimated that about 10% of the rural population had access to safe and adequate water, while the urban population with potable water accounted for about 50%. Four years later, that is in 1975, the World Bank Technical Advisory Group carried a survey and the results for Tanzania showed that only 17% of the rural population were served with potable water while the figure for urban areas had risen to 68%. The figures for 1980 were 28% for rural areas and 82% for urban areas.

Let us look into these percentages in terms of numbers of people. From the 1978 census, the population of Tanzania mainland was estimated at about 17 million, 87% of which live in the rural areas (14.8 million people). With an average annual growth rate of 3.2% the projected rural population for 1980 and 1991 would be 15.8 million and 22.3 million people respectively. So up to 1980, out of the 15.8 million people living in rural areas only about 5 million people had access to adequate and safe drinking water.

An ideal situation would have been a linear curve whereby the 10% figure of 1971 rises linearly to 100% in 1991. (curve no. 1). In this case, by 1975, 28% of the rural population would have been provided with potable water while 50% would have been served by 1980 and the figure should have risen to 73% by the year 1985. As shown by the survey, things have not worked out that well. If the present trend is to be maintained, then Tanzania will be able to provide only 50% of its rural population with adequate water by the year 1991. This will be off the target by 50% (curve no. 2).

To attain the 1991 target, a certain parabolic hypothetical curve could be adopted. From this hypothetical curve, 42% of the rural population will have to get adequate supply by the end of 1985. Three years later the figure is supposed to rise to 75% and by 1991, the whole of the rural population will have access to clean water, (curve no. 3).

Given the present economic situation not only of Tanzania but the world as a whole, no sane man will believe that such an enormous task could be accomplished in the period in question.

If we extend the deadline to the year 2000, things won't be that easy either. It should be recalled that this year (2000) is also the deadline for a WHO programme "Health for All". Using the 1980 data as the reference, and assuming a linear trend, then curve no. 4 indicates that, in 1985, about 46% will be served. By 1990, 65% will have clean water while 85% will be served by 1995. Assuming a trend similar to that of 1971 to 1980, the backlog in the year 2000 will be 35% or 7.8 million people. (Curve no. 2).

The achievements in water supply are quite remarkable. Regional water masterplans have been completed for seventeen regions out of a total of 20 regions. The shallow wells project in Morogoro, and Shinyanga, is in progress though there has been a lot of drawbacks. A good number of wells have been closed either due to low yield from the wells or poor quality of water. This indicated that proper investigations (hydrogeological and microbiological) were not carried out before the wells were constructed. This has greatly affected the credibility of the technology especially in Shinyanga Region. Sumbawanga Region is currently being provided with a water supply system through NORAD. The Wangingombe water supply project is nearing completion. The list presented herein is not conclusive. These are many small projects under the various Regional Water Engineers and the total effect is as has been found from the World Bank survey.

Whereas water supply in urban areas was not a crucial issue compared to the rural areas, sanitation in urban areas is also in a terrible state. Figures from the World Bank Team indicated that, in 1975, only 25% of the rural population had adequate disposal facilities. The figure had risen to 40% by 1980. In 1975, 8% of the urban population were connected to public sewers and 54% had either a pit latrine, septic tank or a soakaway pit. By 1980, 12% of the urban population were connected to sewers while 81% had an on-site disposal facility. About 7% have no proper facility at all.

Going through the various efforts of the government (in collaboration with aid agencies) it is sad to note that sanitation is still being taken lightly. For example, there are so many projects of water supply in the country against very few sanitation projects. The Wangingombe sanitation project which is part of UNICEF's special assistance programme to Tanzania is about the best example. USAID is running a primary school health project in Dodoma and Singida Region while the World Bank through the Ministry of Lands and National Resources and Tourism has put up a few demonstration VIP latrines in Dar es Salaam. At the national level, these are about the only projects. Indeed, at this rate, we are sure of going through the decade with very little to be proud of as far as sanitation is concerned. The Decade is turning out to be a Water Supply Decade. Whereas it is normal for governments to provide subsidies for urban and rural water supplies and urban sanitation, no such subsidy is considered for rural sanitation. There has to be a clear government policy on sanitation which should spell out the level of subsidy since it affects affordability and choice of technology.

So as to speed up the provision of proper sanitary facilities in the country, it is necessary to include the sanitation component in water supply projects. Rural water supply and sanitation projects should be planned for concurrent implementation so as to minimize the costs of support, promotion and health education.

The government has, however, moved several steps forward as far as educating the masses is concerned. Several campaigns have been lodged and their outcome was quite satisfactory. Among the most remarkable was the "Mtu ni Afya" campaign which was conducted in 1973/74. Essentially, this was an environmental health programme with a bigger element of sanitation. At the end of the campaign, the general population had created awareness of the common environmental problems. Unfortunately, the many campaigns we've had do not supplement each other. For example, after the "Mtu ni Afya" campaign came the "Chakula ni Uhai" or "Food is Life" and the environmental problems cited in the first campaign were not emphasised in the second campaign.

The issue of training is of paramount importance to the entire water and sanitation programme. People must be trained at all levels. It is encouraging to note that the government indeed took a positive move towards this direction by establishing the technicians course at the Water Resources Institute and the Department of Public Health Engineering at the Ardhi Institute. The Water Resources Institute trains technicians who are supposed to work in the rural areas maintaining the water pumps and other water equipment. So far, the Institute has trained 750 technicians. If these were to be distributed equally to all twenty regions, then each region will have about 35 water technicians. This is not a small number. But you will be surprised that a good number of water projects are not functioning properly and the reason one gets is lack of trained personnel. Are these people really being utilised?

The department of public health engineering offers professional courses in public health engineering. The graduates of this course are expected to work mainly in urban councils and once their demand in these councils is sufficed, they will be involved in rural areas. The first output was received with very little enthusiasm. In a good number of urban centres, the response was "we do not need a public health engineer at this moment". Which town in Tanzania can claim that the state of its standpipes, sewers, storm-water drains is so good that not even maintenance is required? Why then are these people not so welcome? In most urban centres public utilities are under the Health Department. This is headed by a Health Officer. One would therefore hope that the Public Health Engineer and the Health Officer will team up to provide the best services. This has not been the case.

Training at lower levels has been done through the various projects. That is, each project trains its own operational staff in villages. The Dar es Salaam demonstration latrines were constructed on the belief that people will copy the example and put up their own structures. Local funds participated in this exercise too. Instead, the structures have remained beneficial to those who were lucky to get them free of charge.

The above notwithstanding, it must be remembered that the decade came at a time of extraordinary world-wide recession and financial austerity. The government, with limited resources has been trying hard but we believe it could do better. Now there has to be a shift of emphasis from water supply to sanitation. Friendly countries as well as aid agencies have poured into the country a lot of money in terms of equipment and personnel. While we acknowledge this assistance, we would like their efforts to be properly coordinated. For example, UNICEF, USAID, DANIDA, FINIDA etc. should draw up a training programme where villagers from other parts of the country could learn the technology. Whereas it is difficult to replicate a project due to the many variables involved, it might be possible to replicate the various strategies. As such, we must have people equipped all the time.

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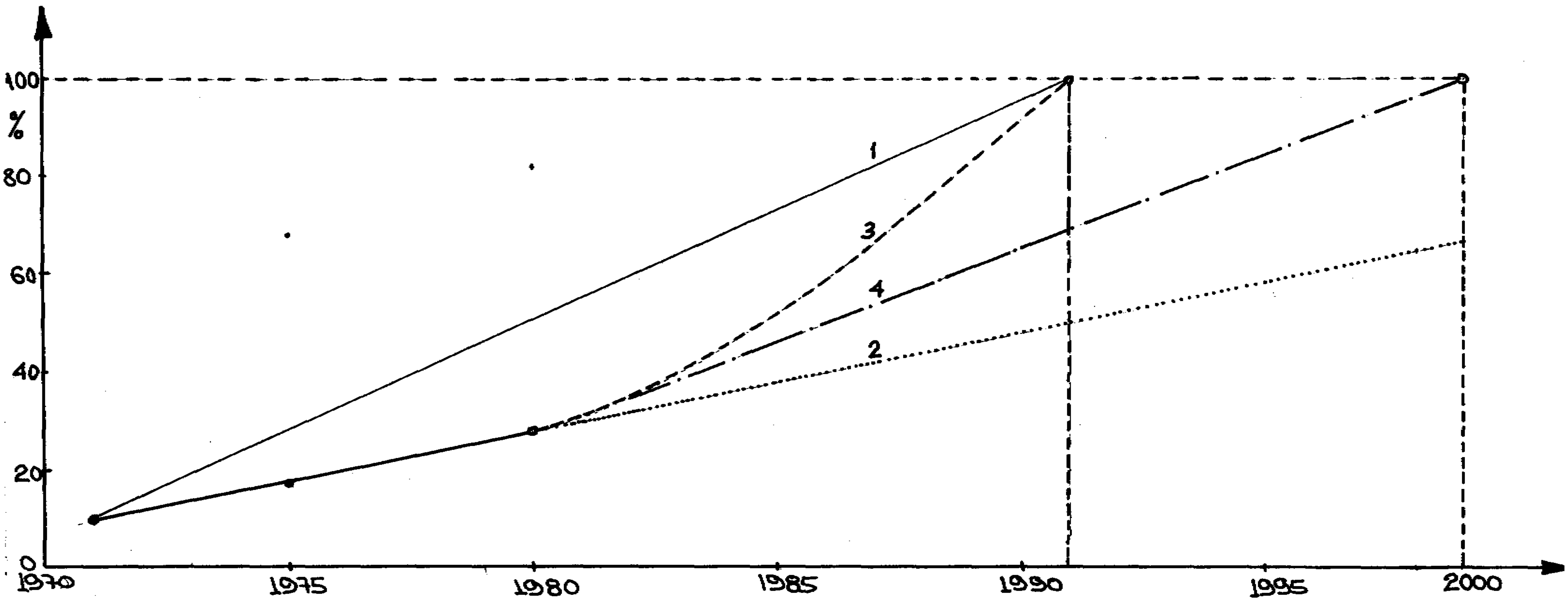
RURAL WATER SUPPLY IN TANZANIA



WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

Dr D M Todd

Political, legal and administrative constraints on appropriate sanitation policies in Zambia

INTRODUCTION

A critical problem in implementing alternative sanitation policies in many Third World countries is that of persuading policy makers at national and local level that alternative sanitation is an acceptable option. In Zambia, few such politicians and administrators have been convinced of the necessity to pursue the matter urgently, since the dominant viewpoint remains that waterborne sanitation is the only suitable system, and that this will be provided for all at some unspecified time when the economy takes a dramatic upswing. In the meantime, unlined, unimproved pit latrines proliferate in the expanding squatter settlements, leading towards an inevitable sanitation crisis.

In this paper, I attempt to pinpoint the main obstacles which prevent the adoption of an appropriate national sanitation policy. These can be summarised as; entrenched housing inequalities, legal barriers, the division of responsibility for sanitation between various Ministries and Agencies, the inadequacies of National and Urban Development Planning, the lack of appropriate research, and the fragmentary nature of development aid.

I concentrate on urban sanitation, because I believe this to be a more urgent problem than rural sanitation in Zambia for the following reasons; firstly, the urban areas already contain over forty per cent of the population, and this proportion will rise as the young age structure gives rise to natural increase. Secondly, the "standards" issue is more critical in urban areas, where pit latrines are more unacceptable to politicians than they are in rural areas. Thirdly, urban land is relatively scarce, and dwellings are close together in squatter settlements, leading to a time limit on pit relocation. This dimension is absent in the rural areas, allowing a certain "breathing space" in which to find solutions there.

HOUSING INEQUALITIES

Sanitation policies are inextricably linked to the provision of low-cost housing, and can only be presented in that context.

Zambia's colonial inheritance in the housing field consisted of a dual structure - a few palatial residences previously occupied by the white minority, and a substantial but inadequate number of mainly sub-standard dwellings occupied by the African workforce. After Independence, there was a rapid influx of migrants to the urban areas, causing a housing demand which far outstripped supply.

The Independent Government had to be seen to be reducing inequality in the housing field, but chose to do so by raising standards at the lower end, without reducing those at the top. Local Authorities were even more determined that "low cost housing" should be of high quality, including mains services and water closets. The result of this pursuit of quality was an ever-increasing backlog of urban dwellers with no formal housing, forced to live in unauthorised settlements without even the most basic facilities.

Gradually, reality caught up with the Government, and "alternative" housing policies, such as site and service housing and squatter upgrading were reluctantly espoused. However, this trend was undercut by a fundamental weakness- a system by which those in well-paid jobs receive, in addition, large subsidies on the rental of their fully-serviced houses. In the meantime, those living in Council houses must pay what is intended to be the full economic rent for their accommodation.

The extent of housing subsidies for Civil Servants and parastatal employees can be demonstrated from housing expenditure figures during the Second National Development Plan period. Institutional and Civil Service housing construction (high and medium cost) received Kwacha 84 million (K1.00 equals £0.38 in February 1985), fifty per cent above the budgeted level, whereas the general housing programmes (mostly low-cost, including squatter upgrading) received only K57 million out of an allocated K100 million. At the same time, the annual subsidy on housing for Civil Servants and parastatal employees was in the order of K90 to K100 million (ref. 1).

The impact of housing policy on the acceptability of alternative sanitation is therefore very clear. The Government has reluctantly moved towards policies accepting lower standards, including squatter upgrading and it is likely that it would be willing to embrace alternative sanitation as part of this package. However, in practice, it has continued to spend most of its money on high and medium cost housing, and therefore on waterborne sanitation. Only if the Government can be persuaded to align its resource allocation to its stated intention to improve housing for the majority will alternative sanitation have any chance of being implemented on a large scale. Those interested in promoting new methods must therefore first promote an equitable housing policy.

The next barriers to progress in this field can be found in the legal system, to which I now turn.

THE LAW AND SANITATION

The two most important Acts relating to sanitation are the Public Health Act and The Local Government Administration Act. Under the Public Health Act, it is stated that a Council may require anyone under its jurisdiction using any type of toilet other than a water closet to convert it into one "within a reasonable time". Further, the supporting Regulations of the Act declare that no pit latrine can be constructed without the written approval of the Local Authority, which will dictate the materials to be used, and the design which is approved by the Medical Officer of Health.

These rules are, of course, not applied, but their continued presence can be seen as discouraging the development of an appropriate sanitation strategy. The next major problem is the political and administrative system.

SANITATION POLICY AND ADMINISTRATION

The Development of a coherent sanitation policy is hindered by the plethora of National Ministries and Agencies which deal with the topic, and by the diverse Departments at Local Authority level.

Nationally, the Provincial and Local Government Administration Division has taken over the responsibilities formerly held by the Ministry of Local Government and Housing. The National Housing Authority and the Department of Town and Country Planning also come under the same Division, which is headed by a Minister of State, and thus has less capacity than does a Ministry to ensure that its requirements receive priority. The aim of the change was to decentralise control of Local Authority housing to the relevant areas. While this no doubt has virtues, it also reduces the capacity to develop innovative National approaches.

Sanitation is also clearly of interest to the Ministry of Health, both for its Planning and Development, and Medical Care and Preventive Medicine Sections. The Ministry of Agriculture and Water Development's Department of Water Affairs also has an importnat role in this area, although its expertise lies mainly in waterborne systems.

Additionally, The Ministry of Works and Supply is responsible for Civil Service housing, a major consumer of sanitation; while the Ministry of Labour and Social Services also enters the field, through its Community Development Department.

Given the complex web of Ministries and Agencies which might claim some say in sanitation policy matters, the simplest tendency is towards inertia.

At the Local Government level, sanitation also suffers from being of concern to several different Departments. A study conducted in the then Lusaka City Council showed that co-ordination between the Public Health and Sewage Sections was very poor, leading to wholly inadequate maintenance performance. Although Public Health officials had to oversee emptying of aqua-privies, for example, they had no idea of the maintenance requirements of the particular system, which had been constructed by the Engineering Section. They thus tended to pump out the liquid and softer solids, and leave solid waste in the tank, uncovered by any water seal (ref. 2). Clearly, it is not reasonable to expect junior Public Health officials to know how an aqua privy operates unless they have detailed liaison with Engineers regarding the specific design features of the system.

Similarly, because construction is carried out by Engineers, and maintenance by Public Health workers, it is impossible to obtain accurate information concerning the overall relative costs of the various systems. Engineers and Public Health Workers in Lusaka still think mainly in terms of extending the sewerage system, while it is mainly officials in the Housing and Social Work Sections who have a realistic view of the situation in the low income settlements.

Unfortunately, the Council is not structured for effective interdisciplinary action.

Contact between the Standing Committees of Senior Officers, which present policy measures to the Lusaka Urban District Council meetings, and field staff in the settlements is minimal. Only under the special organisation of the Lusaka Housing Project Unit was there regular two-way communication, notably through weekly meetings at which Field Team leaders met with Head Office Staff to discuss difficulties in operationalising policies. This has not been repeated in later upgrading projects in Lusaka.

Even major Councils, such as the Lusaka Urban District Council, have no research units, although since the Government system was decentralised in 1980, they have enormous powers and responsibilities. This promotes a strong tendency to continue operating along the familiar lines, which have achieved a degree of success in the past. New developments are not given top priority.

Those interested in propagating the promotion of suitable sanitation systems must therefore address themselves to the issue of co-ordination at both national and local levels if they are to have any chance of success. The lamentable failure to develop policies or actions in this area in the past is well illustrated by National and Urban Development Plans.

SANITATION IN NATIONAL AND URBAN DEVELOPMENT PLANS

In Zambia's three National Development Plans there has been progress towards affordable sanitation as a policy for low cost housing, but this has not yet led to action. Thus, in the First N.D.P., sanitation did not appear as a topic. Under the Second N.D.P., the concept of squatter upgrading was introduced, but sewered systems were proposed. No budgetary provision was made for sanitation projects nationally.

By the time of the Third N.D.P.. the urgency of the housing and related sanitation situation was indicated. The Plan states that eighty per cent of new urban households can only hope for partly serviced plots, without waterborne sanitation. It concludes that "alternative sanitation methods will be used. Government will, therefore, pursue actively a sanitation research programme, designed to introduce an economic solution to sanitation in low-cost housing areas" (ref. 3). However, no funds whatsoever are allocated for such a research programme, although 29 sanitation and water projects of a "conventional" nature receive budgetary provision.

The T.N.D.P. specifies the National Housing Authority as the Agency which will conduct the research, even though it has no research budget, and such activities are therefore restricted to what can be subsidised out of house sales and rentals, or externally financed. Inevitable, this implies very lengthy delays. Although N.H.A. is seen as playing a central role in the development of a national sanitation policy by the TNDP it is not represented on the National Action Committee of the International Drinking Water Supply and Sanitation Decade, which is currently drawing up a national plan for these facilities. This again illustrates the fundamental lack of co-ordination in the sanitation field.

If the National Development Plans have had minimal impact on sanitation policy, Urban Development Plans have failed even more comprehensively. Four Plans, dealing with areas of different size, were investigated-those for Kitwe (364,000 in 1978), Chingola (134,000 in 1975), Livingstone (43,500 in 1975), and Mpika (8,000 in 1975). All list schemes for the extension of waterborne sanitation, but none make any mention whatsoever of alternative possibilities.

Clearly, the concept of alternative sanitation has not found its way into the consciousness of those responsible for planing Zambia's urban areas, whether they be internal (National Housing Authority), or external (Doxiadis). Here again, before progress can be made, planners need to be re-educated.

ALTERNATIVE SANITATION RESEARCH AND PROJECTS

Despite its early start in alternative sanitation (with aqua privies in the 1960's) Zambia now lags behind many of its neighbours in East and Central Africa. A study conducted by the National Housing Authority in 1979 recommended certain systems for field trials. The fact that no follow-up study has resulted indicates that the research was not part of a continuing development strategy.

However, when the National Housing Authority was given the task of implementing the first European Development Fund Sites and Services Project in six District Centres in rural areas, the sanitation provision was to be Ventilated Improved Pits, although the option of installing a w.c. to septic tank was also available. The six participating Councils were to take responsibility for organising self-help construction, technical assistance and so forth, with direction and assistance from N.H.A.

Unfortunately, project implementation does not seem to have followed the approved direction, since most participants have built ordinary pit latrines, rather than V.I.P.s. It appears that while the N.H.A.'s construction co-ordinators were briefed on the correct V.I.P. construction, they did not pass this on to the Councils' Assistant Co-ordinators or to participants. Furthermore, no demonstration units were constructed in order to spread knowledge of the new design and its benefits, and the specially constructed vent pipes were not generally available. As well as these operational difficulties, it seems that some of the Councils concerned were of the opinion that a new housing scheme using pit latrines could damage their perceived prestige.

It is clear that much detailed preparatory information needs to be given to Councils of all sizes, if an innovative toilet type such as the V.I.P. is to be introduced. Central and Local Government Officials generally regard such ideas as unacceptable, and as a lowering of standards. Such is the tradition of collections problems, subsidies, and so forth, among Local Authorities that affordability to consumers and Councils is not yet seen as a primary consideration. Expectations as to what can and should be provided are still far too high.

INTERNATIONAL AID AND SANITATION

In 1975, the World Health Organisation and the IBRD jointly prepared a Water Supply and Sewerage Sector Study for Zambia (ref. 4). Unfortunately, this simply proposed vast expenditure to extend waterborne sanitation wherever it was needed, and it rapidly became another shelved report of merely historical interest.

In 1979, the National Housing Authority study was financed by the International Development Research Centre of Canada, which has played a major role internationally in the alternative sanitation field. It is not, however, an implementing agency. UNICEF is showing interest in beginning "environmental sanitation" projects, while UNCHS is training Housing Officers and related personnel in upgrading techniques. The EDF is promoting Sites and Services projects with VIPs, and the Finnish Government is aiding the NHA. The International Drinking Water Supply and Sanitation Decade promises a flurry of activity over a limited period.

All of these international efforts will no doubt make worthwhile inputs, but the critical problem is how to work out a sustained and consistent approach to the development and implementation of an appropriate sanitation programme throughout Zambia. At the moment, a sense of direction and commitment is lacking, largely because of the related factors discussed earlier. Unless this sense can be developed, it is certain that no substantial progress will be made. If foreign aid is to make an impact on the problem it will need to be much more closely co-ordinated than it has been thus far.

CONCLUSIONS

If alternative sanitation is to establish itself in Zambian development policy, a radical change in thinking at the levels of Central and Local Government is necessary. Unless sanitation experts realise this, their efforts will produce only disjointed pockets of change. Sanitation must be considered as part of the overall problem of housing provision, since the "appropriateness" of a latrine is inevitable judged in relation to the housing area in which it is located.

If appropriate sanitation is to reach a substantial proportion of the population, it will therefore be necessary to reduce the amount of money spent on high and medium cost housing construction,completely realign the subsidy system to favour low income families, and concentrate on "upgrading" squatter settlements and providing "basic" serviced plots.

In the area of legislation, the preoccupation with positive prescriptions for sewerage reticulation, and negative references to other systems needs to be revised. Alternative sanitation needs to be legitimised, and impractical, redundant, regulations removed.

With regard to the numerous Ministries and Agencies involved in the field, co-ordination must become regular and permanent. The NHA should be strengthened, adequately funded, and given responsibility for relevant research. Co-ordination is also essential at the Local Government level. Accurate records concerning different sysyems must be kept, and a local research capacity founded.

In urban and national planning, alternative sanitation programmes must be specified and funded. Trial projects should begin with intensive briefing of Council Officers, and demonstration units are essential. External aid must be co-ordinated by NHA to reflect Zambian priorities.

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WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

Timo Vuori

Good drinking water at low cost for one million people in western Kenya

GENERAL

The Rural Water Supply Development Project in Western Province of Kenya is based on the Agreement on Technical Cooperation between the Governments of Finland and Kenya, signed 1975. The Project was started in April,1981 with a mobilization, planning and design phase. During 1981 - 1983 the water supply development plan was elaborated through extensive field investigations including surface and groundwater reviews, a test drilling program, and construction of a series of test wells. The First Implementation Phase of the Project was launched November,1983 and will end December,1985. The Ministry of Water Development of Kenya and the Ministry for Foreign Affairs of Finland have jointly accepted the joint venture Kefinco to execute both phases just mentioned. Kefinco has been established by YIT Ltd. (General Engineering and Contracting Company) and Finnconsult Consulting Engineers, both from Finland.

PROJECT AREA

Population

The Project area consists of four districts, Kakamega, Busia and Bungoma from Western Province and Siaya from Nyanza Province, covering altogether about 3700 km^2 and 0.85 million people, i.e. population density 230 persons/km^2. Population growth is about 3-4 % annually. The area is mainly rural, the urban places of the area were excluded mainly because their water supply had already been constructed to a certain extent.

Rainfall

The mean annual rainfall of the area varies between 1100 and 2000 mm, the mean annual pan evaporation ranging from 1600 to 2100 mm. The annual mean of the daily minimum temperature varies from 14°C to 16°C and the annual mean of the daily maximum temperature from 26°C to 30°C.

Geology

The Project area is on a gently sloping peneplained surface, south of Mt. Elgon and west of Nandi Escarpment. In the west the Project is bound by Lake Victoria and the Ugandan border. The main rock type is granite which is intrusive to both Kavirondian and Nyanzian system rocks. The granite is usually medium to coarse - grained biotite type, often porphyritic. Part of the area consists of Nyanzian volcanics. Sedimentary rocks lie in western and south-western parts of the project area. Superficial deposits, with the exception of laterite, are not common.

Economy

Among the eight provinces of Kenya, Western Province is No. 7 by per capita income, the current average figure being in the project area in the region of 1500 KES per capita annually. More than 95% of people earn their living from agriculture and livestock in small farms, a few hectars at best. Foodcrops consist of maize and cassava, and cashcrops of sugar cane, coffee and cotton.

Water Supply before the Project

The first idea the Project personnel gained from the area was that the water resources, both surface and groundwater, were apparently substantial and quite under-exploited, and uninvestigated. In thirteen months the known list of 30 springs amounted to about 3000 springs and the groundwater resources only were estimated to be ten times bigger than the potential water demand in 2005, of 1.7 million people, making about 5% of the whole Kenyan population. Only a few percent of the people in the project area were within organized water supplies, mainly small piped schemes, frequently failing. Rivers, springs and at worst, occasional ponds of rainwater, served as sources of water. Some hundreds of private wells were identified but they were uncovered without pumps or any other advanced devices for lifting the water, all very much susceptible to contamination. In certain areas, although sporadically, cholera is an annual visitor.

CHOICE OF TECHNOLOGY

It was estimated that piped water all over the project area could cost up to 1.7 billion KES (1 £ = 17.81 KES on 27 Feb.1985) up to 2005 while low-cost alternatives were probably to save roughly 80% of that money resulting in the total of approx. 0.34 billion KES. These calculations were based on the following per capita investiment costs: piped water 1000 KES, low - cost technology (handpump wells and spring protections), 200 KES. This dramatic difference in investment is further emphasized by the fact that the annual running costs of piped schemes were estimated to be in the region of 30 - 40 KES per capita and those of low cost in general less than 10 KES per capita. A general conclusion was also drawn that handpump wells and spring protections are for the time being most appropriate solutions at the current development stage of the area, compact piped water alternatives were evaluated to be feasible in the small centres of the project area.

WATER SUPPLY DEVELOPMENT PLAN

The Government's and also the Project's long term objective is to provide the entire population of the project area with the benefits of a safe supply of water by the year 2000. This objective can be fulfilled most economically, and still keeping a good service level, by constructing 7000 handpump wells and 1500 protected springs for 1.6 million people. An augmentation of the present piped water system or a construction of a new piped scheme will be performed for three urban and eight rural centres with a total population of 0.1 million people. In addition, all existing piped systems outside the urban and rural centres are proposed to be rehabilitated.

I Implementation Phase Nov 1983 - Dec 1985

The current phase includes the following components:
- Construction of altogether 845 handpump wells and 120 spring protections
- Design and construction of two piped water supply schemes, (Butula, Chwele)
- Rehabilitation of six existing piped water supply systems, (Kakamega, Shikusa, Malava, Alupe, Sega, Moding)
- Monitoring the quality of water in the wells of the project and monitoring the utilization of handpump wells,
- Achieving an operation, maintenance and revenue collection system for the handpump wells,
- Continuation of the hydrogeological field investigations,
- Preparation of training programme and commencement of its implementation, and
- Preparation of the programme for the Second Implementation Phase 1986 - 1988.

By the end of 1984 the Project has reached almost half of the above figures, this means that the programme is executed according to the schedule.

Costs and Financing

The cost of the First Implementation Phase up to the end of 1985 is estimated to be 85 mill KES, from which 75 mill KES on grant terms from Finland.

TECHNICAL SOLUTIONS

Hand-dug wells are normally lined with concrete rings, diameter 80cm - 100cm. Brick-lining has been tested but so far the results were not very promising. Special attention is paid to the general arrangement of the above ground part of the well, a proper concrete slab with drainage downwards, preferably to a small vegetable garden, can hinder contamination of the well.

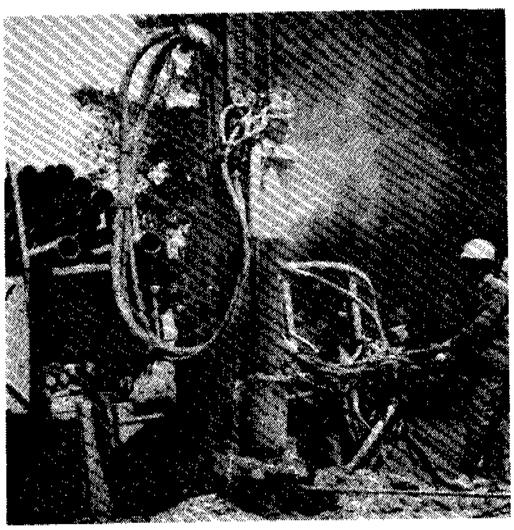
Hand-digging of a well

No more extra miles to walk for water

A spring protection consists of retention wall, filter bed, shielding plantation. Where applicable, hydrams are installed, they are manufactured locally at Weco, see below.

Drilling is carried out by two rigs, AQADRILL 661 and ROTAMEC 50. Steel casings are used to help to penetrate the loose overburden. All wells are testpumped and furnished with proper PVC-casings and screens. Annual production is approx. 200 boreholes, average depth about 50 m. All drilling places have been carefully sited with seismic soundings.

Spring protection furnished with a locally made hydram.



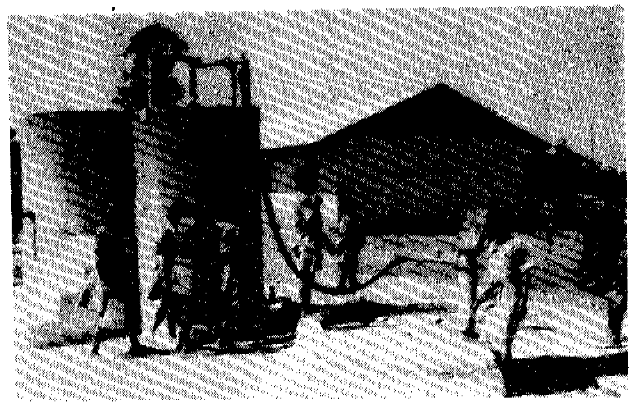
Drilling is the option for the driest areas.

WATER QUALITY

In general, the groundwater quality of the area is quite acceptable. Fluride does not occur in concentrations above 0.5 mg/l and excessive amounts of chlorides are quite rare. Iron above 2mg/l seems to characterize about one fifth of the borehole wells. Measures have already been taken to tame the problem and the Project has developed a practical low-cost iron removal system for handpump wells, it is already operated at two schools.

COMMUNITY PARTICIPATION

It was realized in the very beginning that the beneficiaries must be involved both in the implementation and maintenance of water supplies, as well. Community development



Iron removal at Lusumu Primary School. The handpump is locally made.

officers of the Project start to activate the wanainchi at least one month before construction starts. The local leaders have been informed on the Project's phisosophy, targets and conditions for wanainchi. At hand-digging sites, people have to dig down to the groundwater level before the Project group comes to complete the well. At spring protection sites, people have to collect construction material like stones for the work. There is a precondition that the pump will not be installed before the well committee is formed and active, as an indicator of which funds collection for future maintenance is one of the most reliable.

MAINTÉNANCE OF HANDPUMPS

It has become quite obvious that the rural people cannot afford multimen maintenance groups mobile with four- wheel vehicles. The Project has, since the implementation started, worked to develop a system in which bigger repairs could be carried out by private fundis paid by the well committees, moving with bicycles fitted with toolboxes. The minor faults should be fixed by the pump attendants, every well committee is supposed to appoint one . The training of the fundis is mainly on-the-job based, the pump attendants are educated in groups of thirty in their own locations. The project has developed education and training material from its field experiences. The consumers' price consciousness has been developed. Every committee has the recommended prices for different spare parts, labour and transport. future handpump development will play a major in the success of village level maintenance.

Information on Handpump Maintenance Costs of the Year 1984.

Labour costs

	2 foremen - drivers	4 helpers	4 trainees	Total
Salary	36 000	38 400	26 400	100 800
Night allowances	49 500	66 000	26 400	141 900
Housing allowances	14 400	7 200	-	21 600
Overtime	15 000	15 000	12 000	42 000
Total	114 900	126 600	64 800	306 300

Transport Costs	KES
Annual capital costs of 2 Land Rovers (10% interest 4 year repayment time) 0.316 x 2 x 210 000 KES/year	132 700
Maintenance of the vehicle 1 KES/km x 80 000 km	80 000
Fuel	
15 1/100 km x 80 000 km x 6 KES/1	72 000
Tyres	
4 tyres/25000 km, 13 x 1900 KES	24 7000
Insurance	2 000
	311 420 KES
Spare parts	60 000 KES
GRAND TOTAL	667 700 KES

The project maintenance teams have installed 220 handpumps and repaired 350 breakdowns during the past year. The exact division of costs is difficult to make because both teams have maintained and installed handpumps simultaneously. The average costs of maintenance and installation activities in 1984 were approximately as follows:

Installation (39% of salaries and transportation costs)	244 800 KES/year
Maintenance (61% of salaries and transportation costs + spare parts)	432 900 KES/year

The average cost of a handpump installation was appr. 1113 KES and the respective repair cost was 1237 KES. The latter figure lays stress on the importance of village level maintenance system and handpump development work.

A baraza, well committee members and the appointed repairman.

Today, two fundis trained by the Project operate within an area of about 80 wells. By the end of the year, at least half of 800 wells will be under similar care. In the meantime, mobile groups are repairing the pumps but even in those cases we insist on full payment by the well committee according to the price lists.

HANDPUMP DEVELOPMENT

The Project started the test well production with Finnish NIRA- shallow well pumps. Very soon it become obvious that about half of the wells demend a deep well pump. Two years ago, in 1983, the project had one INDIA Mk II pump manufactured locally at WECO, Western College for Arts and Applied Sciences, Kakamega. The institute is supported by DANIDA. This year the project will buy more than half of the pumpheads needed, 250 from WECO. In addition to that, the riser pipes and piston rods to all pumps are made locally, only the cylinders are imported so far. Local manufacturing of handpumps seems to offer several advantage over imports such as

- quick and reliable deliveries of pumps
- chances for immediate modifications and improvements.
- improved availability of spare parts
- positive impact on employment
- increased interest of local people and authorities in the low-cost approach in general. The project has ordered 250 pumps for 1984 and other orders to WECO amount to 150 pcs.

Quality of the pumps has been surprisingly good, not a single problem with the pumps cannot be attributed to the local manufacturing.

ABSTRACT

Rural Water Supply Development Project in Western Kenya was initiated in 1981 as a part of technical co-operation between Kenya and Finland. The Project represents implementation of low - cost technology in a big scale, the project population is altogether about 5% of the whole population of the country, about 1 million people at the moment. The project was started with an investigation and planning phase when the water resources of the area were studied and the water development plan elaborated. Implementation started November 1983. By the end of 1985 about 400 borehole wells and the same of hand-dug wells will be constructed, equipped with handpumps, and 120 spring protections will be made as well. A few existing piped supplies are to be rehabilitated and two compact schemes constructed. The main target, however, is not the maximum amount of water points produced but promoting the establishment of village level maintenance system for the wells and the pumps. The target is approached through intensive community participation activities. The first pump repairmen are already working in the area mobile with bicycles and tool boxes. They are paid their services by the well committees. Local manufacturing of handpumps is one of the target areas of the Project, as well. The second phase of the Project, under planning right now, will start 1986.

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

K. Lesaoana, B. Rafoneke and W. Arnold

Maintenance in village water supply section, Lesotho

INTRODUCTION

The Rural Water and Sanitation project funded by USAID effectively began in May 1981, to provide clean water and maintenance for new and existing systems country-wide and to build up the institutional capacity of VWSS. With the success of this project other donors are now participating recognizing the importance of good maintenance and are providing funding for both maintenance and transport as well as for new construction materials.

A basic organizational structure was established with maintenance sub-divided into sections according to responsibility.

The maintenance engineers are responsible for all vehicles, equipment, water system maintenance and transport. Personnel have been recruited and trained to fill the job slots and to absorb the workload.

At the beginning, the maintenance capability of Village Water Supply was very low, however the situation has since reversed. We now have three regional workshops in operation, two workshop managers trained overseas, a systems maintenance supervisor, 4 regional water system repair crews, a drill rig repair crew and a transport officer. The section is well organized and staffed such that at present level of activity, vehicles and water supplies are attended to on a timely basis.

The maintenance engineers directly supervise the activities of all three regional workshops, a welding shop, transport officer with 14 professional drivers, 60 vehicle fleet, 4 systems repair teams and a drill rig repair crew. The M.E.'s design all diesel engine powered pumping systems for water supplies and are responsible for their installation. Steel frames have been designed and built in the VWS welding shop for various combinations of engines and pumps for standardization. A machine has been designed and built to test borehole yields. Reusable steel frames have been designed and built for the casting of handpump slabs and standpipe foundations. Crews have been trained for the installation and repair of handpumps.

VEHICLE MAINTENANCE

The Maseru workshop (Central Region and Headquarters) employs one workshop manager, three mechanics, one welder, one helper and two storekeepers full time. The Maputsoe workshop (Northern Region) has one mechanic stationed full time and resident in the area. One workshop manager trained in Germany divides his time by spending approximately half of each week in Maputsoe and the remainder of the week in Maseru. The maintenance facility in Mohale's Hoek (Southers Region) is equipped to handle most routine services and repair. There is one mechanic full time. This mechanic has been utilized outside the workshop to weld base plates on boreholes and service a few diesel enginer powered water systems.

The two workshop managers are working managers, that is, they are responsible for the supervision and scheduling of the workload among the mechanics and are doing service and repairs on vehicles right along with their subordinates. They are active in training or consulting with the other mechanics upgrading their skill and assisting them in difficult repairs. When workloads demand, a mechanic is pulled in from one of the field system maintenance crews for temporary duty.

The Maseru workshop is equipped with modern tools giving the capability for wheel alignment and balancing, engine analyzer and tune-up, engine rebuild, transmission overhaul, and general service. Training courses have been given on all specialized equipment making each mechanic more versatile.

Vehicles are routinely scheduled into the shop by a jobcard system initiated with the transport officer who monitors kilometer usage. Every 2,500 km each vehicle passes through the shop receiving major or minor service as the kilometer usage indicates. Breakdowns are also reported to the transport officer who sends the vehicle to the shop with a jobcard requesting specific repairs.

An inventory of spare parts has been built up gradually as experience is gained. A new computer has been added to VWS by the Project which will enable all spare parts to be better controlled. Security of the spare parts store is also being strengthened in that with two store keepers on duty there will always be one on the counter to supply the mechanic with needed supplies or parts without the mechanic or some unauthorized person having access to the store.

Spare parts constitutes the major portion of the vehicle maintenance budget. Their purchasing and control, especially since the stock on hand is growing, must receive the attention that it deserves. All parts requirements (that is, new purchases) are first listed on a requisition form. This requisition is reviewed by the M.E. for correctness in terms of source, quantity and cost. A vote number is then assigned to the requisition by the M.E. informing the accounts section from which vote to commit the necessary funds to cover the purchase. The financial controller or senior accountant will check the vote to be sure that funds are available , initial the requisition which is then taken to the general stores office for order preparation. The order is accepted as guarantee of payment by suppliers and is quoted on their monthly invoice.

When the new spare part is received it is logged in on its own special inventory card by part number. If the part is to be used immediately it is logged out to whatever vehicle, machine or piece of equipment that is being repaired. If, when a part comes in, there is no inventory card as this is the first time to purchase that particular item then a new inventory card is created and the part logged in/out as appropriate. A decision is made as to the adviseability of having a spare in inventory and if so, one or more as needed will be ordered through the requisition process for stock.

A complete shelf count of parts has been completed and all parts have been coded by part number, assigned a bin location, an inventory card prepared, and this information has been computerized. The emphasis now is on training and motivation to ensure that all movements of spares both in and out are properly recorded. Each inventory card has a max/min quantity level for that particular item. As a part is issued it must be recorded on the card telling where it was used, a deduction in the balance on hand, and a check to see if the new balance indicates a recorder level. If reorder is required then a sufficient quantity should be ordered immediately to bring the stock level up to the maximum level indicated. When an entry is made on a card, the card is "flagged" with a paper clip. Once a week the information entered on the cards which have been flagged is entered on the computer such that an up to date inventory report is always available showing stocks on hand, stocks on order, value of stock, current cost for each item and total value of stock in the store. At present there are over 800 different spares in stock with a value exceeding R65,000.

The small inventory of spare parts currently in stock in the regional centers needs to be supplemented and expanded. We plan to implement an inventory control system compatible to Maseru and train the mechanics in its use. Maximum and minimum levels of stocks will be dictated based on the number of vehicles to be served. Once a month the inventory cards will be sent to Maseru for computer updating and new printouts showing current price information and stock levels will be supplied. A printout of the Maseru stock levels will also be furnished to the centers so that the mechanic will know what is available directly from the Maseru store.

III. Other District Workshops (Country-wide)

At the present time there are no immediate plans to staff the District Offices with a mechanic. With three exceptions, Mokhotlong, Thaba Tseka, and Qacha's Nek, the district offices are fairly convenient to a regional workshop which can serve their requirements. In the three exception districts there is only one vehicle for each District engineer and normal monthly visits to regional centers have been sufficient to meet service requirements.

IV. Drill Rig Maintenance

We are slowly building up a stock of spare parts for the drill rigs such as bearings, belts, and other perishable items. In addition we try to keep two engines in stock ready to go on an exchange basis. When an engine goes down for something other than routine service the policy is to exchange the complete engine with one in stock and put the rig back in to production in a matter of hours. The faulty engine is then brought in to the workshop and repaired or overhauled and placed on the shelf.

An effort has been made to keep all 12 rigs working in close proximity to each other. As long as this is feasible the present repair crew can continue to handle all repairs. If it became necessary to split up the rigs then a second crew would have to be organized, equipped and trained to keep down-time to a minimum. The present team has performed well to date with all the requirements for repair and service.

V. Systems Maintenance

The burden on systems maintenance at the beginning of the Project was to "catch up" on all of the old requests for repairs. Through equipping and training 4 separate crews under the supervision of a Mosotho who holds a Trade Test "B" Certificate and successfully completed the VWS foremans course, the backlog has been erased and current requests are promptly answered. The challenge now is to continue the rapid response recognizing that 229 new systems of all types have been placed into operation since the beginning of the Project and approximately 100 new systems are being constructed annually.

The tremendous expansion of the handpump program in response to drought relief necessitated a separate crew being trained for installation and repair of handpumps. Training is under way to help the system maintenance teams to also become proficient in service and repair of these pumps so that the installation crews can concentrate on new work and keep up with the various drilling programs currently underway. By the end of this Project approximately 1,000 new handpumps will be installed. It is envisioned that eventually all handpump repairs will evolve to the systems maintenance section.

With all the activity in VWS it is expected that the workload will substantially increase. To offset some of this increase the policy is to have selected villagers named by the Village Water committee to work with construction technicians during the building of a system. These people known as water minders are taught and receive on-the-job experience in how to cut, thread and seal pipe joints, assemble and lay pipe, install water taps, assist in catching springs, building silt boxes, pipe stands, and water tanks. They mix concrete, shape stones, and learn many more useful skills. In the process they become familiar with how and why the system works. Upon completion of the system each water committee is issued a tool box with sufficient tools to carry out simple repairs.

The above policy is newly implemented and with each new system completed there are more and more waterminders with some basic skills. There is a large skill gap between waterminders from the older systems and the newer systems. Frequest changes in waterminders cause voids in repair knowledge as the more skilled leave the village for more lucrative jobs. We wish to identify all villages that have an improved water supply completed within the past 5 years. The objective is to train a team of trainers, equip them with plumbing and construction tools and hold maintenance courses in each village on the list. This program would be continuing, never quite catching up as once through the list (which grows by approximately 100 systems per year) the team would begin again at the start of the list to either reinforce or train new waterminders. The prime objective is to assist the village to become more self-sufficient thereby reducing the burden on the system maintenance teams for routine repairs.

The SM supervisor has been maintaining jobcard records on each repair since June, 1983. Costs are recorded for materials, parts, labor, and transport on each job. Much discussion has taken place on how to recover part or all of the costs from the village rather than have a donor or GOL cover the bill. Each system is only constructed after the village has collected money on a per capita basis and deposited that money in a bank account which is controlled by the village water committee.

A first draft of a policy paper has been prepared and submitted to the VWS coordinating committee for discussion and revision. It was recommended that upon completion of a repair a bill prepared by the maintenance section covering actual cost for materials and parts be presented to the village committee with payment to be made to the D.R.D.O.'s office. This would accomplish several things. Firstly, a portion of the cost (or all) of maintaining systems would be returned to VWS relieving the financial burden on the government. Secondly, it would reinforce the philosophy that the system belongs to the village and not to the government. Third, when the village becomes aware of the cost of repairing their system they will be more interested in protecting it from damage. Fourth, it will encourage them to make the repairs themselves which are within their level of expertise only calling on VWS when the repair is beyond their capability. In summary, funds could be collected to recover a portion of the annual maintenance budget and current resources within VWS could be spread further. The mechanism of submitting a bill to the village can be developed within the maintenance section. The collection of payments and the return of those funds to VWS operating funds will have to be set up.

Training of maintenance personnel continues as we try to expand the skill base. A four day course taught by the Salister Diesel Engine supplier in the R.S.A. was attended by all the SM foremen and their supervisor in early December, 1984. The course content was devoted to preventive maintenance and trouble shooting.

TABLE M-1

MAINTENANCE SECTION PROGRESS SUMMARY

60 VWS vehicles countrywide
30 Project vehicles purchased plus 3 on order
31 Mechanical training courses completed
3 Regional water system repair teams
1 National preventive maintenance team
1 Drill rig repair team
4 Handpump installation crews trained
1 Borehole yield test crew
3 Regional workshops in operation
2-way radio communication in each district
Maseru workshop expansion complete
Maputsoe workshop expansion under construction

Spare parts store in operation
Computerized inventory control system implemented
Welding shop constructed
Workshop equipment and tools expanded and upgraded
Workshop jobcard system implemented
Transport officer appointed
Individual vehicle fuel consumption report
Transport policy paper published
Best driver award program implemented
Servicing offered for other Ministry vehicles

TABLE M-2

SUMMARY OF REPAIRS MAY,1984 - APRIL,1985

Repairs are based on completed jobcards

Vehicles:	997
Drill Rigs:	165
Windmills:	116
Diesel Engines:	80
Water Systems:	564

A. North Team

The foreman for the Northern Region was officially retired from Government service in December, 1984. He has been rehired and is working on a daily paid basis. This is a temporary respite as he may decide to retire the second time at any point. This man is the resident VWS windmill expert and we are transferring men from other teams to work with him to learn as much as possible about windmill repairs. We are looking at all members of the SM crews to identify a candidate for promotion to foreman to step in when Mr Molemane does decide to retire. At the same time the man selected for this position should have experience in small diesel engine service and minor repairs which is a current shortcoming within the North team.

B. Central Team

This team is perhaps the most versatile team in the section. They have been specially trained (in addition to their "normal" duties) to cast foundations and install the diesel engine powered pumps. We have started the policy of having a second team participate in any new such installation. This will enable us to transfer these skills eventually to all the SM teams and make them less dependent on help from outside their home region. Since each section of the country will or does have each type of water supply we must have each team as versatile and able to work independently as possible.

C. South Team

This team is perhaps the weakest in terms of overall repair knowledge. What they can do, they do well such as gravity system repairs, rebuilding silt boxes, recatching springs, etc. As outlined above, steps have been taken to broaden the base of knowledge and skill for this team. In the southern region there are several diesel engine powered systems so whenever a problem develops a second team knowledgeable on diesel repairs will assist in the repair, teaching the south team on-the-job. Likewise when a windmill or handpump has a problem then a second team will come in to assist. A member of the North team is being transferred to the South to help them gain windmill experience. Similarly when a spring escapes, the South team will be called in to assist one of the other regional teams. It is felt that this approach of sharing skills amongst ones peers will be the quickest and most effective form of training that we can implement.

D. Preventive Maintenance Team

This team is by design the most specialized team in the section. It was founded with the purpose of working with mechanical (engines and windmills) systems country-wide. The foreman holds a Trade Test "A" certificate and is very proficient in Lister diesel engine repairs. This team also supplements the Drill Rig team by doing most of the engine overhaul or repair when an engine is brought in to the Maseru Workshop. There are no plans at the present to change the status of this team which performs specialized work for all the other regional teams.

The original idea was to have this team circulate around the country on a regular basis following a route that would touch each mechanical system. A survey was made identifying the villages that depend on a windmill or engine. Once that was complete they were to periodically visit each of these systems to prevent, as much as possible, a breakdown by doing routine services such as replacing a worn rod on a windmill before it breaks, or checking oil levels in engines, etc.

To date this route has not been set up because the normal workload of the section has been too great. In addition to maintenance duties the foreman taught several courses at the village level throughout each region to water minders responsible for diesel engines. He showed them the proper engine oil levels, how to clean air filters, and gave instruction on the proper care of "their" engine and pump room. This course will be repeated from time to time because waterminders change frequently. An example of the type of problem we hope to eliminate is the placing of diesel fuel in the crankcase which of course does substantial damage to the engine.

VI. Handpumps

There is a crew headed by a Danish volunteer that is based in Mafeteng. They were set up two years ago to build pads and install handpumps. That crew has split into a pad building crew and an installation and repair crew. A faulty handpump has historically been repaired by the installation crew with the occasional help from a systems maintenance team.

With the advent of the EEC drilling program, other donor input, and USAID furnished handpumps the numbers of handpumps to be installed is expected to reach 1,000 over the next couple of years. Crews have been trained to install the pumps in Leribe, Berea, Maseru, Mafeteng and Mohale's Hoek districts. These crews with one exception are all construction personnel. Regional SM teams are being trained to service and repair handpumps but considering the large quantity it is expected that another full time team will have to be organized.

VII. Borehole Testing

A trailer mounted unit has been built and placed into service to test borehole yields. A crew devotes full time to testing "doubtful" wells, wells to see if increased pumping is feasible such as replacing a windmill with a diesel engine, or to test a well as a production well for large villages. When not actually testing a borehole this crew is used to repair handpumps.

VIII. Transport

Transport control is under the supervision of a Mosotho transport officer. He has the responsibility for the supervision of the drivers, interviewing, testing, and hiring new drivers as well as discipline for offenders of G.O.L. and VWS vehicle policy. A transport policy has been written as a guideline for driver and vehicle control. A driver job description has been developed and each new driver is required to read and sign it.

The T.O. monitors and schedules vehicles for service based on kilometer usage. Each vehicle is routinely scheduled for either a major or minor service every 2,500 kilometers. The VWS fleet has grown to 60 vehicles logging approximately 1,000,000 kilometers per year. On a monthly basis the T.O. prepares a report on individual vehicle fuel consumption. This report is used to assist VWS in its budgeting process, as a cross check on accounts on fuel billings by government garage, and as a check on misuse of fuel.

All vehicle accidents are investigated and recommendations made as to whether or not driver discipline is warranted. Some serious accidents have occured but we believe that the transport officer's attention, enforcement of discipline and constant monitoring has contributed to an overall good safety record.

Both heavy and light duty vehicles are allocated wherever possible by job tasks and assigned to the individual responsible for carrying out that work (See Table M-3).

IX. Communications

There are now resident engineers in each district equipped with 2-way radio communications. Three times a week a regular call-up schedule is observed such that each engineer can relay important information, transport requests, repair requests, and maintain closer contact with Maseru headquarters. The base stations in Maseru and Mohale's Hoek stay on call during working hours 5 days a week.

X. Training

There have been 31 mechanical training courses completed. The majority of the courses were held locally using Project personnel and special instructors. Two Basotho have returned after completing workshop manager training overseas and are in-charge of the Maseru and Maputsoe workshops. Three maintenance men have obtained the trade test "A" certificates and all mechanics now hold the trade test "B" certificate. All "professional" drivers have a minimum of a heavy duty license.

A syllabus has been written and translated into Sesotho for a course in basic engine maintenance and operation. This course was presented to village water minders who are in charge of a diesel powered system. A maintenance team foreman was the instructor.

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

M. Paulo and S. Radojicic

Water supply and sanitation in Mozambique

The people's Republic of Mozambique is situated on the east coast of Africa between Tanzania and South Africa, with a land area of 300.000 km^2 and a coast line of 2500 km approximately.

The 1985 population is estimated at 13.6 million of whom about 2.4 million (18%) live in urban areas and the balance, 11.2 million (82%) live in the country side.

The coverage of the population by water supply and sanitation is as follows (Estimates in 1980).

Water Supply	47.5%	urban coverage
	6.0%	rural coverage
	13.3%	total coverage
Sanitation	67.0%	urban coverage
	12.0%	rural coverage
	21.6%	total coverage

Decade Plan

With respect to water supply and sanitation, the targets defined by the Government for completion by 1990, the end of the decade, are as follows:

a) To make piped potable water accessible to 75 per cent of the urban population.

b) To provide a protected potable water supply sources to 75 per cent of the rural population, specifically:

- to provide one source of safe water per 100 families (500 persons) within 500 metres distance in rural areas.

c) To provide sewer services to 50 per cent of the urban population served with piped water latrines within their homes and to serve another 30 percent with septic tanks and pit latrines.

d) To extend excreta disposal systems to all rural populations living in communal villages (70 percent of the total rural population).

Because of the inadequacy of present water supply systems and institutional facilities for the rural population, priority is given to them. The total rural population served by substantially improved water supply by 1990 is thus expected to be 7.585.000 or 57 per cent of the total rural population.

a) Rural Water Programme

This programme is based on the construction of wells and drilling of boreholes usually equipped with hand pumps in a few cases windmills and more complex motor-driven pump systems are used.

The provincial Agency surveys needs at the level of the districts and the communal villages to confirm their requests and define a programme which respects district priorities and prepare the participation of the communities.

Attempts are made to involve the communities in the selection of water sources and later in the construction of the water supplies. Later the plan is analysed and approved at provincial level and compatibilised with other sectors, as well as with available financial and material resources.

At the moment, a study is being made of how best to develop mobilization and health education activities in parallel with these programmes on a formal basis. Some pilot projects are underway.

b) Rehabilitation and Improvement of Urban and Semi-Urban Water Supplies

The poor operation and maintenance of the systems due to the lack of qualified personnel and spare parts has hastened their deterioration. On the other hand, many systems which were built in the 50's and 6P's now need renovation and expansion. In the smaller systems, the programme is defined by the municipalities, the systems managers, with technical assistance from provincial agencies.

In the larger systems, UDAAS (Water Supply and Sanitation Agency) analyses and approves the technical feasibility of the programmes and seeks the necessary external finance.

c) Sanitation

In the rural areas, sanitation activities are essentially the construction of latrines. This work is defined and carried out entirely at the local level by the health authorities.

Some promotional work is however carried out at provincial and national level.

In the urban and peri-urban areas however, the population densities are high and the health impact of poor sanitation more serious. In the past, sanitation was even more neglected than water supply.

Since 1980 some pilot programmes in the application of low cost sanitation of latrines

WATER SUPPLY AND SANITATION INVESTMENT

('000s $US)

		1981	1982/83	1984	TOTAL
URBAN WATER SUPPLY	CONSTRUCTION	US$ 1.720	US$ 5.530	US$ 5.130	US$ 12.430
	STUDIES AND PROJECT	US$ 120	US$ 1.390	US$ 530	US$ 2.540
RURAL WATER SUPPLY	CONSTRUCTION	US$ 640	US$ 8.200	US$ 2.040	US$ 10.880
SANITATION	CONSTRUCTION	US$ 70	US$ 7.550	US$ 3.740	US$ 11.360
	STUDIES AND PROJECT	US$ 56	US$ 660	US$ 130	US$ 896
TOTAL		US$ 2.606	US$23.330	US$11.620	US$33.106

(1 US$ = 43.95 MT)

External Financial Support for these Investiments have been received from the following Agencies UNICEF, Governments of Holland, Switzerland, USSR, China and Denmark, Lutheran World Federation, Caritas, Cuso-Suco and Oxfams América and Belgium.

Maputo, March 1985

construction programmes in the peri-urban areas of the main cities of Maputo and Beira.

This activity was in its initial stages promoted and planned at national level.

At the moment, the intention is to develop at city level the capacity needed for the management and continuation of these programmes.

It is also intended to expand the programmes to other cities.

d) Man Power Training

The National Directorate of Water (DNA), the National Water Resources Authority, has training schools where basic level technicians for water supply and sanitation are trained. This school will in the future train medium level technicians as well. The course content, is defined on the basis of the requirements of the provinces which also recruit candidates.

While this plan emphasised appropriate low cost technologies, it is apparent now that some of the targets will be difficult to reach by the end of the decade.

The deterioration of the economic situation in the country has resulted in a shortage of resources.

Since 1979/80 Mozambique has suffered both severe drought and devastating floods. As well as the disastrous effects of the undeclared war promoted from outside which has worsened the economic situation. The lack of foreign currency and of qualified personnel are at the moment the major obstacles to sector development.

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

I.L. Nyumbu and J.W.K. Duncan

IDWSSD in Zambia - implementation and coordination

INTRODUCTION

01. Preparatory Activities
The National Action Committee for IDWSSD was established in April 1980 with mainly advisory and coordinating functions under the chairmanship of the National Commission for Development Planning and with the participation of the Government ministries and agencies involved with water and sanitation sector programmes. The first activity organised by the NAC was the joint meeting of the Government, the UN system of organisations and representatives of the Bilateral Aid Community on the IDWSSD which took place in Lusaka on 30th July 1980. Overall assessment was made of Zambia's progress in the area of water supply and sanitation. From discussions which followed it was clear that the Government was aware of, and concerned with finding effective solutions to the problems resulting from the lack of available clean water and good sanitation facilities.

02. In November 1980 the text of Zambia's declaration of intent on the IDWSSD was presented at the official launching day ceremony of the IDWSSD. Zambia accepted the IDWSS objectives of providing safe water supply and adequate sanitation for all, and would make a concerted effort to achieve the goal within the Decade (1981-1990). An improvement in the quality of water and in its availability together with a parallel provision of better sanitation would result, inter alia in a large reduction in the incidence of waterborne diseases and would also witness a marked decline in infant mortality.

03. Decade Plan
The need for the preparation of a Decade Plan was proposed as early as February 1979 by a WHO/SIDA Mission to Zambia, and endorsed by a Primary Health Care National Conference in April 1980. The NAC undertook the task and completed the draft document in December 1983. The Decade Plan was the very first step of a comprehensive evaluation of the most important elements associated with development of water supply and sanitation in Zambia. The objective of the Plan was to provide the Government with the necessary tool for making sound decisions in development of water supply, sanitation and other related sectors; as well as to provide a working document for external donors which should make their commitment of assistance easier and better assured.

04. Exchange Visits
IDWSSD has the specific intention to cause more awareness among the member nations of the UN about the urgent need to do more to improve on water supply and sanitation in their countries. The most difficult communities to influence are the rural communities who live in small groups which are remote and sometimes inaccessible. The NAC recognised therefore the many advantages to be gained from exchange visits to neighbouring countries and requested financial assistance from WHO which was provided for mounting the visits to four countries - Tanzania, Malawi, Zimbabwe and Swaziland from 13 November to 13 December 1982. The consensus from the visits clearly identified the need for sub-regional cooperation in the implementation of IDWSSD programmes and for Governments to take deliberate efforts to make the rural communities realise that they need water supply and sanitation facilities for their own good health, and they should be made to take part in establishing them.

CONFERENCE OF ZAMBIA IDWSSD

05. Participants and Objectives
The conference on Zambia IDWSSD was held at the main campus of the University of Zambia in Lusaka from 26-30 March 1984. Participants from government ministries, district councils, educational institutions and organisations in the country participated. Also participating were invited national officers from neighbouring countries of Zimbabwe, Tanzania, Swaziland and Lesotho and representatives from UN and other specialised donor agencies. The objectives of the Conference were to promote the necessary administrative and management policies, political, technical and financial backings for a successful implementation of the IDWSSD programmes in Zambia. Furthermore, the Conference would provide the opportune environment for participants to offer constructive suggestions for improving the contents of the Document Plan of Action for Water Supply and Sanitation in Zambia, as well as help evolve a national consensus

for a definitive policy on the development of the sector in general and the achievement of the Decade objectives in particular.

06. Main Conference Recommendations
The Conference reemphasised many of the recommendations made in the Plan of Action Document among which were the following:

(i) The NAC be given Cabinet approval and be allowed to operate as an independent legal body with a servicing secretariat.

(ii) A National Water and Sanitation Authority be established with the functions of coordinating technical planning and implementing all national water resources and sanitation projects.

(iii) Health education and community participation must be strongly encouraged, not only for ensuring community appreciation and cooperation, but also for meeting the unskilled labour requirements for implementing and executing sector projects.

IDWSSD ADVISER PROJECT

07. Commencement and Objective
The first project of the NAC is a UNDP funded and Government executed project that falls within the IDWSSD. The project started on March 1, 1984 with the appointment of a national (Zambia) expert as IDWSSD Adviser. The development objective of the project is to assist in the coordination of IDWSSD activities in order to improve both urban and rural water and sanitation sector needs of all communities and to attain the overall objective of primary health care for all by the 2000.

08. Project Activities
These include:

(i) Preparation of conference reports, financial statements of income and expenditure on the Zambia IDWSSD Conference.

(ii) Organisation and establishment of IDWSSD secretariat.

(iii) Preparation of the Mid-Decade Evaluation document on water supply and sanitation sector.

(iv) Review of comments and finalisation of the Plan of Action Document.

(v) Production of a report on consumption figures and population projections for design of water supply systems which would lead to the drawing up of guidelines and standards for design of water supply systems.

(vi) Management support on the public standpost Water Supply project also being implemented by the NAC with financial assistance from the WHO/IRC in The Hague.

09. Future Activities

(i) Manpower survey for the water supply and sanitation sector.

(ii) Project identification, planning and formulation of priority activities of water supply systems in the rural areas; terms of reference for Water Master Plan for large and small urban townships.

(iii) Handpumps survey and recommendations of appropriate types for Zambia.

(iv) Water quality monitoring project to be implemented with financial assistance of WHO and NORAD in the Western Province of Zambia.

(v) National workshop on drinking water quality to be organised late 1985.

ZAMBIA - SOCIOCULTURAL AND ECONOMIC ASPECTS

10. Location and Geography
The country covers an area of 752,614 square kilometres of which 8,789 km^2 is water surface area. It is landlocked, situated in Central Africa and divided into 9 provinces which are further divided up into 55 districts. It lies in the savannah woodland zone with altitudes ranging up to 1200 metres, having a tropical climate characterised by wet summers and dry winters. The country is fortunate to be drained by four major rivers - The Zambezi, Kafue, Luangwa and Chambeshi rivers. There are also a number of fairly large lakes - The Tanganyika, Mweru, Bangweulu and Kariba. Zambia has in general an abundance of water resources both from surface and underground sources but these have not been fully explored.

11. Socio-cultural Aspects
The socio-cultural parametres that are needed to understand how people perceive water supply and sanitation projects have not been well studied in Zambia. To this end the WHO/SIDA cooperative project based in Zambia from 1981-1983, attempted to provide a synthesis of socio-economic and cultural information for nine countries in South-Eastern Africa (see Table 1) which enabled a fair comparison of some of the typical distinctive features of the countries, high lighting the socio-economic context, and the cultural constraints governing sector operations. From Table 1 the following issues are noticeable:

Table 1 Comparative Socio-economic and Cultural Data

	POPULATION		GNP PER PERSON		OTHER SOCIO-CULTURAL DATA				
	Total (000) 1981	Rural (%) 1981	US $ 1981	Average Annual growth (%) 1960-81	Adult Literacy (%) 1980	Primary School attend-ance(%) 1980	Life Expec-tancy 1981	Infant Mortality per 1000 1981	Daily Calorie % 1980
Botswana	930	84	1,010	7.9	61	NA	57	80	NA
Ethiopia	31,800	86	110	1.4	8	43	46	150	76
Kenya	17,363	85	420	2.9	47	100	56	80	88
Lesotho	1,372	88	540	7.0	52	100	52	110	107
Malawi	6,241	90	200	2.7	35	62	44	170	94
Mozambique	12,500	91	350	NA	33	93	NA	110	70
Swaziland	641	85	760	5.5	65	NA	54	156	NA
Uganda	13,600	91	220	0.6	53	50	48	100	83
Zambia	6,000	56	600	0.0	68	95	51	104	93

Sources: (ref. 1 & 2)

(i) Population - There was a consistent pattern of large rural population (85-91 percent) in all the countries except Zambia on account of her mineral wealth resulting in concentration of population along urban centres on the lines of rail.

(ii) Life Expectancy - on the average stands at 51 years and appears to correlate well with higher income levels.

(iii) Infant Mortality - This rate can be considered as indicator of foremost need for improved water supply and sanitation based on the evidence that disease due to contaminated water and lack of hygiene account for 80 percent and more of infant deaths. The aggregates presented for the countries underline the current weak state of primary health care, not only in Zambia but in other countries as well. The Health for all strategy objective is an infant mortality rate below 50 per 1000 live births by the year 2000.

12. Economy
Over the past decade, the course of the Zambian economy as revealed by the available data on Gross Domestic Product, has been characterised by an uneven and inadequate growth performance. Various conscious efforts and attempts have been made by Government at economic development of the country particularly in agriculture mining, manufacturing, energy, transport, communications and manpower development. The past decade had also been crisis years for foreign exchange situation which had continued to be critical and was a major constraint on domestic economic growth. Government has tried to meet the situation by tightening its fiscal and monetary discipline and through exchange rate adjustment which in December 1984 was 2.4 Zambia Kwacha (2.40) to 1.0 British Sterling (£1).

MAGNITUDE OF IDWSSD PROGRAMMES

13. Present Service Levels
In 1983 the coverage and service levels in water supply and sanitation were estimated (ref. 3) as follows:-

(i) Large urban areas water supply systems catered for 48 percent of urban population with house connections, 22 percent by shared/communal taps whilst the remaining population used traditional sources of unacceptable quality.

(ii) For the smaller urban townships Water Supply Schemes, 27 percent of the population had house connections and 18 percent used shared/communal taps, the remaining population used stand posts and traditional sources.

(iii) For rural water supplies, only 32 percent of the rural population had access to clean water supplied through protected shallow wells, boreholes and small piped water supplies.

(iv) Large urban areas sanitation facilities included: individual flush toilets used by 45 percent of the population whilst 7 percent used communal flush toilets and the remaining 48 percent used other excreta disposal methods, mostly pit latrines.

(v) For the small urban Townships, 28 percent of the population used individual and communal flush toilets whilst the remaining 72 percent used other excreta disposal methods.

(vi) Rural sanitation facilities of pit latrines were used by 48 percent of the rural population.

14. Capital Expenditure
The present level of yearly capital expenditure for water and sanitation sector is estimated at 22.1 million kwacha (£9.2 million). External funds available during 1982/83 totalled 129.1 million kwacha (£53.8 million) made up of loans and grants. For a 100 percent coverage of the population a high level service capital expenditure of 163 million Kwacha (£67.9 million) is envisaged yearly.

15. Recurrent Expenditure
The present level of recurrent expenditure (excluding debt charges) and revenues total 42.04 million Kwacha (£17.5 million) whilst the recurrent expenditure for 100 percent coverage has been estimated at 69.6 million kwacha (£29 million).

16. Manpower
The manpower requirements to be trained for water supplies and sanitation facilities include 180 professionals, 1900 subprofessionals/technicians, 2200 plant/pump operators, plumbers, welders, etc. The present position regarding staff and manpower for running sector programmes is however not very good. No comprehensive data concerning present establishments exist for all the sector agencies.

IDWSSD EFFECTIVENESS AND IMPACT

17. National Development Plans
IDWSSD is yet to receive the recognition it deserves in Zambia. The party (UNIP) had already spelt out the next 10 years Natinnal Plan 1985 - 1995. Apart from this, Government has National Development Plans, and an Annual Plan which contains projects carried over from previous year and addition of new programmes with summary of programme for the following year. NAC aims to have written into the next 4th National Development Plan IDWSSD Programmes which would ensure full coverage of the population within the period of the 4th NDP 1986-1990.

18. Decade Approach
There is a national commitment to practice approaches of extending services to the rural population and theurban poor, community involvement, health, education and integration of IDWSSD with primary Health Care/Health for all by the year 2000. Assessment of impacts and progress for the sector had been a difficult step since water supply and sanitation programmes could not readily be separated from other socio-economic development programmes of the country. Furthermore the financial resources made available for sector projects have been grossly inadequate. For the implementation of the proposals for 100 percent coverage, an increase in the annual capital investments including recurrent expenditure from the 1983 level of 64 million kwacha (£26.7 million) to about 233 million Kwacha (£97 million) shall be required.

19. Prospects for the Future
This paper has outlined Zambia's efforts for implementation and coordination of IDWSSD programmes. The magnitude of the problem is enormous yet the economic capability of the country for achieving the stated goals is not very bright. Success of IDWSSD programmes in Zambia will require concerted efforts. Unlike in the past, water supply and sanitation schemes must become self-financing; more efforts are needed to revamp revenue collection so that recurrent costs, at least, can be met and, wherever possible, part of capital costs. In the rural areas the user community must be mobilised and educated to effectively support the programmes. Significant savings in construction costs operation and maintenance costs can be realised through community participation. UNDP, WHO, UNICEF, World Bank, and many donor agencies have continued to provide financial and technical assistance for IDWSSD programmes. The role of external aid, agencies should continue and ensure that Zambia is assisted in the implementation of its programmes and projects - procurring finance, assistance in importing materials (foreign exchange component) organisation of workshops, conferences and others. The Government of Zambia appreciates the need for the international community to herald IDWSSD; but in Zambia there are other basic free services like health and education, which are very costly to Government. Thus the provision of potable water and adequate sanitation should be seen in this context.

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WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

SESSION G

CHAIRMAN:- Mr. Frank Jones
DSSD
Dar es Salaam Tanzania

Discussion

1. Mr JACKSON agreed with the need for integration of water and sanitation activities, at least at a policy level where, for example, the choice of sanitation in an urban area such as Dodoma has a marked effect on water supply quantity. Lesotho had moved further in its Decade planning as, since preparing its National Plan, an up-to-date Position Paper had been prepared. This contained details of finance needs (in accordance with the Plan) for the next five years. This was to be discussed together with policy, at a Donor Consultative Meeting in June, 1985.

2. Mr MSIMBIRA made the general comment that funds provided by donor agencies was not effectively used in the development of water or sanitation programmes because most of them were spent on overheads and technical assistance. This denied an effective control of standardisation. He also commented on the training of technical manpower, saying that movement among technicians was a result of many of them being taken for training as engineers.

3. Mr HUTTON suggested that the training and awareness programme on sanitation and public health be concentrated on local and central government officials, councils and publically-elected representatives. It should stress the affordability and benefits of sanitation - pit latrines can be upgraded in stages. Doing it better must be followed. He wished to know if there were plans for training the 'officials'.

4. Mr NYUMBA replied that currently there were no specific plans for involving local government officials, but that implicit involvement had been initiated through representation of such officials in the National Action Committee in IDWSSD. The suggestion made would be followed, however, and a more active and direct participation would be sought.

5. Mr JACKSON informed delegates that he had suggested to the World Bank that Economic Development Institute tape/slide programmes (on economic planning for water and sanitation) should be circulated to a region, possibly with a travelling trainer. He added that there may be scope for various countries to co-operate in order to train their economic planners in the issues of water supply and sanitation.

6. Mr MWANAKATAMBO made the general comments that various options for water supply and sanitation, development and improvement may not be workable in Zambia, e.g. taxation, commercialisation. The prospect of complete decentralisation to grass root level offered basic and promising results. Hospital advisory committees and village health committees were looking after health.

   He added that delegates had not stressed sufficiently the importance of formal water quality control of all projects. In his opinion this should be part of any project because quality is as important, if not more important, than quantity of water.

7. Mr GREY expressed the opinion that Mr Nyumbu's record of the success of the National Action Committee in Zambia was an important lesson for other countries in the region: few had made such progress in coordination and planning for Decade activities. He wished to know the recipe for this success, whether it had included pressure from within government or pressure from outside agencies such as the UN system, or both.

8. Mr MWALE replied that the National Action Committee on IDWSSD in Zambia is an interinstitutional body representing Government Ministry, the University, and Research Institutes. The function of the Committee is to advise the Government on how best to implement the IDWSSD programmes in Zambia. So far the Committee had prepared a National IDWSSD Plan to be presented to the Government. The Committee also intended to prepare National and Provincial Master Plans as part of a five-year National Development Plan (1986-90). The Committee which has subcommittees, meets once a month.

9. In a written comment, Ms MERINYO who was

working on the rehabilitation of waste stabilization ponds in Dar es Salaam observed that workers waded into the sludge unaware of the harmful bacteria/ parasites in it. She suggested that education of the laborors plus the provision of washing facilities should be provided. It was her opinion that many contractors and engineers were more concerned with keeping up to schedule than with the exposure of workers and their families to diseases.

WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

D A L West

Total asset management for water and sanitation projects in Africa

WHAT IS TOTAL ASSET MANAGEMENT?

Only seldom does a completed project meet all it's objectives. Even those considered successful through to satisfactory run-up, often fail in the long-term due to operational inefficiency or complete breakdown from inadequate maintenance. One way of considering the benefits of a water or sanitation scheme is on a life-cycle basis (see Figure 1) Investment occurs from it's conception to it's commissioning. If all is well the return begins when the plant comes into use and continues until disposal. To maximise benefit the lead time to first use should be as small as possible, while operating life and the total benefit as large as possible. Such aims are difficult to achieve, but there is a growing recognition of life-cycle costs, especially in the project management area, which can make such an impact on life costs, and in subsequent maintenance.

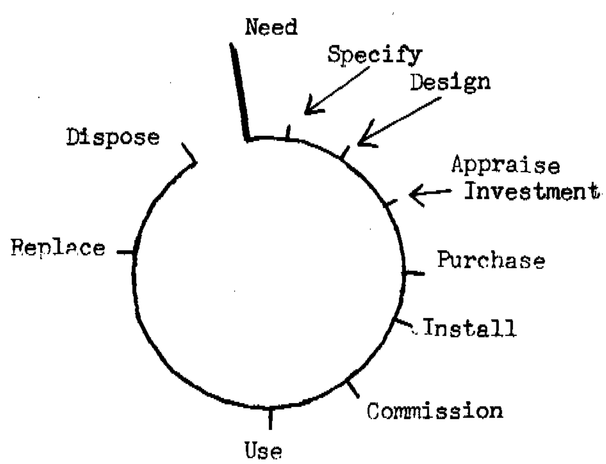

Figure 1

It is the focussing of attention on these matters which make up the concepts of Total Asset Management.

The basis is a combination of management and technology, and can be applied by users and providers of water and sanitation services. The principles can be applied at top level and also by managers, engineers, accountants and other specialists in their day-to-day working lives. Such ideas can also be applied to any enterprise. The application of asset management can result in the following benefits: lower cost of ownership of assets; better and more comprehensive specifications, leading to procurement procedures which will provide lower cost of ownership; reduction in indirect costs due to breakdown; general improvement in efficiency; improved quality of service and better material specifications; increased availability through improved reliability; more and better information available for decision making; better communication between users and suppliers, and between personnel in different functions. For management this is one of a number of concepts which can contribute to overall efficiency. Like others it can be classed as '*common sense*' or '*easy when you know how*' - but it requires careful thought and planning to realise the potential benefits of application.

Asset management requires no new techniques or disciplines. It is essentially a way of examining and grouping some familiar activities; a 'bringing together' of well tried methods in a way which can be used to improve management of assets in accordance with the enterprise's objectives. It is defined as - A Combination of Management, Financial, Engineering and Other Practices Applied to Assets in Pursuit of Economic Life-Cycle Costs. In practice it is concerned with the specification and design for reliability and maintainability of plant, machinery, equipment, buildings, structures, with their installation, commissioning, maintenance, modification and replacement, and with a feedback of information on design performance and costs. Asset management is essentially a multi-disciplinary approach to optimising life-cycle costs, and experience of a number of specialists is required for it's implementation. The basics can be applied without changing organisational structures, and there is no need to create a new breed of experts, but the range of skills, knowledge and experience necessary for full application is unlikely to be acquired by one person. Moreover it can only be successful with the active participation and understanding at the highest level of Senior Management. Asset management is also concerned with the 'cost of ownership'. (see Figure 2)

Application of asset management to water and sanitation projects is basically - the selection and provision of permanent assets providing the service; caring for these effectively and efficiently; co-ordinating them to help achieve overall minimum costs over

water/sanitation - life cost example	
Cap.	feasibility/dev./design purchase/install/commission training/plant staff manuals/tools/initial spares
Ops.	labour - plant ops./engineering energy materials (oil, general)
Mtce.	labour/materials/contractors o/heads (planners/supervisors/engs) spare parts holding (stores)
Loss	non-availability mal-function
Dispose	demolition

Figure 2

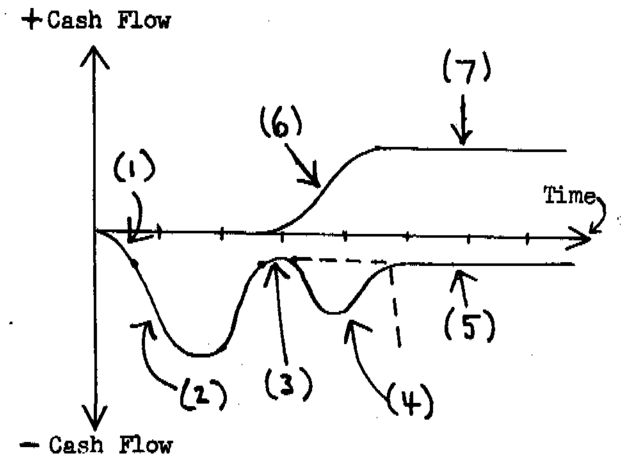

Figure 3

their life-cycle; feeding back data to improve them; which at least requires - deciding what service targets are to be met; deciding assets needed, how to use them, and achieve the targets over a specified period, taking into account their forecast cost of ownership; specifying the performance of the assets to be acquired; acquire, install and commission them; care for them; monitor their use; replace, improve the assets for better care, using the data to help minimise life-cycle costs. The successful application depends on the ability to balance factors. It brings together many techniques and disciplines, in a team situation, such as investment analysis, operational research, replacement analysis, accounting, design for reliability/maintainability, preparing specifications, installation, commissioning, maintenance methodology, information systems and technical communications, etc.

AVOIDING SOME PROJECT PITFALLS

Project investment suffers from - misunderstanding of a project as a unique and single task utilising the skills of a team working together; non-acceptance that the meeting point of all these disciplines is at the top - project organisation and direction must include a professional top management input; being unaware that the special risks concerning projects arise because attempts are being made to forecast the future. Innovation and problems of a special team, on a one-off job, can lead to not understanding ways on how problems can be tackled; not settling all the necessary decisions fairly early on. It is important that problems are thought through, policies made, and procedures set-up.

Consider the cash flow curve of a typical project (see Figure 3) It can easily be seen that the model can be considered in seven phases - 1. Planning. The period of evaluation and planning. 2. Procurement and Construction. Typically a curve, as expenditure rises, and then recedes, as parts of the project are completed. 3. Commissioning. The time between completion of construction and committing the investment to operations - testing and proving the facilities are safe and fit for use. 4. Operational Run-Up. The period between the date of operational commitment and that on which the performance is held to have reached steady-state conditions. 5. Steady-State Costs. The time span from which it is decided that problems of Phase 4 have either been solved, will never be solved, or will require a long-term plan to solve. 6. Benefits Build-Up. The term 'benefits' means the positive cash flow or 'services indicator'. The slope of this line entirely depends on prevailing circumstances. 7. Steady-State Benefits. Similar to 5, in that it is the period immediately following decisions on problems which prevent objectives being reached, are either solved or not and need further treatment.

So what is new in project work and can be learnt from experience? There are three areas of newness different from regular activities. The project team is generally composed of people brought together specifically for the task, often without any special team training and maybe many inexperienced in project work. All are expected to operate harmoniously from day one. Project teams have to shake down on the job so they must use all the practices which can help them to do it effectively. Also there is the effect on projects of the ever increasing rate of technological change. It is unusual for any large water or sanitation project today not to have some innovating part. Some consider that any investment which includes more than a modest amount of innovation will be a disaster. It is imperative to have available the competence which can judge what is acceptable, and so avoid unnecessary risk of failure. Allied to this, but separate, is the increasing complexity of systems which are appearing. They require technicians to interact with each other better than before. But again there is a limit to complexity, and ability to judge these aspects must be inherent in the team.

The disciplines of project management can be considered under six headings. 1. Finance. Three types of expertise are needed. Initially, investment planning, then others dealing with project evaluation, and thirdly, those dealing with project control, which might be described as continuous cash-flow predication. It is the last that causes the most trouble, and accountants are the least happy with. The first is allied to economic studies and the evaluation stage is largely main-streem accountancy. 2. Technical and Design. It is imperative that a clear, simple and well discussed brief is the basis. Otherwise cost over-runs and failure to meet objectives is certain. Both the nature of water and sanitation processing, together with performance standards of proposed installations must be well understood, if technical design is to be adequate. Technical inputs are often well below expectations; also sometimes inferior staffing and accepted lower standards prevail. These factors then manifest themselves on commissioning when the excess costs are attributable to lack of adequate design early enough. 3. Contracts and Contracts Structure. Good contracts are vital. Instead of a minefield of legal jargon and infinite detail, what should be is a clear, comprehensive, yet simple description, leading to a sound working relationship, on a mutually beneficial basis, between two contracting parties over a finite time period. Present weaknesses could be reduced if managements had a better understanding of the important features of this relationship, and the need to avoid ambiguity. 4. Time. Almost always regarded as important, but normally ineffectively managed. Full use should be made of the many well developed techniques and install high class co-ordination. Time management concerns all functions and dependencies between discrete events. 5. Organisation and Co-ordination. As projects are one-offs and finite, much early effort is needed to reduce to a minimum the learning period - this means specifying things normally taken for granted. 6. Resources. Too often given little forethought. Resourcing requires attention to money, manpower, machines, land etc. which is committed, so that problems are anticipated and dealt with. Manpower planning is vital.

The overall project view must accept the need to be in control of events. This means everything that has to be foreseen, is foreseen and there are no surprises or unexpected happenings. This is particularly difficult because of inbuilt uncertainties. So before financial committments are made, the main intellectual effort has to be put in before Phase 1. There are four ingredients to be implemented. 1. Planning is the setting out of an action plan, which specifies intentions, why particular options have been made and how action is to be taken. 2. Systems of measurement must be introduced for main items - the plan then compared with actual results. Regular monitoring throughout. 3. Arrangements for control of events must make sure of individual delegation of responsibility and provide for co-ordination. 4. In spite of efforts to predict and control, some drift will happen, and if regain is to be made, performance monitoring must look forward to the future events and the overall impact. Control is not analysing the past.

So concluding, if a project is to have any chance of being under control then there are four steps to be taken and completed, if possible, before any commitments are made. The Investigation - takes the idea, gives it form and substance, produces a recognisable proposition and has been compared with other competing options, gives a status and priority. This needs the skills of analysing choices to be done properly. The Project Proposal - turns the generality into a detailed and specific proposal. This is often when things go wrong, because many judgements may be made on 'best guesses'. Even when factual data is evaluated it can be unco-ordinated. The Project Plan - uses the proposal, quantifies what is going to be done, so that objectives can be met at minimal risk, and with control. This must set out policy, tactics, procedures for all items, including organisation, staffing and monitoring method. This stage can be a source of difficulty because those deciding ahead of commitment are reluctant to recognise important areas. There may be reluctance to create organisation and staffing, to allocate responsibility and commit resources to studies. The Check List - to minimise risk it is essential that this is compiled to ensure that all relevant matters requiring attention when investment is being planned will be evaluated. It will incorporate the knowledge of the organisation's executives, past experiences, discussed inter-functionally - then regarded as the pinnacle from which the project is planned.

NECESSITY FOR MAINTENANCE

Maintenance can account for about 30% of life-cycle costs - often equal to the project sum itself. Bad maintenance will mean enormous indirect expenses due to losses or permanent shut-downs. To be effective it needs not only special expertise, but high calibre managerial ability - as it is complex and demanding, especially in continuous processing, as in water and sanitation. But it has an oily-rag image, is a neglected area, and much left to inferior staff without adequate development. In the past decade this has been changing, largely due at last to recognition as a big cost centre. Maintenance must: be recognised as necessary; have time allowed for it to take place; be planned as much as possible; be preventive rather than corrective after failure; have resources allocated to it; be recognised as part of a new project with asset management. As downtime is more expensive, without maintenance there will be catastrophic results. Maintenance is Work Undertaken to Keep or Restore Assets to Acceptable Standards at Economic Costs.

The first task is to set and define objectives, which must be quantified. Maintenance will be judged by the cost and how well it does it's job, so the objectives will always reflect these criteria - and invariably, availability is the key indicator. The money, manpower, materials etc used form direct costs, but the return can be many times the outlay. It provides 'an insurance in time', where simple action now prevents major repairs later, and minimises the huge losses in service due to unavailability. So Planned Maintenance is Maintenance Organised and Carried out with Forethought, Control and Use of Records to a Predetermined Plan. This takes the form of four 'basic' steps: specify - what has, how it it, when it is, where it is, to be maintained; carry out specification - record work and notify 'corrective' actions needed; do repairs - record work details; analyse - information produced by the system, and review, modify the plan to 'optimise' within the policy and standards. Managerially this is planning needs, organising resources, controlling results, and measuring the performance of the system. A modern system will use mini or micro-computers as this leads to effective manipulation of volumes of data on large schemes, and incorporate the rapidly developing 'condition monitoring' approach, as health checks on assets, only taking remedial action when sickness trends become intolerable. But all methods will adopt the same programming approach (see Figure 4)

VITAL MANAGEMENT SKILLS

All these practices require a high level of managerial skills. A Manager is a person who is responsible for the work of others, and needs to perform the primary tasks of Planning, Organising, Motivating/Leading and Controlling. These are vital for success. But not of less importance are other skills such as personal, numerical, specialist, in

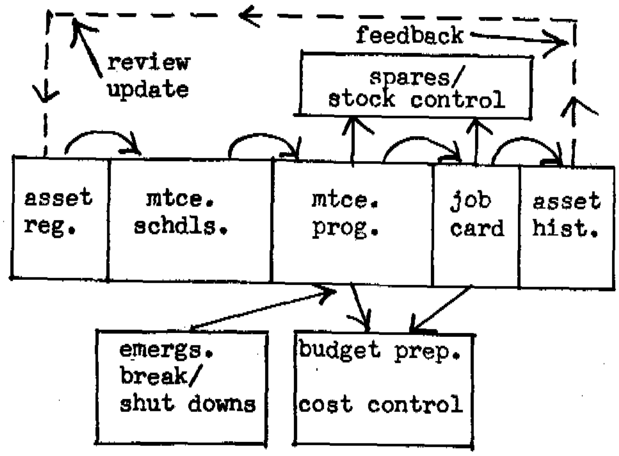

Figure 4

order to meet on-going tasks and new projects. There are also special techniques knowledge, but of special significance, personal skills can perhaps be selected for special reference. A range will include leading, persuading, counselling, thinking creatively, writing reports, communicating, remembering, managing time etc. Most can be regarded as people skills.

Total Asset Management can only be successful, by the very nature of the concepts which concern human effort, if there is team working and total participation. Leadership features strongly and concerns mainly acknowledging the task, the team and the individual in obtaining objectives. Success can be attained through realising that people at work seek self-fulfillment. Managers having good initial attitudes can be very effectively developed. Management is, quite rightly, the first discipline embodied in the definition of asset whole-life approach. Moreover it is a team exercise. (see Figure 5)

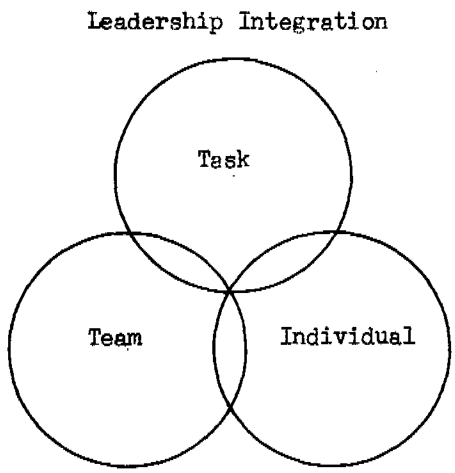

Figure 5

11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

W L Kilama and J N Minjas

The mounting Culex p. quinquefasciatus problem in urban East Africa

INTRODUCTION

The rapid urbanization in Eastern Africa has ushered in unprecidented increases in populations of Culex quinquefasciatus mosquitoes which flourish mostly in such on-site sanitation systems as pit latrines, soakage pits, septic tanks and such other habitats as ditches and drains whose water is highly polluted with organic matter. Other favoured, but less abundant sites include unkept waste stabilization ponds and waste-discharge ditches from agroindustries, at sisal and sugar processing plants. These mosquitoes may also breed in clean water as that in wells, tanks, cisterns, domestic earthenware,peridomestic discarded containers, old tyres and coconut shells. These breeding sites have become more readily available with urbanization with the consequence that Cx. quinquesfasciatus is the most prevalent mosquito in urban East Africa today.

PUBLIC HEALTH IMPORTANCE

Besides constituting the most prominent biting nuisance, Cx. quinquefasciatus is the major vector of urban Bancroftian filariasis, an often disfiguring disease, which is highly endemic in coastal East Africa (1,2,3,4). Infection rates range between 6% and 53% and may average between 20% and 25%. The infection rate in Dar es Salaam is currently about 15%. The commonest clinical manifestation is the hydrocoele and hydrocoele rates in males over 25 years may be over 60% in some localities. Large hydrocoeles result in dragging and tiredness which must inevitably lead to decreased ability to engage effectively in manual work. Surgical and treatment costs may be substantial in endemic areas and hydrocoeles are a stigma and socially unacceptable (5). In East Africa, elephantiasis is relatively rare, but lymph gland enlargement, filarial fever and funiculitis are extremely common. Bancroftian filariasis is therefore a significant public health problem in East Africa.

CONTROL METHODS

Cx. quinquefasciatus has proved difficult to control in many areas. Attempts at the control of these mosquitoes in Tanzania date back to the 1950s. However, despite heavy investments in control, mosquito populations in both the treated and untreated areas have been rising over the years (6). When the species became resistant to the organochloride compounds (7) there was a switch to the use of organophosphates such as diazinon, malathion and chlorfenviphos. However, it is with chlorpyrifos (Dursban) that good results have been recorded (8,9). Recent studies have however shown very high levels of resistance to this insecticide in Tanzania (10). This has necessitated an increase in spraying frequency from once in every 9 weeks in the early 1970s to once every two weeks now, with consequent strains on finances and logistics. The current paucity of foreign exchange has often meant that control activities have not been regular and therefore ineffective. The use of domestic detergents may also have worsened the situation (11). Furthermore, the mushrooming of semi-urban areas, the increase in waste water, the installation of certain types of sanitary facilities are all rapidly increasing the number of potential breeding sites. It has however been suggested that selective larviciding when the insecticides are available may reduce costs (12).

Availability of appropriate materials and costs as well as some elements of human behaviour have precluded effective use of personal protective measures in Tanzania. There is no suitable method of attacking the adult mosquitoes nor is there a suitable biological control agent. The immediate consequences have been significant increases in biting densities in urban and suburban areas (13). Given the relatively good vectorial competence of this mosquito species and the fact that breeding occurs all year round due to the nature of the breeding sites, the resultant implications on disease transmission cannot be underestimated.

ALTERNATIVE CONTROL METHODS

Use of bacteria:

Bacillus thuringiensis (H-14) has potential for mosquito control and is relatively safe for operational use (14). In a small scale field trial, B. thuringiensis was very effective as a larvicide in controlling Cx. quinquefasciatus in pit latrines and cess pits in Dar es Salaam. It did not, however, have residual effects and will therefore require weekly applications, which may complicate antilarval operations (15).

Use of exit traps:

Easily constructed exit traps placed on pit latrine drop holes catch large numbers of mosquitoes (16). The efficiency of these traps is however greatly impaired by the rough surfaces of the existing latrine slabs. This could adversely affect community acceptance. The traps may, however, have a role to play in well built pits and in integrated vector control strategies.

Use of expanded polystyrene beads:

A suggestion has been made on the use of cheap and widely available expanded polystyrene beads as a layer on the water surface for mosquito control (17). The beads are light, biologically inert and non-biodegradable. Limited trials in Tanzania and Kenya showed dramatic declines in numbers of emerging young mosquitoes following treatment. A layer on a pit in Dar es Salaam made over two years ago is still intact. In pit latrines with a long drop, faeces pass through the bead layers which then reform immediately. This incidentally renders the latrines less offensive to users. The permanent elimination of pits as breeding sites may be viewed as a means of providing control teams more time to concentrate on other breeding sites such as keeping the drains clean and larviciding other breeding sites. The savings in the long run may be considerable. Plans are underway to undertake extended field trials in Dar es Salaam and Tanga.

Use of dry sanitary systems:

Since in coastal East Africa where the ground water table is high, pit latrines constitute the major source of Cx. quinquefasciatus breeding, the installation of pit latrines that do not reach down into the ground water table, would preclude mosquito breeding in such sites. Unfortunately mounted structures complicate construction and may not be afforded by the residents of poor periurban areas.

Double-vault compost latrines and the multrum (18) do not reach into the ground water even during the rainy season, and may therefore constitute plausible alternatives. In a previous field study in Dar es Salaam, these systems when properly used remained completely dry and therefore free of mosquito breeding for several years, although pit latrines, in the same area were wet.

CONCLUSIONS AND THE ROLE OF ENGINEERING TECHNOLOGY

The major Cx. quinquefasciatus breeding sites in coastal East Africa are pit latrines, soakage pits, cess pools, gully traps, septic tanks, drains, ditches and artificial containers. The Cx. quinquefasciatus problem is therefore man made and engineering technology must be employed in for example building latrines that do not breed mosquitoes even in high ground water-table areas, the timely repair of septic tanks and soak pits, the prevention of water pool formation, the correct disposal of sewage and sullage, the proper construction and maintenance of waste-water treatment sites, the installation of water reservoirs and containers with tight fitting lids, the drainage of run off water from stand pipes, and the early repair of leaking water supply systems. Engineering technology must also consider provision of such appropriate personal protection measures as housing that can be protected with wire gauze, and house lighting that minimizes mosquito resting inside houses.

Since engineers are a major cause of the Cx. quinquefasciatus problem, and have the knowhow in environmental control measures, they must also be major contributors in rescuing the desperate situation.

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WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

O.A. Obadina

Housing and environmental improvement in Nigeria
Administrative and technical strategies

ABSTRACT:

The various types of housing systems in Nigeria were studied and the differences noted. The existing public health facilities within the different systems in various cities, towns and villages were assessed, identifying areas of sufficiency and deficiency. The need for environmental improvement in all categories of housing systems was established and far-reaching suggestions and recommendations which will ensure a definite improvement in the quality of housing and environment were made.

HISTORICAL BACKGROUND AND NATIONAL AWARENESS:

Various Nigerians including but not limited to Aluko, Fadahunsi, O. O. Oladapo, Oluwande and Obadina have, at various times and places talked about different aspects of environmental problems, protection of the Nigerian environment and even conservation of resources in achieving solutions to the problems of the environment. The most striking and most relevant landmark in national awareness in Housing and the Environment was in 1976 (the environmental sanitation year) when the Nigerian Society of Engineers chose the theme for that year's Annual engineering conference as "Housing and Environmental Development in Nigeria". The conference was held in Port Harcourt and useful recommendations were made.

NATIONAL AWARENESS:

National awareness of the need for the improvement of the environment among individuals communities, local, state and the federal government in Nigeria has always been on the increase. In 1983 the Environmental Pollution Agency Bill was submitted to the National Assembly but unfortunately it never became law before the new administration took over on December 31, 1983. The awareness, since 1984 can be said to be unprecedented. There was hardly any week in 1984 that the mass media particularly the press does not carry an article or a policy statement either by an individual or an agency or representative of government on the issue. Sanitation committees and task forces have been set up by some state governments while sanitation edicts have been promulgated by some. Silent wars in one form or the other are being waged against filth in different parts of the country. This national awareness is undoubtedly the first right step in the improvement of the environment in which the various housing systems and patterns develop.

LAND DEVELOPMENT AND TOWN PLANNING:

Aside from population the most important factor that affects environmental development and improvement in Nigeria today is land development. This is because the type of land development and housing patterns can, to a large extent, dictate the type and/or cost of any sanitation and surface water systems to be provided or the type of environmental improvement that can be embarked upon. In areas where the buildings are closely grouped together difficulties occur with respect to access and available space for construction of facilities to improve the environment. On the other hand in areas where the buildings are too widely spaced the costs of sophisticated environmental improvement facilities like sewerage are usually not within reach of the few people that live on the land.

Planning of development in most of the cities, towns and communities in Nigeria today has been devoid of all-embracing overall plans and control has been the responsibility of various government agencies without adequate coordination. While markets, motor-parks, council roads, maternity centres and dispensaries are controlled by the local government, state buildings, state roads, some new estates and the state Government

Residential Areas are all controlled and maintained by the state governments. The Federal Government however looks after the development, improvement and control of Federal roads and buildings. The various Planning Authorities all over the country are in charge of development and control of privately owned estates. The unpatriotic and corrupt attitude of many officials in the Planning Authorities have contributed in no small measure to development of modern slums. In addition to the controlled housing development enumerated above, random unplanned and uncontrolled housing development resulting in traditional slums still exists in the 'Old Town' areas of Nigerian cities. Within these central core areas the greatest problem inhibiting environmental improvement is access. There is no doubt that the apparent lack of coordination among the various government agencies controlling different portions of the cities towns and communities is a basic vital factor affecting environmental improvement.

HOUSING PATTERNS AND QUALITY OF HOUSES:

Before any specific improvement in the quality of the environment can be suggested recommended or implemented mention has to be made of the patterns of housing and quality of the houses themselves. In Nigeria today, all possible housing patterns and house qualities exist. These can be itemised as follows:

(a) Old Development

(b) Private New Development

(c) Government Residential Areas and Government Agency Owned Estates

(d) Rural Development.

The pattern of housing in the central core of Abeokuta is shown in Table I.

STRATEGIES FOR BETTER HOUSING AND ENVIRONMENTAL IMPROVEMENT:

1. Administration:

In order to ensure effective implementation of the technical recommendations in this paper and reduce or remove the present state of confusion in the administration of Housing and Environmental Improvement, it is imperative to establish relevant organised bodies and restructure existing ones in Housing and Environment at the Federal, State and Local Government levels in Nigeria. This could take the following forms:

(a) The Housing Division of the Federal Ministry of Housing and Environment should be merged with the Federal Housing Authority to be in full control of Federal Housing matters including regional, urban and rural planning in the country. The new set up should operate on profit-oriented basis and cater for itself and coordinate the activities of the states counterparts.

(b) The Housing Divisions of the State Ministries of Works and Housing should be merged with the State Housing Corporations or Authorities and Boards to be in full control of all State Housing Matters including urban and rural planning in the State. They must also operate on profit-oriented basis and fend for themselves.

(c) The long awaited Environmental Protection Agency must be set up immediately and absorb the Environment Division of the Federal Ministry of Environment to be in charge of regulation, prevention or control of environmental hazards at the Federal level. It should coordinate the activities of the State counterparts.

(d) The Public Health divisions of all the Local Governments in the country whose manpower, to date are grossly inadequate should be merged with Sewerage and Drainage divisions of the States Ministries of Works and Housing to consistitute State Wastes Disposal Boards to be in charge of wastes collection and disposal and control of environmental hazards in the States.

(e) A Coordination Bureau for Housing and Environment must be set up to do nothing but coordination of the activities of the Federal and State Housing Organisations and Wastes Disposal Boards as well as those of the existing Federal Ministry of Water Resources and the States Housing Corporations and Boards and relevant Institutions of Higher Learning.

2. Institutional and Industrial Cooperation:

To date, there has not been any marked relationship between institutions and industries on one hand and Government Agencies on the other in matters relating to the problems of the

TABLE I - PATTERN OF HOUSING IN THE CENTRAL CORE

Sample Area No.	1	2	3	4	5	6
No. of Compounds	27	20	14	6	9	13
No. of Houses in Compounds	126	118	63	26	81	64
No. of Single Houses	6	7	4	26	4	1
Total No. of Dwelling Houses	132	125	67	52	85	65

environment. The little study carried out for this paper revealed that NISER made an effort in 1974 in this direction when it organised a seminar on Research Needs in the Field of Environmental Sanitation. A few meetings were held by key participants in the Seminar as a follow up to the seminar. Since 1976, nothing has been heard again and the relationship between that institution and the then Ibadan Wastes Disposal Board has been killed. In 1977, Adedipe and Nwoboshi both of the University of Ibadan prepared a paper for the Ford Foundation, West Africa Office on Resource and Environment-Oriented Research Programmes in the Ibadan Area and recommended among others that the Foundation should consider supporting of research programmes in Environmental Sanitation, Land Use and Natural Resource Management, Pollution of Air, Water and Food. The strong recommendation put forward in this paper is that Industries should be sponsoring environment-oriented research programmes by cooperating with the various institutions where relevant courses are offered. The institutions, must however, ensure that the research subjects to be approved are those that are relevant to the Nigerian environment. Also both the institutions and industries must ensure adequate cooperation with the various tiers of governments in ensuring that existing and would-be legislations to protect and improve the quality of housing and environment are strictly abided with.

3. Housing Improvement:

Some of the strategies which can be adopted to ensure Housing improvement in Nigeria today include:

Slum Upgrading:

So far, only Lagos can be said to have experienced an amount of slum upgrading in Nigeria. As a matter of fact cities and towns like Abeokuta, Ibadan, Oyo, Bauchi, Kano, Onitsha, Asaba, etc. are all long overdue for slum upgrading. Nigerians have always reacted sharply against slum upgrading. This is mainly because residents to be affected are always relunctant to leave the environment in which they have been for years. Slum upgrading projects have now assumed international outlook. Casablanca in Morocco, Peru, Togo and Tamale in Ghana have all benefited from USAID in this direction.

Housing Finance for Existing Substandard Houses:

The policy of different housing agencies in Nigeria on loans is to grant loans for new buildings. To ensure the much desired good physical and mental health for Nigerians and a healthful environment for them, this policy must right away include loans on low interest basis for home improvements. Alternatively, the loans may be in form of tools and materials to be paid for by the beneficiary.

Decentralization of Urban Development:

This is an area where Nigeria governments, federal and state have not shown much interest. Except for Ajoda in Oyo State and Abuja the new Federal Capital, development of secondary cities has been at a standstill since Adam. Though creation of secondary cities can be expensive, it should be noted that the environmental problems created in the existing big cities may, without adequate control cost more to abate than developing new settlements, well planned and more organised than older towns.

4. Environmental Improvement:

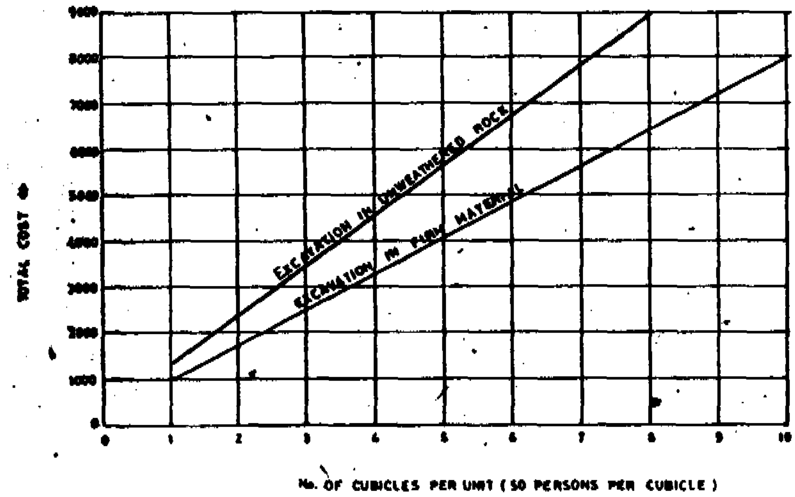
In order to ensure improvement in the quality of the Nigerian environment some of the most vital steps to take include the following:

War Against Garbage:

The overall strategies for improved refuse collection consist of:

A study to provide the guidelines of the most suitable method for the particular community.

Pilot schemes to test the proposed methods.



NB: Life of pit likely to be less if in impermeable rock and renewal/emptying cost greater

FIG 1 COST GRAPH - PIT LATRINES

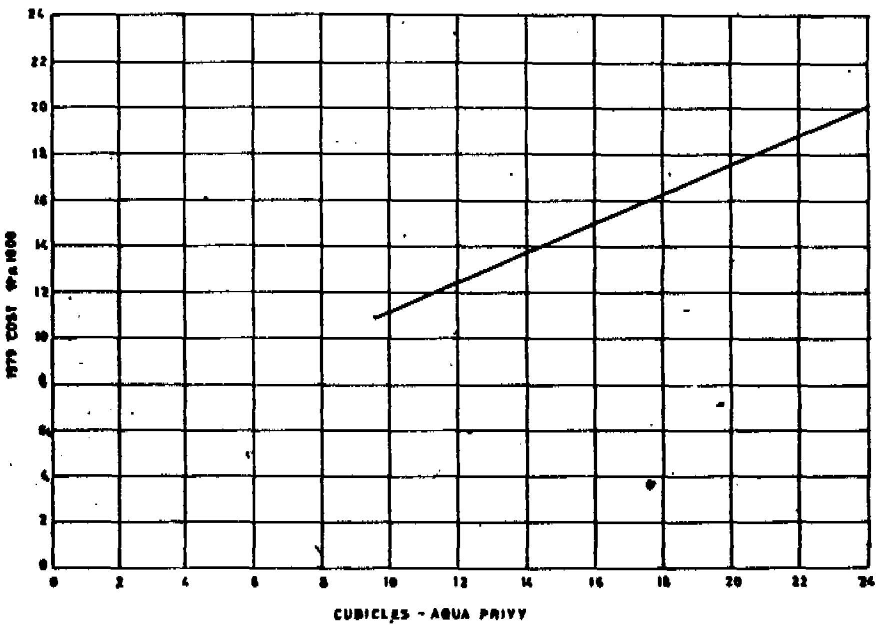


FIG 2 COST GRAPH - AQUA PRIVIES

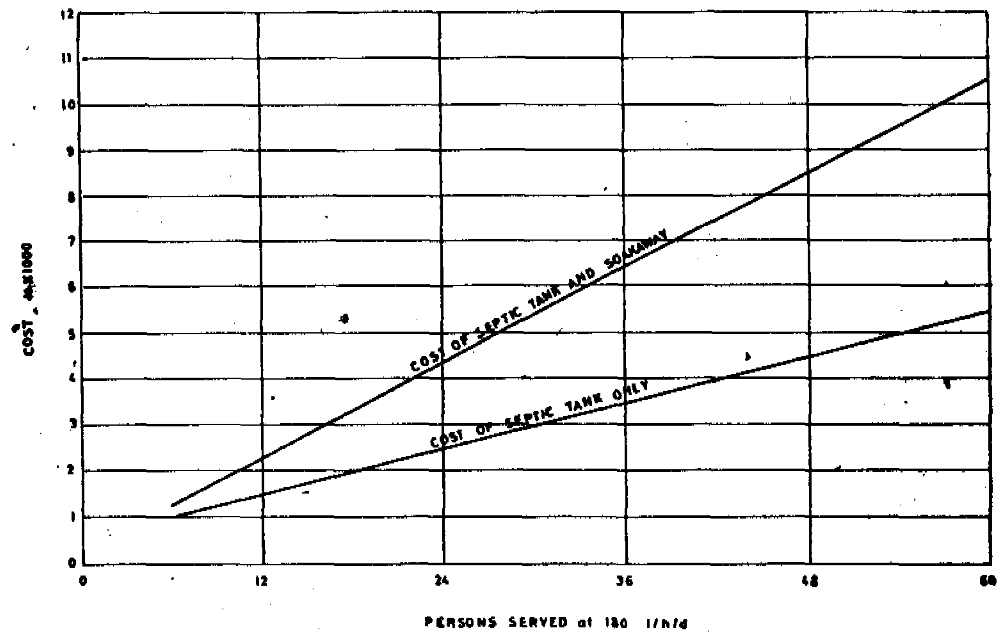


FIG. 3 COST GRAPH - SEPTIC TANKS

Preparation of masterplans based on the result of the pilot projects and

A meticulous implementation of the Masterplan.

Appropriate Technology for Sanitation:

Results of various studies in which the author has been involved in Nigeria since 1969 have shown very glaringly that more than 80% of the population of the study areas cannot afford the capital cost of the sewerage system. Therefore the only reasonable strategy for Nigeria to adopt for excreta and wastewater collection and disposal is the 'Appropriate Technology' options. The cost graphs for some of these options for the City of Abeokuta on which the author worked in 1980 are shown in Figs. 1 to 3.

Sanitation in Housing Estates:

Most of the package treatment plants installed in many housing estates in Nigeria have broken down for years for lack of spare parts with no hope of reactivation. In the light of these, wherever sewerage is to be installed, the treatment recommended is the Wastes Stablisation Pond System - reasonably effective, cheap and hardly breaks down.

Appropriate Technology for Water Supply:

Like for sanitation, the immediate measures strategy for supply of Water to Nigerians is by construction of deep wells and boreholes both filted with either handpump or submersible powered pump where possible.

CONCLUSION:

Before Nigeria can be certain of an improvement in the quality of its housing and environment it must first of all discard the idea of keeping up with the Joneses, hold the bull by the horn in making necessary administrative reorganisations, start improvement in low-income communities, put aside sophisticated tastes and concentrate on Low-cost options appropriate technology and recognise the need for multi disciplinary approach, coordination and cooperation among various government bodies, industries and institutions of higher learning to achieve the much need housing and environmental improvement.

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WEDC 11th Conference: Water and sanitation in Africa: Dar es Salaam 1985

SESSION H

CHAIRMAN:- Mr. N.K. Mwimbira
MAJI
Dar es Salaam Tanzania

Discussion

1. Mr HUTTON asked if dragonfly larvae had been tried as a biological control for Culex larvae. He commented that elevated pit latrines were an engineering solution to the water table problem.

2. Professor KILAMA replied that they had not tried such biological control but that he thought that, after an initial period, predator-prey relationships would become oriblematic. He suggested that the time-lag in fly population increases relative to that of mosquitoes would also be a problem. In his opinion elevated pit latrines were a poor solution as building costs escalate, leakages directly pollute the ground surface and these latrines are socialogically embarassing.

3. Ms. BURT recommended, in addition to technological preventative measures, large scale education and awareness-raising programmes directed at both the general population and government. Behaviour and attitude changes should eliminate breeding sites caused by poor maintenance or illegal practices. She had experienced a number of superstitions associated with hydrocele in Dar es Salaam and wished to know what the Ministry of Health or the Health Education Unit were doing in this respect.

4. Professor KILAMA answered that there was good awareness among the medical profession of the problem but agreed that the general public did not understand the cause of hydrocele. He made no comment on education programmes.

5. Dr. MTEY stated that the fight against mosquitoes in urban centres in Africa must adopt a mix of several pertinent strategies rather than relying on insecticides or engineering techniques exclusively. Raising community awareness and involving the community in various environmental sanitation measures must be given more scope than hitherto. The rising costs of insecticides together with mosquitoes' resistance pedicate more research so as to obtain an optimal mix of strategies in all areas.

6. In replying, Professor KILAMA agreed saying that finding the right mix was inherent in integrated vector control. He stressed the value of engineering measures, including timely maintenance, in mosquito control.

7. Mr. MUGONDO requested additional information on the installation and functioning of the polystyrene beads together with comments on their effectiveness at trial sites.

8. Professor KILAMA explained that the beads were imported in granular form and expanded either at a local factory or by immersion in boiling water. The expanded beads, which are non-bio-degradable are poured onto the faecal/water surface making it more acceptable. The beads stay on the surface, rising and falling with the water table. One pit latrine had an intact surface of expanded beads after 2 years of usage.

9. Mr. HAWKINS wished to know the cost in U.S. $ of treating one pit with beads. He reported that vent-pipes reduce the incidence of Culex breeding in latrines by more than 50% and that natural scum seems to occur more in pits of smaller cross-section, suggesting that the problem in Dar es Salaam is related to large pit dimensions.

10. Professor KILAMA did not have the exact costings but stated that cost was initially higher than that for insecticides but that, as one treatment lasted for years, the beads were cheaper in purchase costs by the second year. Beads constitute an investment with no recurrent costs, logistical problems, labour salaries etc. He suggested that a 50% reduction in numbers when latrines are producing thousands of mosquitoes is insignificant in reducing the biting nuisance and disease transmission rate. On the question of natural scums, which were outside his experience, Professor Kilama supported instigating collaborative studies.

11. Mr. MBWETTE asked which size of beads had the best blockage efficiency on mosquito breeding. He wished to discourage the large-scale use of oil for limiting or preventing mosquito breeding because of the potentially permanent contamination of aquifers.

12. Professor KILAMA replied that in laboratory trials several sizes of beads were effective; the depth of the layer being varied with bead size. He totally agreed with Mr. Mbwette's comments on usage of oil. An additional problem in Tanzania was saponification as people also bathed in latrines. Furthermore, oil interfered with the natural

digestion of pit contents by bacteria and other organisms.

13. Mr. HUTTON, commenting on the paper by Mr. Obadina, said that Kano and Maiduguri in northern Nigeria were both disposing of garbage by landfill and were creating parkland areas. In Kano communal toilets for city areas were being privatised and so run efficiently and so profitably that competitive tenders were sought. In addition several declarations regarding indiscriminate defaecation had been made.

14. Mr. OBADINA agreed with Mr. Hutton saying that similar situations now hold for most state capitals of Nigeria. Nigeria had never been as clean as at present. For example, Ibadan City had been zoned into 17 areas, each one being given to different contractors for collection and disposal, to landfill sites, of garbage.

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CLOSING ADDRESS

Hon. Paul Bomani Minister for Lands, Natural Resources and Tourism

Mr Chairman, Distinguished visitors, Participants, Ladies and Gentlemen. Today you have come to the end of a three day Conference on Water and Waste Engineering for Developing Countries which has been held in Tanzania for the first time. It was timely that such a conference is held here and particularly so in Dar es Salaam where, as you may have seen for yourselves during the field visit, a massive rehabilitation programme is in progress, and a Ventilated Improved Pit (VIP) latrine Kit Manufacturing Plant, the first of its own kind is in the final completion touches. You have now seen for yourselves the dangers inherent in neglecting maintenance of existing assets.

Mr Chairman, for us Tanzanians, we count ourselves fortunate to have had this opportunity to be Host at this conference for it enabled the majority of our people to meet in this house experts and professionals of various disciplines on water and waste engineering who have accepted to come and exchange experiences and learn from each other of your successes and failures in your implementation programmes, so that in the years to come, you can serve your people better.

You have discussed many issues concerning operation, maintenance and rehabilitation of water supply and sewerage systems, Low-Cost Sanitation including the most delicate issue on community participation which directly touch the welfare of the many rural and urban poor whose presence at this International gathering would not have been possible, but I believe that what has been deliberated is representative of their needs and interests and that when you go back to your countries you will disseminate as much as possible the outcome of the recommendations of this conference.

Mr Chairman, you have been discussing and trying to find solutions and answers, on ways and means of utilizing this valuable commodity called "Water" without which life could not have been possible. Water is one of the most valuable yet is one of the least valued resources. When this commodity is available in in abundance, both in quality and quantity, its existence is ignored and there is a tendency of abusing it, but when there is scarcity its existence is strongly observed. This is now the case in most developing countries. In Tanzania, it is only recently that we held a National Conference on Afforestation. Our forests are being depleted faster than they are replaced. The results have been very conspicuous. Some of the water sources and springs have gone dry and others are continually diminishing. This is seen in Shinyanga, Singida and Dodoma Regions of Tanzania and I guess it is also the case in your own countries. The outcome of this is suffering. It is your duty, therefore, to continue to encourage and educate the masses of the need to plant more and more trees and preserve existing ones. In so doing we shall conserve our water sources, minimise erosion and hence avoid desertification. It is only through this that we can preserve our environment.

Mr Chairman, it goes without saying that, once water is made available to a community whether within reasonable reach or at a fair distance, then its continuity of supply must be guaranteed to the community to avoid panic, frustration and disruption of other productive activities. It is no good continuing to build new schemes when those that have been constructed at great cost are inoperative through poor maintenance or operation. It is your duty to train the right skills in order to achieve the benefits of these investments. This, therefore, stresses the need to encourage the use of the most appropriate technology mix during design. In Dar es Salaam for example, the sewerage system started deteriorating some ten years ago and we are compelled to restore the system at a great cost - of more than Tsh 425 m/=.

We have a saying in Swahili "Usipoziba ufa utajenga ukuta" - the nearest meaning in English would be an adage that 'a stitch in time saves nine'.

Mr Chairman, when we talk about water, we are not only talking about the quantity, we are also concerned about the quality. The developed world is now spending large sums of money to purify water that was once acceptable for domestic use. We have continuously abused this commodity by throwing into the water courses and water bodies toxic and harmful industrial effluents which are a result of the activities of Man and his animals without due regard to the consequences. The high seas have become a common place for dumping toxic effluents without due regard to the danger on fauna and flora. Again, it is now your duty to discourage, if not abolish through legislation such malpractices through proper handling and disposal.

My speech will not be complete without mentioning the dangers of rural urban migration which has a direct impact on the services being provided - water supply, sanitation, health services, communication, schools, housing, to mention only the major ones. People have a tendency to move to the towns in anticipation that services will be forthcoming without due regard to the financial implications. The result of this has been the creation of slums and overcrowding. The authorities concerned can no longer provide adequate water to the communities, cannot provide adequate garbage collection facilities, schools, health facilities, roads and surface water drainage systems. These communities therefore become agents of pollution and unless they are assisted in improving their hygiene through proper construction of cheap excreta disposal facilities, fulfilling basic minimum health standards, proper garbage collection and disposal and in preserving their water supplies they stand a danger of ruining our environment and our own lives. It is therefore important that I stress the need to integrate primary health care, water and sanitation with the ultimate aim of decreasing morbidity and mortality and ultimately improving our wellbeing.

Mr Chairman, it is an expensive affair to organize a conference of this magnitude without assistance both financial and in kind. I would therefore like to take this opportunity to thank the following companies: Howard Humphreys (Tanzania) Ltd, H P Gauff, Carl Bro (Tanzania) Ltd, Nor Consult, J W Ladwa and Spencon Services of Nairobi, Kenya for their donation towards assisting in making this conference a real success.

Finally Mr Chairman, I hope you have enjoyed your stay here in Dar es Salaam despite some of the inconveniences you may have experienced for which we apologise. And I wish you all safe journey back home and please convey our most heartfelt greetings to all back home.

I declare this conference closed.

THANK YOU

VOTE OF THANKS

Dr. P. Mtey

Ministry of Health, Tanzania

The Honourable Minister of Lands, Natural Resources and Tourism, Mr. Chairman, distinguished guests, fellow participants, ladies and gentlemen, it is my privilege and pleasure to perform the pleasant task of thanking you, sir, on behalf of the conference participants for taking time off your busy parliamentary session schedule to officially close this conference. I am sure I will be speaking on behalf of every participant when I say that your sage, sound, stimulating closing address is a fitting close to what has already been a very successful conference. It's success, sir, I may suggest has been due to several factors:-

(1) it has been well attended with 133 participants from 27 countries, 17 of which were African

(2) the papers presented have had great scope, depth and relevance

(3) there have been heated but constructive discussion sessions
and

(4) your presence, sir, as a symbol of the city, the country, the people, the government and the party.

Your personal global experience has helped to give context and direction to the implementation of decisions taken and recommendations made.

I would like to thank you Minister and through you the people, party and government, for making us remember WEDC as <u>W</u>e <u>E</u>njoyed the <u>D</u>ar es Salaam <u>C</u>onference.