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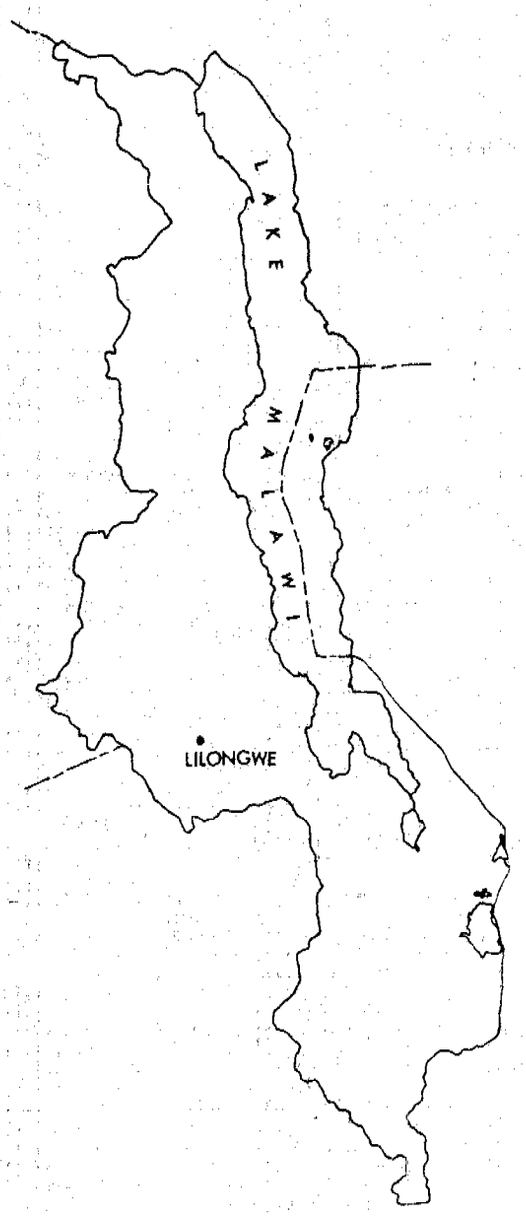
THE EDITED PROCEEDINGS OF THE 13th WEDC CONFERENCE



RURAL WATER AND ENGINEERING DEVELOPMENT IN AFRICA

Malawi 6-10 April 1987

published by WEDC

University of Technology
LOUGHBOROUGH
Leicestershire LE11 3TU
England

February 1988

ISBN 0 906055 19 9 softback

Printed by the University Printing Unit

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Malawi: 1987

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Introduction to Conference

C Clark OBE Permanent Secretary,
Ministry of Works and Supplies

Sirs, as Principal Secretary for the host Ministry, it falls to me to introduce the Honourable Louis Chimango, Minister of Health, who on behalf of His Excellancy the Life President, Ngwazi Dr H Kamuzu Banda, has kindly come here today to deliver the Opening Address and officially open the 13th WEDC Conference.

Before doing so I would like to thank firstly all the donors who have made the conference possible and then to spend a very short period giving guests and delegates the background to today's events.

Today's conference is the culmination of two years of effort. WEDC, based at Loughborough University and covering water and wastewater engineering for developing countries, is world renowned for its interest in applied technology in the field of water and its dedication to advancing the principles of sanitation and health, particularly in the rural communities. These principles find an equal commitment in Malawi from the Government and the many other agencies with whom the Government works. Because of this a ready partnership arose between WEDC and the Ministry of Water Supply when, in April of 1985, Professor Pickford proposed Malawi as the host country for the 13th WEDC Conference. His Excellancy the Life President graciously approved the proposal to host the conference in February 1986. Since then a local committee, consisting of a multi-membered team from the Office of the President and Cabinet, the Ministries of Works and Supplies, Health and Community Services and the Lilongwe Water Board, has been working behind the scenes to bring this morning's meeting and this week's events to fruition.

I would like to take this opportunity to thank that team for their untiring efforts in this respect. One does not gather representatives from some 20 countries without a considerable amount of work. The fact that this additional burden, imposed upon them in addition to their already onerous daily duties, was picked up so willingly speaks volumes of praise for them. However, that they have done their work well is seen clearly by the presence of you all today anxiously waiting to begin the affairs of the Conference.

Therefore, with no more delay and with much anticipation may I call upon the Honourable Louis Chimango, Minister for Health, to deliver his address and officially open the Conference.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Opening Address

Hon L J Chimango MP, Minister of Health

The Conference Chairman, Professor Pickford
Member of the Diplomat Corps
Principal Secretaries
Members of Parliament
The District Chairman, Malawi Congress Party
The District Chairman, League of Malawi Women
The District Chairman, League of Malawi Youth
His Worship the Mayor of the City of Lilongwe
Delegates
Distinguished Guests
Ladies and Gentlemen

It is my very great pleasure and privilege to be able to welcome all of you on the occasion of the official opening of the 13th WEDC Conference. I am particularly grateful to be given the opportunity to welcome the visitors to Malawi. We who live here believe Malawi has a wide reputation for friendliness and we trust that you will discover just how well deserved is this reputation. Therefore, I hope that while you are in Malawi you will not find it necessary to spend all of your time in debating the important affairs of the Conference but that occasions will arise that will allow you to mingle with the citizens of our friendly nation.

However, it is not only our desire to add to our reputation as the Warm Heart of Africa that made Malawi eager to host this Conference. It would appear to us that the whole philosophy of the WEDC organisation is totally compatible and supportive of the declared aims of the Malawi Government. These aims have been eloquently identified on numerous occasions by the Father and Founder of the Malawi Nation, His Excellency the Life President, Ngwazi Dr H Kamuzu Banda when he has made it abundantly clear that the main responsibility of his Government is to see that the people of this nation have adequate food, proper clothing and good houses. In reaching out to achieve these objectives it has been necessary to build up the infrastructure of the country and it seems to us in Malawi that WEDC's enthusiasm for the International Decade of Water Supplies and Sanitation Development and the dedication shown to the these of Health for All by the Year 2000 would make WEDC and Malawi partners in a search for an improvement in the quality of life for our population, particularly those living in the rural areas. Malawi has made great strides since Independence in improving the infrastructure and the facilities for the people living in the rural areas. We can point with pride to our gravity-fed water supply system as being one of the finest examples of the combination of appropriate technology and enlistment of local participation. Examples of the scheme are to be found in over 20 districts in Malawi and at present we are able to boast that 55 gravity-fed schemes are in operation consisting of a total of 5,700 km of pipes and 8,000 taps. All of these are in areas where previously only inadequate groundwater or contaminated wells were available.

Our Village Access Roads and Bridges project have also attracted much admiration. With a policy of providing for all weather access for light traffic to markets, schools and health centres, the pilot project in the Northern Region of Malawi has created 147 km of roads and built 175 bridges all again involving local participation and utilising methods that are within the reach of those who will use and maintain the roads.

In the field of rural housing, once more we have much to be proud of as also in our urban sanitation projects. Both projects, as I am sure Delegates will find out during the cours of the Conference, contribute much to improve housing in the rural areas and better sanitation in our high density site and service plots in the urban areas.

All of these projects contribute not only to the quality of life but to the sustainment of life itself. As Minister of Health, I am very much alive to the problems created by water-borne diseases. Such diseases are perhaps the greatest threat to life expectancy on the continent of Africa and their containment and elimination is one of the main objectives of the Ministry of Health's drive towards Health for All by the year 2000. I am therefore particularly happy about the advances made in Malawi towards providing potable water and improving sanitation. I would like to include my thanks to all the donors who have helped make these advances possible in Malawi.

But we cannot in any way afford to be complacent. The gravity-fed water supply system accounts for supplies to only 1.2 million of the rural population and it has to be recognised that the possibilities of expansion are

limited. In this situation we must turn to the other alternative source of rural water, that of groundwater supply. However, it is oatently obvious that the country cannot afford to carry on as has been done traditionally in the past by making both supply and maintenance of boreholes the responsibility of Central Government. Our resources are limited and our need to explore new possibilities for both construction and maintenance is clear. These will include contract drilling for borehole construction, the provision of lightweight pumps that can be handled without the need of winches and the participation of the local community at an early stage in both siting and maintenance. These ideas must be moved from the drawing board into the field urgently and your help in planning this is needed.

In other fields assistance and ideas are also needed. If our Village Access Roads and Bridges policy is to continue to be a success it must be supplemented by a rural transport policy that will provide transportation facilities which are both light and reliable thus causing a minimum maintenance problem on the road and providing a maximum service for the users.

Our rural housing programme cannot stand on its own. We must intensify our efforts to train and instruct owners and occupiers in the simple arts of maintenance and construction, and the experience of others in this field will be welcomed. From the summary of the papers presented I note that many of these problems will be addressed by the Conference delegates in the days that lie ahead. I am impressed by the content of the papers and the calibre of the delegates. I know that among you are many learned experts but I would plead with you not to allow this to become an academic forum. I would ask all of you not to forget the people but to apply the increasing knowledge of appropriate technology and the increasing understanding of rural communities and their involvement.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Keynote Address

L A H Msukwa, Director Centre for Social Research

Mr Chairman, ladies and gentlemen, I feel greatly honoured to have been asked to give the keynote address to this important conference. I am not a water engineer nor a technician but a Social Scientist with interest in rural development in general and rural water supply in particular. I guess it is due to this interest that led to the organising committee to ask me to give this address as the theme of this 13th conference in Rural Development in Africa.

Indeed the term rural development encompasses all efforts made in order to improve the standard of living of rural communities including water supply and sanitation schemes, health development, agriculture, etc. Very few countries in Africa can look back to the past with any degree of satisfaction. News prints are full of failure stories, declining per capita food production, starvation in a number of countries due to natural and/or man-made calamities, high rates of inflation, high debts, etc. In the field of water supply and sanitation, the majority of our rural population remain unsaved. Conferences like this one enable us from Africa and Asia to share our ideas, experiences and evaluate our past efforts. More important though, for the people in rural areas, is what we do with what we learn from each other after returning to our own countries. The success of WEDC series of conferences will not depend on how many conferences have been held but to what extent have they contributed to better implementation and management of Water Supply and Sanitation Schemes in Africa and Asia.

I have gone through past conference papers and I note that three topics have always featured high in the discussions. These are appropriate technology, maintenance, and community participation. The three areas or subthemes are central to most of the papers that are to be presented at this conference. I will briefly dwell on each of the three areas.

To many people, appropriate technology has meant low-cost technology. The basis for this is that we are predominantly dealing with poor communities, the vast majority of whom are illiterate. The technology employed in these communities, it is agreed, should therefore be simple and low-cost. The authors of paper 2 remind us that attempts to increase the pace of providing improved community water supplies have often been frustrated because the technology used is impossible to sustain under village conditions. We are therefore advised to ensure that "technology chosen should match the financial and human resources available in the region".

There are two other factors which I think are important in considering what is appropriate technology. The first is the cultural setting within which it is going to be implemented. In other words, the technology must be acceptable to the population who are to benefit from it. The developing countries are full of case studies, especially in agriculture, where the population has rejected a given technology, e.g. improved seed, because it does not really conform to established ways of doing things. Secondly and related to this is that a technology should be considered appropriate only if it provides a solution to the problem we are trying to solve. If our problem is lack of adequate potable water, then the technology we employ must be one that is going to provide potable water to our target group to the extent that the water will be available in adequate quantities all the time.

We sometimes become short sighted in our search for "appropriate" technology and only look at the cost of such technology at the time of installation without much consideration as to the cost of maintaining such a technology, its efficiency and availability of spare parts. We have a clear example in Malawi with regards to shallow well pump which is very cheap but most of the wells on which it was installed are either not being used or the covering has been removed and people draw water with a bucket due to the fact that the pump is broken down and spares cannot be obtained anywhere. However cheap such a technology might be it is not appropriate. On the other hand we are told (paper 1) that some of the pumps installed during the early days of missionary work in Sierra Leone are still working today. This is over 80 to 100 years ago and I ask - are such pumps appropriate? Before any technology can be considered appropriate it must at least fulfil the three conditions; it must be affordable and sustainable; it must be acceptable to the intended beneficiaries and

It must meet the needs of the beneficiaries. This may even mean that a piece of technology considered appropriate in one country may not be suitable for a neighbouring country and this point is made clear in paper 12 when the author writes "The fact that these latrines are suggested to have worked well in other places should not be used as a basis for universal adoption in all countries and even from region to region".

The management and maintenance of completed projects is another area that has received a lot of attention in the previous WEDC conferences and this one too. The author of paper 2 reminds us of the gap that exists between what was planned to be achieved during the International Drinking Water Supply and Sanitation Decade and what has actually been done. The problem, they say, is compounded by the growing number of completed projects which are broken down and abandoned or functioning well below their potential capacity. Africa cannot afford such wastage and yet it is here where "white elephants" are commonplace due to lack of adequate provision for maintenance of completed projects and the use of "out-of-place" technologies. The problem arises due to reliance on expensive and unsustainable maintenance systems which are often highly centralised. In the field of water, the authors of paper 2 give some suggestion ".....pump design should be suitable for repair by a trained caretaker or area mechanic with basic tools ..... Highest potential is achieved when the community is involved in all phases of the project, beginning with the planning stage". We are told in paper 9 that prior to 1980, Malawi was experiencing serious maintenance problems in its groundwater systems due to an inadequate and expensive maintenance system. One of the suggested solutions to the problems was "maximum involvement of the villagers".

This brings me to the third aspect I would like to touch on, "community participation". The term community participation has become fashionable in today's development literature. There are still some crucial questions that are not clear in literature, who in the community should participate ? When should people be invited to participate? At what level should the community be invited to participate, ect.

To many people, community participation has often meant the community providing local materials, labour and sometimes even cash to complement government or development agency resources. Seen in this way, community participation has become a means of doing things more cheaply. This in itself is important but the benefits for community participation are deeper than just being able to do things more cheaply. At times, genuine community participation may even lead to project investment costs being higher than if hired labour was used. It is quite conceivable that a project that could easily be implemented within six months using hired contractors and no involvement of the people may take up to two years or more if the community was involved in the planning and implementation of the project. In the short term, given the high rate of inflation the cost of materials and equipment may increase to such an extent as to make the project much more expensive when it is finally completed.

To me this must be seen as a short term loss if it happens. Genuine community participation instills in the people a sense of pride and responsibility. It also helps cultivate skills, both organisational and technical, that are required for sustaining the development process. The rural piped water schemes in Malawi provide a good example where vandalism is almost nil and schemes are working fifteen or more years after completion through a joint effort by the government and the community. Through this programme, it has been demonstrated that given proper community organisation, an efficient back-up system and adequate resources, the community is capable of undertaking most of the maintenance work required in some projects meeting up to 78% of maintenance costs.

In order to achieve genuine community participation "experts" must stop thinking, planning and doing things for the people but with them. It calls for a degree of humility on the part of the "experts" to recognise that they too can learn from local people anden enter into genuine partnership with the local people. The view that local people have to be told what must be done has some times led to very costly mistakes. In agriculture, for example, lots of efforts have been made in persuading people to practice mono-cropping to the extent of denying credit facilities to those who did not follow our rules. In spite of this, many people have resisted and it is only a few years ago that agriculturists have come to recognise the value in multiple cropping and are beginning to actually encourage it. Genuine community participation may save us from making such costly mistakes by attempting to understand why people do things as they do.

There are other interesting issues raised in the papers that are going to be presented and I do not wish to comment on all of them. However, allow me just to mention the importance of integrated rural development approach which comes out in papers 6 and 9. Amanda Geake warns "..... Those responsible for planning Sanitation Schemes need to recognise that a potential pollution hazard

exists, and to be aware of the importance of ground water for potable supplies. It would be desirable for low-cost sanitation and ground water supply programmes to be planned on an integrated basis with careful design to minimise the aquifer pollution".

There are several interesting issues raised in the different papers. It is my hope that all of them will be fully discussed during the conference both in the hall here, in groups, and informally during break periods. My last call is that let the environment we are in today not distract us from the real problem area, the rural people.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Small-scale irrigation in Zambia

J A Stoutjesdijk and Josy B Siakantu

SUMMARY

Some attempts of small-scale irrigation developments have been made along the shore of Lake Kariba in Zambia. In Chiyabi a 10 ha unit has been constructed by GRZ/FAO where 30 farm families are presently cultivating two crops per year. These farmers eventually have to run the scheme as a cooperative without too much Government involvement. The IRR of 25% is favourable. The scheme layout is replicable in many other areas along Lake Kariba.
In the paper development aspects of Chiyabi are discussed and recommendations for a strategy for future developments are given.

1. INTRODUCTION

Zambia has a large irrigation potential, but so far irrigation development is still in its infancy. It has been limited to approximately 20,000 ha, most of which are under large scale irrigation both in the parastatal and commercial sectors.
Some attempts of small-scale irrigation developments have been made. The Government of the Republic of Zambia (GRZ) has been involved in developments along Lake Kariba in the Southern Province. Buleya Malima (61 ha) and Siatwinda (32 ha) were developed in the early seventies, while Chiyabi (10ha) was developed in 1985-86 with FAO technical assistance. Buleya Malima and Siatwinda have not been very successful to date, not only because of operation and management problems, but also because of the receding Lake waterlevel during the drought years from 1981-84, as a result of which the pumps fell dry. The schemes have been partly brought back to production during the past two years. The development in Chiyabi, which is located at a more strategic place along the Lake as far as water source is concerned, and its lessons learned so far will be discussed in the next paragraphs.

2. CHANGING NEED FOR IRRIGATION IN THE GWEMBE VALLEY

The local inhabitants of the Gwembe Valley along the Zambezi River, the Gwembe Tonga were resettled in the latter part of the fifties with the creation of the Lake Kariba. Approximately 36,000 people were relocated on the higher, less fertile areas along the shores of the new Lake.

The Tongas continued with Zilili farming, i.e. utilization of the residual moisture after the recession of river or Lake water. In order to increase the reliability of this method of farming, the Government and FAO embarked on a programme of pilot small scale irrigation development. Planning for Chiyabi was done in 1982. As much as possible use should have been made of the floodwater of the Lake to grow a rice crop during the rainy season (November-April). During the dry season (May-September) vegetables would be grown on residual moisture, supplemented with irrigation water when needed during the latter part of the dry season. For this low-lifting engine pumps would be used.
However, during the drought period from 1981 to 1984 the Lake level receded from 485.1m above Kariba Datum (K.D) to 478.8m K.D. During the past two years, the Lake level remained low, despite two years of average rainfall. No one can at the moment predict what the future Lake level will be. Thus a permanent irrigation system was designed and contructed in Chiyabi in 1985-86.

3. CHIYABI DESIGN

Figure 1 shows the layout of Chiyabi Pilot Irrigation Scheme.
The pumpsite was selected on a steep slope of the Lake. A manifold and the Asbestos Cement pipeline are situated above the known flood level. Portable diesel pumps can be placed on reinforced concrete platforms at three levels, thus the Lake level can be followed. The discharge of the 5 pumps is 56 l/sec at a design head of 10m. This design discharge exceeds the required water need with 40% thus expansion is possible.
Except for the field canals, the canals are lined with concrete slabs. The lined canals have been designed for the design discharge of 56 l/sec. The scheme has 30 field canals. Each of the 30 farmers has been allocated one field canal for which he/she is responsible. The area each farmer is cultivating is 0.3 ha. The remaining hectare will serve as a communal orchard.
Several rural structure, e.g. office, storeroom and assembly hall have been constructed.

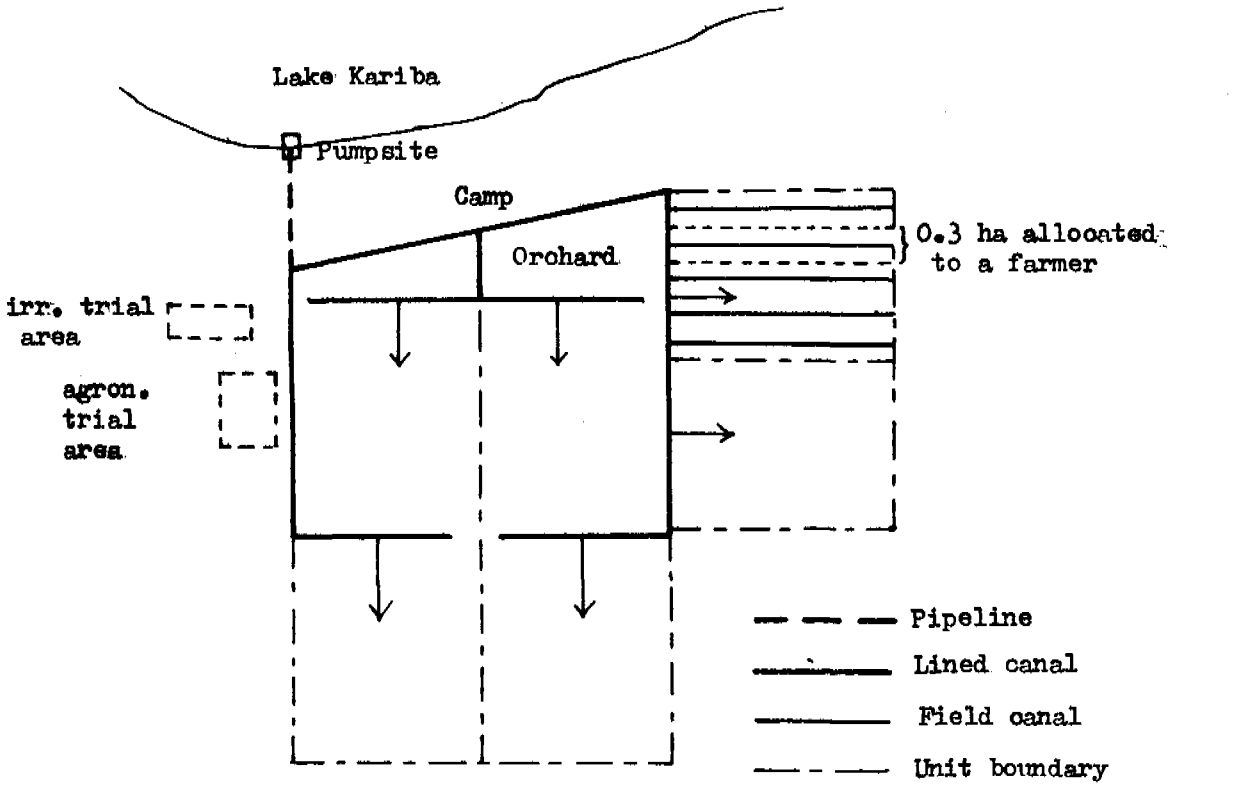

Figure 1 : Scheme layout (Scale 1:5000)

The construction costs per ha were ZK 9,900.00, i.e. $1,650.00 (1 US $ = 6.0 ZK). This amount excludes the costs of the rural structures. If lining could be avoided for future schemes by selecting sites with less permeable soils than Chiyabi, the costs per ha would drop to $ 930.00. The Internal Rate of Return (IRR) for Chiyabi is 25%, which is favourable.

4. FARMERS' PARTICIPATION

As irrigation is a new phenomenon in the Gwembe Valley it was and is up to date difficult to make the farmers in Chiyabi interested.
During the implementation of the project only very few potential farmers were participating as casual workers.
Participation of the farmers in the scheme has been mixed successful. Most of them are not yet fully aware of their schemes' potential and their obligations towards the scheme. It will take some time before they will accept the scheme as theirs and not just as another Government scheme for raising revenue on which they work as labourers.
The present cropping pattern is rice and vegetables.

However, Chiyabi is located in a remote area with difficult access throughout the year. This makes marketing of perishable crops difficult and indeed last year farmers had to be disappointed as not all their vegetables could be transported to the markets, which is not good for their sustained interest. Thus during the dry season those crops should be grown that can be stored for a period, e.g. okra, Irish potatoes and green maize. It is thought to provide the farmers' group with a small rice mill, so that they can at least tripple their return on rice.
Part of the scheme area is planted with bananas and cashew nuts to provide most of the revolving funds for running the scheme.
With the assistance of the GRZ/FAO Project the farmers should build up confidence in irrigated agriculture. The final result should be the establishment of a Cooperative after which the scheme should be managed to a great extent by the farmers themselves.

5. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE DEVELOPMENTS

The FAO/GRZ project will in the next 18 months develop more pilot schemes on which local groups of small farmers should settle. Once this exercise turns out to be successful there is scope for expansion as there are several thousands of hectares suitable in the Gwembe Valley for the type of small scale irrigation development as attempted in Chiyabi. In such a programme the following should be taken into account:

- Farmers should be made interested and knowledgeable on what will come. They should be involved from the beginning in each development stage, i.e. selection, planning and construction, so that they come to regard the scheme as their own and thus take a far greater interest in ensuring the success,
- Careful selection of pump sites and pumpsets is necessary to avoid disasters as occured in Buleya Malima and Siatwinda,
- Availability of electricity is important for continued running of the schemes. Diesel pumps maintenance is difficult under self-help conditions in remote areas,
- Marketing possibilities for the crops are important for success of the scheme. Together with the farmers a cropping pattern should be sought that allows for easy and complete marketing,
- An orchard is important for obtaining revolving funds,
- The farmers could be assisted with
  - pre-construction study
  - field survey
  - detailed design
  - cost estimate and obtaining necessary financial support

For this a unit should be established in the Ministry of Agriculture and Water Development. A construction manpower and equipment unit to assist the farmers in skill required construction works should also be established,

- Training of farmers in elementary irrigation techniques,
- Organizing farmers towards forming cooperatives,
- Once schemes are developed, evaluation of SSIP is important as the efficiency of utilization is expected to vary considerably. Therefore a methodology for the rapid evaluation of project performance should be made. This should include irrigation efficiency, water supply, state of irrigation works, use of irrigation water, use of land, agricultural production, benefit per ha, water users' association involvement and storage facilities.

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Dambo resource use in Zimbabwe

Patricia Hotchkiss and Morag Bell

INTRODUCTION

Most environmental resources in rural Africa have multiple uses and need to be seen in this context when planning any development programmes. Dambos are an example of such a multipurpose resource. Alan Windram, at the 1985 WEDC Conference (ref. 9) described dambos and their use in Zimbabwe for agricultural purposes. Dambos are treeless headwater depressions with groundwater close to the surface. They comprise 1.28 million hectares in Zimbabwe, with 263,000 hectares in the communal areas (ref. 7). They are also widely distributed throughout sub-Saharan Africa (ref. 1).

Dambos provide land and water resources for three main purposes in the Zimbabwe's communal areas: domestic water supply, livestock grazing and garden cultivation - each of which provides economic and social benefits to rural households. Little is known about the role of garden cultivation in the livelihood of individual households. Our research shows that this form of cultivation forms part of an integrated agricultural system with dry farming on the interfluves. Families with gardens grow enough vegetables to feed themselves throughout the year. Many families also grow rice and maize as staple crops in the garden, with a harvest in January, which is usually the "hungry season" when nutritional levels are at their lowest (ref. 3). Dambo farming therefore complements dryland agriculture, the main harvest from which is in April. Even families without gardens can benefit in areas with dambos since they often have access to crops from their neighbours' gardens.

In some areas, gardens are the sole source of family income, providing $100 to $3,000 per year from the sale of vegetables. Irrigation technology used is simple -- watering cans and buckets, oil drums and hosepipes, and, in a few cases, diesel pumps.

In Zimbabwe there are government-imposed regulations restricting the use of dambos as a land and water resource. In the communal areas where people do not hold title to land, there are also local rules and traditions affecting dambo use. These are partly affected by the national policy but also greatly influenced by local needs and the historical use of dambos. In this paper the local management of dambos is discussed and compared with national policy. National legislation, which is of colonial origin, is compared with present government policy. A case study approach is then used to describe indigenous management, drawing upon information from one dambo which has been studied in detail for the past two years. Brief comparison is also made with dambos studied in other areas. These same case studies are then used to illustrate how the implementation of government policy affects and is affected by indigenous management systems.

NATIONAL MANAGEMENT

Legislation

There are two pieces of legislation which affect dambo use: The National Resources (Protection) Regulation of 1975 (commonly known as the Streambank Protection Regulation) and the Water Act of 1976.

The Streambank Protection Regulation originally enacted in 1952, prohibits cultivation within 30 metres of a stream, and on "wetland", which includes dambos. This legislation was introduced due to fears of environmental degradation which was widespread in Southern Africa during colonial times. Beinart (ref. 2) refers to discussions as early as 1913 over degradation of dambos by settler farmers. Later, this degradation was blamed on peasant farmers. Wilson (ref. 8) contends that this type of legislation was enacted as a means of controlling peasants and reducing competition for agricultural markets. Whatever the reasons for the legislation, Wilson and Thiesen (ref. 6) have both shown how detrimental this legislation was to the welfare of peasant households.

The Water Act originating in the 1930's, defines vaious uses of water and how these uses are regulated (ref. 4). "Primary use" is for "drinking, washing, cooking and

stock watering". Usually, official permission is not needed for primary use of water. Permission is needed for "secondary use", which includes irrigation. There are also restrictions on the use of "public water", which includes water in dambos. These restrictions were imposed due to concern that use of water in dambos would affect downstream flow, and therefore, water supply in the catchment. Reduced flow from the catchment might, in turn, reduce the water supply available in the river basin as a whole, thus affecting domestic and irrigation supplies in other areas.

National Policy on Dambos

National interpretation of these two pieces of legislation varies depending on the ministries involved.

The Natural Resources Board is most concerned with the Streambank Protection Regulation. In the 1970's, the NRB became more lenient in enforcing this legislation. This was due to the fact that maize was successfully grown during the recent drought, without environmental damage. Work by Thiesen, which showed that cattle did more damage to the dambos than cultivation, was also instrumental in changing the views of NRB officials. Thus, only that part of the regulation which refers to streambank cultivation was enforced, while cultivation on dambos was permitted beyond the 30 metre line. NRB policy is now one of education in proper conservation measures, rather than widespread enforcement of legislation. This education is the responsibility of the Ministry of Agriculture. However, despite NRB policy, some Land Inspectorate Officers (part of the NRB) continue to enforce the regulation. In Gutu, for example, since Independence some people have been prohibited from using their gardens.

NRB literature encourages the use of dambos for domestic water use, but permission to dig a well should be obtained from both the Ministry of Agriculture and the Ministry of Water Development. This is not enforced. NRB officials are not, at present, concerned about excessive use of water for garden irrigation. However, as garden cultivation increases, they recognize that further legal clarification of these issues may be needed.

Agritex (the agricultural extension service), is responsible for giving technical advice to the Natural Resources Board on environmental matters. The definition of wetland in the Streambank Protection Regulation was written by Agritex. However, the NRB makes the final decision on any regulations passed referring to environmental resources. In terms of soil classification, dambo soils are referred to as Class V, which means they are only suitable for grazing. While Agritex field officers generally recognize the importance of dambo gardens to the welfare of rural households, middle and upper-level officials remain more concerned over the environmental hazards. Thus, although field officers continue to allocate new gardens more than 30 metres from the watercourse, they are not well-trained in safe and effective cultivation of dambos. They are also unsure whether they should be giving extension advice on gardens.

In terms of the Water Act, Agritex feels that as long as only handpumps and watering cans are used for watering garden crops, this is "primary use" of water, not "secondary use". Therefore permission is not needed. However, this interpretation adds to the official perception that garden watering is "domestic water use" rather than irrigation. Garden cultivation is therefore ignored in irrigation policy.

The Agricultural Finance Corporation (AFC) which gives loans to farmers for agricultural inputs, does not give loans to farmers for gardens. this is not a result of legislation, but due to the fact that vegetables are the cash crops on gardens. The AFC argues that since vegetable prices are not government-regulated, it cannot be sure that farmers will repay their loans. Also, vegetables are more perishable than staple crops such as maize and rice. This sometimes results in crops spoiling before they reach the market. However, some farmers make large profits from their gardens, at much less risk than those farmers depending on the rains for growing maize. After the recent drought, most of the loans given to farmers for dryfield crops had to be written off.

The Ministry of Water Development (MWD) is most concerned with dambo use as it relates to the Water Act. As with Agritex, they see dambo cultivation as primary use of water. They do not therefore consider permission to be necessary for irrigation of gardens. Officials are, however, concerned about the effects of garden watering on the water supply of the catchment. This concern persists despite

the lack of evidence to prove that dambo cultivation in communal areas has a detrimental affect on stream flow.

The Ministries of Health and Community Development are encouraging group and individual gardens as a means of increasing family income and improving health. These gardens are often located on dambos.

National Land Use Policy

In some areas of Zimbabwe, the government has enacted "villagization" programmes. These involve moving households closer together, providing basic services such as water and electricity, and allocating land specifically for cultivation and grazing. In Gutu these programmes will include provision for wetland cultivation, as long as gardens are located more than 30 metres from the streambank.

LOCAL MANAGEMENT

Chizengeni Dambo

This dambo is located in Chiota Communal Area, some 80 kilometres southeast of Harare. The total area of the dambo is about 80 hectares, with approximately 30 hectares under cultivation. There are 27 gardens, ranging from 0.5 to 4 hectares. The remaining area is used for cattle grazing. Twenty-nine families live around the edge of the dambo, forming a total population of 180. These families cultivate dryland plots and gardens. Half of the families obtain their drinking water from wells on the dambo. The remainder use protected wells at their own or a neighbour's home.

Agricultural land in Chizengeni, as in all communal areas, is allocated by a Village Chairman, in consultation with the local Agritex officer. Local people are generally aware of the 30 meter rule, but do not think it is illegal to cultivate on other parts of the dambo. Male heads of household are given permission to use the land, but do not hold title to it. Only three families in the village do not have access to gardens; these are young couples whose requests for a garden have not yet been met. Widows are permitted to have gardens inherited from their husbands. Wells for irrigation are inside the gardens and can only be used with permission of the "owner" of the garden.

Wells for Domestic Water Supply can be dug on the dambo anywhere outside the gardens without permission. They are generally shared between 2-3 families and are dug on the dambo margins close to the homes. Clothes washing normally involves using water from irrigation wells in the gardens, not domestic water supplies.

Cattle obtain water from irrigation wells on the edge of gardens or from the river. They are kept away from domestic wells. Herding is organized in groups during the rainy season in order to protect dryfield crops and save labour. In the dry season, when only gardens are cultivated, cattle are not herded, although they must be kept in the kraals at night. Good fencing is therefore needed to protect garden crops. Households with inadequate fencing either do not cultivate their gardens during the dry season, or ensure a family member is always in the garden to keep the cattle away.

Dambos in Other Areas

These indigenous practices relating to access to dambo land in Chiota are found also in Zwimba and Gutu Communal Areas. Zwimba is in the same agro-ecological region as Chiota, and is a similar distance from Harare. Gutu is in a more marginal agro-ecological region some 300 kilometres from Harare. In Zwimba, 90 percent of those surveyed have gardens which are much smaller than those in Chizengeni due to the need for more elaborate fencing to keep out the goats. In Gutu, people have a similar problem with goats. However, a greater constraint on garden cultivation is access to a plot since the Land Inspectorate is much stricter in enforcing the Streambank Protection Regulation. Thus, only 52 percent of those surveyed have gardens.

DISCUSSION

Effects of National Policy on Local Management

It is apparent that the national approach to dambo cultivation in Zimbaber is divided. Policies of the NRB, Agritex and MWD towards cultivation are not well-defined. Officials in these institutions are primarily concerned with the effects of dambo cultivation on both land and water resources, notably soil erosion, water loss in the immediate dambo catchment and in the overall river basin. In contrast, the Ministries of Health and Community Development, in their concern to improve the nutritional and economic status of farming households, support group gardens on dambos.

This ambiguous government policy results in conflicting messages to communal farmers, making successful dambo cultivation more difficult. Since dambos tend to be ignored in policymaking, they are also left out when budgets and development plans are formulated. Farmers have no access to credit for dambo gardens and little extension advice. Research on cropping patterns and pumping technology is minimal. Furthermore, families in some areas are severely restricted from using gardens. With the exception of a few experimental grazing schemes, there is no government control over grazing on dambos.

Local Conflicts

Government policy on land and water use creates constraints to dambo cultivation in all communal areas in Zimbabwe. However, one additional constraint not addressed by government has been identified by local people. This relates to a perceived conflict over access to land for gardens and cattle grazing. The severity of this conflict varies between dambo areas. While in Zwimba and Gutu it was not reported to be a problem, in Chizengeni no further allocation of dambo gardens is planned due to the need for grazing land. This decision has been made by the Village Chairman in consultation with local farmers.

CONCLUSION

Two major policy issues emerge from the above discussions: the first relating to priorities, the second to government intervention.

Clearly, problems and priorities relating to dambo use are different at local and national levels. National policymakers are concerned with the effects of dambo use on land and water resources at local and regional levels. By contrast, communal farmers are primarily concerned with the local effects of dambo use as a land resource. Thus, government concerns and those of communal farmers only coincide over local problems with use of dambo land. Yet even here there is a difference in priorities. The government is most concerned with land degradation in the form of sheet and gully erosion on dambos. Communal farmers do not ignore the problems of land degradation, but their more immediate priority is the conflict over land for grazing and cultivation.

In the communal areas, the management systems for controlling dambo use are well-established and effective. Policymakers need to understand local priorities in order to work effectively with these indigenous systems. Generalizations about communal areas need to be avoided. The study of local practices and constraints should be as area-specific as time and financial resources allow. Government will then be better able to assist with the safe and beneficial use of dambos.

ACKNOWLEDGEMENTS

This paper arises from the dambo research project, based at WEDC, Loughborough University. We would like to thank the Overseas Development Administration for financial support for the project (no. R3869) and the University of Zimbabwe for providing facilities and funds.

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Micro-scale irrigation in Africa

R A Lambert and others

INTRODUCTION

Food security is one of the highest priorities of rural development in sub-Saharan Africa. Variations in rainfall from year to year lead to conditions of food surplus being followed quickly by conditions of shortage or even famine. In some cases surplus and shortage may exist at the same time in one country due to the difficulty of transferring the surplus production to the areas where it is needed.

The development of irrigation has been seen as the means to reduce vulnerability to climatic variations. However, with the exception of Sudan, Madagascar and Nigeria, irrigated agriculture has a minor place in the economies of sub-Saharan African countries (ref 1). It has been estimated that in 1982 only some 20% of potentially irrigable land was actually being irrigated, whether under modern or traditional methods (ref 1).

Much of this irrigation is devoted to the production of cash crops, so reducing the impact on food security. The performance of many of the irrigation schemes has not come up to expectations (refs 2 & 3). This is in spite of considerable investment.

One reason for this failure of irrigation to live up to the expectations has been the reluctance of planners to acknowledge forms of irrigation not conforming to their definitions. A large area of irrigation, that of garden cultivation on dambos and similar wetlands, goes unrecorded in the statistics.

In Zimbabwe it has been estimated that this area may be in the order of 30,000 hectares (ref 4), and contributes significantly both to rural cash incomes and to food security. In Nigeria, it is reported (refs 5 & 6) that fadama (wetland) irrigation has increased almost seven-fold between 1958 and 1978. This is a far greater increase than that achieved in the formal sector, despite massive investment.

An analogy may be drawn with the field of environmental health through the provision of clean water and sanitation. It is now being accepted that conventional schemes, with piped water, flush toilets and centralised sewerage systems, cannot serve the needs of most of the rural population in the foreseeable future. Hand-dug wells, simple pumps and, especially in Zimbabwe, Blair improved pit latrines are the accepted, appropriate and very effective means to achieving the end of improved enviromental health.

While this type of informal small-scale irrigation, which we refer to as micro-scale irrigation, does not receive the recognition it deserves, policy formulation on food security and irrigation development will remain far from optimal.

BACKGROUND /CONVENTIONAL IRRIGATION

While formal irrigation schemes will remain important in sub-Saharan Africa it is useful to appreciate some of the factors which limit their widespread success.

Large scale conventional irrigation schemes often require a massive upgrading of the existing infrastructure. Roads may need to be built, housing provided and facilities such as health and education provided from scratch.

The cost of conventional irrigation development can be immense. An investment cost of US$10,000/ha is considered standard with some schemes such as the Bura scheme in Kenya costing many times more,up to US$50,000/ha (ref 3). While a large proportion of this cost takes the form of non-productive infrastructure, this infrastructure is necessary for the success of the schemes. It has recently been estimated that when investment costs exceed US$6,000/ha none of the cereal crops can make a profit (ref 1), and high value crops must be grown. This leaves the problem of food security unsolved.

The demands of the market are notoriously hard to predict in advance. Where a demand exists the sudden entry of a new large scale scheme can have undesirable effects on those already supplying that demand.

In many cases, large numbers of people must be relocated to the new scheme. These

people need to be given the skills to participate in the schemes, skills that take a long time to acquire. Of particular importance is the fact that in Africa, women do most of the agricultural work and it is the men who are targeted in many of the large new schemes. Conventional irrigation is a high cost, high risk and very lumpy investment.

One solution to the problems encountered by the large scale schemes has been to promote small-scale schemes. However, in many cases the only small-scale element in these schemes is the size of the individual plots. While a scheme extending over only 80 hectares is indeed small compared to some of the large schemes the problems of co-ordination among a large number of users will still remain. The area under irrigation is not the only factor to be considered.

WHAT IS MICRO-SCALE IRRIGATION ?

Micro-scale irrigation has been around for a long time. A system of rice cultivation on dambos was described by Leask in 1867 as he travelled through southern Zimbabwe (ref 7). It has continued in Southern and Central Africa despite official lack of recognition and even prohibition (ref 8). Similar types of cultivation are widespread throughout Africa with the lack of recognition being emphasised by the dearth of statistics.

An example

As one travels through certain parts of rural Zimbabwe in the dry season, one frequently sees small gardens situated on dambos. Cultivation is by ox-plough or hoe and the plants receive water either through residual soil moisture in the early dry season or from a shallow well using watering cans and occasionally pumps.

A wide variety of crops is grown on these gardens, with staples such as rice and maize being grown in the wet season and vegetables for home consumption and for sale in the dry season.

Generally the plots are worked by individual families although there is often a lot of co-operation with their neighbours through the tradition of 'nyimbe'. This may take the form of shared labour at peak periods of the year or a collectively erected fence to protect the gardens from animals.

Recent research (refs 8 and 9) has illustrated the potential for developing this resource. Until recently dambo gardens have been given little recognition and have often been prohibited by the authorities.

Objectives

The two main objectives of micro-scale irrigation as it is currently practised are:

(i) Food security for the individual or group involved and;

(ii) Income from the sale of produce. This income is often the only means by which the rural poor, particularly women can obtain cash for such things as clothing and school fees.

Main features

The main features of micro-scale irrigation are:

Control: is the single most important feature of micro-scale irrigation. Control is exercised as far as possile by the individual, family or group that does the work. This control covers cropping patterns, choice of technology, labour timing, marketing and use of income generated.

Investment Cost: is low. In assessing what is low, account should be taken not just of the strict financial viability of the investment but of the reduction in the need for food relief and the advantages of having a healthy food production sector widely dispersed in the rural areas.

Scale: The basic unit of the traditional micro-scale irrigation plot varies from a few hundred square metres to several hectares. In addition to unit size, the concentration of plots within any one area must relate to the ability of the existing infrastructure to sustain it. Traditionally the growth of micro-scale irrigation is limited by constraints such as lack of finance or markets. This means that when growth does occur it is sustainable, as it only occurs when conditions allow it. The scale is small and growth is organic.

Integration: Because micro-scale irrigation is firmly set in the local community, it fits in with local practices and capabilities. New developments must fit in with the existing situation and involve the local community as far as possible. In particular, they should fit in with the existing farming system. In these systems, labour is generally a scarcer resource than land and rain-fed agriculture will retain a dominant role in food production.

Water source: the water source in most micro-scale irrigation is small, localised and directly accessible to to the user. This obviates the need for complex water management systems.

Technology The technology that is most likely to succeed is that which relates to those tools that are presently used, such as watering cans, simple hand-pumps, ox-ploughs and hoes. The value of indigenous technical knowledge and the dangers of imposed technology, not firmly rooted in local practices, are now being recognised (ref 10).

Present extent

Few figures are available for the extent of micro-irrigation in Africa. In Nigeria it has been estimated that 800,000 ha of wetland is under cultivation (ref 2). In Mali flooded rice is grown over an area of 80,000 ha in holdings of about 1.5 ha; in Sierra Leone about 30,000 ha of boliland is cultivated, with similar areas being utilised in Guinea, Burkina Faso, Cote d'Ivoire and Ghana (ref 10). In Zimbabwe dambo cultivation may account for between 10,000 and 50,000 ha with a provisional estimate of 30,000 ha (ref 4). In Tanzania, a wide variety of micro-scale irrigation is practised from the traditional furrow irrigation on the slopes of Mount Kilimanjaro to the mbugas (dambos) in the central plateau.

When looking at the total area cultivated it is important to keep in mind the fact that micro-scale irrigation, as with any form of irrigation, allows a more intensive use of the land than it is possible with rain-fed cultivation. On the dambo gardens of Zimbabwe two to three crops are often harvested in one year from the same piece of ground.

It is also important to have some idea of the number of people affected. Micro-scale irrigation plots are generally in the order of one hectare. When one considers an area of 30,000 ha under micro-scale irrigation in any one African country one can appreciate the large numbers of people affected. In Zimbabwe cash incomes from larger gardens can reach US$3,000 per annum (ref 8).

Finally, one must consider which people benefit. In Zimbabwe most people living near dambos have access to them. The dambo gardens are particularly important to women, and hence to family nutrition and food security.

Environmental Health

Irrigation projects can be serious health hazards and micro-scale irrigation is not exempt. However, in the case of dambos people are using a resource that is close to where they live and encountering hazards with which they are familiar. They are not be exposed to the type of new health hazards associated with large-scale schemes with large areas of open water, especially those involving extensive population relocation. In Zimbabwe a positive correlation was shown between the health of families and their use of dambos for micro-scale irrigation (ref 11). The important question is whether or not the improved nutritional and income status justifies the risk to health.

MICRO-SCALE IRRIGATION AND RURAL DEVELOPMENT

Fundamental to the promotion of micro-scale irrigation is its recognition not only as a desired end result but also as part of the development process. This process is most likely to succeed if it is a series of small steps where an assessment of success or failure can be made at each stage of the process. Thus sudden cultural or organisational change or quantum leaps in technology must be approached very warily.

Small scale irrigation is often viewed as a useful entry point to rural development (ref 10). However, given the successes of micro-scale irrigation, government encouragement or attempts to link it with other forms of development must be given or made with due recognition to the self-reliance and sustainability that are among its chief characterisitics. The creation of dependancy must, as far as possible, be avoided.

CONSTRAINTS AND NEEDS

Inattention by government, research and

funding agencies has resulted in a situation where a successful form of irrigation receives negligible consideration. It may appear that this inattention has been beneficial, especially in the light of the attention given to many large schemes and their lack of success. However there is a need for sympathetic attention, respecting the successes and addressing the real perceived problems.

Finance is never sufficient for farmers but there are special requirements for micro-scale irrigation. Large numbers of small farmers needing small amounts of finance can impose difficulties for the traditional financial institutions. This is especially so in the case of vegetable produciton where markets and prices can fluctuate sharply. Financing institutions such as community revolving funds or credit unions may be necessary.

Technology requirements include the need for improved water lifting devices (ref 8). Micro-scale irrigation deserves the same sort of attention that has rightly and effectively been given to appropriate rural sanitation.

Environmental Issues such as soil degradation and the impact on catchment hydrology must be addressed. This should be done using the knowledge and experience of the local community, who are often the only real experts on the likely effects of changes in land use, in addition to standard techniques.

CONCLUSION

In the context of rural development micro-scale irrigation deserves recognition for the role it plays in providing food security and incomes in sub-Saharan Africa. It should however be considered in conjunction with conventional irrigation and not simply as a replacement.

For governments and aid agencies, the promotion of a dispersed micro-scale irrigation programme involves low cost and an evolutionary growth. The risks involved are far fewer than those associated with large scale schemes, the failure of which can be disastrous to both finances and morale. The potential for micro-scale irrigation is very real and the rewards are already evident.

ACKNOWLEDGEMENTS

This paper arises from the dambo research project, based at WEDC, Loughborough University. We would like to thank the Overseas Development Administration for their financial support for this project (no. R3869) and the University of Zimbabwe for providing facilities and funds.

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SESSION 1 - DISCUSSION

Chairman: B H Mwakikunga
Ministry of Works and Supplies
PB 316, Lilongwe 3 Malawi

J A STOUTESDIJK and J B SIAKANTU
SMALL-SCALE IRRIGATION IN ZAMBIA

1. Mr STEPHENS wished to know if the difference in elevation levels between Kariba's dry season low and wet season high levels (2.5 m, peak in July, low in February/March) was high enough to affect efficiency of pump as pressure duty is only 10 m.

2. Mr STOUTJESDIJK replied that pumps had been designed on a maximum operating head, which included the annual fluctuations and also a further drop of the lake level.

3. Mr HUNINK asked who was going to execute the construction works - the beneficiaries themselves or (hired) labour from elsewhere? In addition, if beneficiaries were executing the works, were they paid for their contribution and, if so, how much (cash/hired)?

4. Mr STOUTJESDIJK said that preferably beneficiaries should be involved in project execution. However, as this project was a new development in the area, interest was low and local people were hired to work as casual labourers for approximately US$ 0.50 per day.

5. Mr BHAIJI queried the extent of FAO funding of the project and wished to know when would the farmers take over. He also asked how the funds from the orchards were utilised for the revolving fund.

6. Mr STOUTJESDIJK replied that construction costs of the project are jointly funded by the Government of Zambia and FAO and that farmers are not required to pay back these capital costs. Initially farmers are assisted with some grants and loans to settle in the scheme: once they are established they will run the schemes with little Government involvement. Funds from the orchard are important, therefore, to serve as a buffer. Money will be placed in the bank in the name of the 'Farmers' society and will be used when needed, e.g. to pay for electricity or repairs.

7a. Dr KENNEDY expressed the opinion that the paper seemed to suggest that the farmers are not really interested in the irrigation scheme. He asked how the farmers were motivated and what community participation process was used.

7b. Mr SIBALE also wished to know, in order to make the scheme successful, how farmers had/would be motivated.

8. In reply Mr STOUTJESDIJK suggested that real motivation might only come when the farmers are used to the new ways of farming, and after seeing the benefits. He stated that to motivate by talking alone is not easily accepted: farmers must be interested through involvement from the beginning, preferably from the planning phase and during each decision phase. Farmers participate from field level. i.e. cleaning canals, land preparation etc. The project should guide the farmers when needed but never impose decisions.

9. Mr POLELA suggested that motivation could have been a problem in the Zambian irrigation scheme because of the nonavailability of other related facilities like schools, clinics, prayer houses etc. He asked the authors if these factors resulted in the lack of interest shown by farmers to moving and hence being separated from their families and existing social set-up.

10. Mr STOUTJESDIJK explained that as this was not a resettlement scheme, as farmers come from within a 5 Km radius, this could not explain the problem.

11. Mr MPHANDE commented that there is always a problem where schemes are introduced to the people in an effort to make them accept and adopt a new technology. Eventually it ends up being a liability to the government, farmers not having much responsibility towards the scheme. With these experiences, he wished to know what steps were being taken in order to avoid proliferation of such small schemes amongst the rural community and what level of input came from the government.

12. Mr STOUTJESDIJK explained that through a long duration process farmers are made ready to run the scheme through a Cooperation Society, without Government support, except for extension work. If the Society fails the scheme fails and the Government seems not ready to take it over.

13. Mr TAREMBA put the following questions:-
Had a pre-feasibility study been carried out?
How were farmers selected for membership?
Before setting up the scheme, what consideration of infrastructure and its impact had been made?
He also wished to know if rice was the best alternative available or was this crop/seed being imposed on local farmers resulting in their lack of interest.

14. Mr STOUTJESDIJK replied that:-
A reconnaissance study was carried out. Farmers were selected by a committee after a baseline socioeconomic survey was complete. Poor infrastructure limits the choice of cropping pattern, but the aim was to set up a pilot irrigation scheme: the road was now being considered.
He informed participants that rice grows well in the Gwembe Valley and that interference of the irrigated crop with the rain-fed crop was a more important factor. Farmers have to divide their work, which is new for them, therefore results during the rainy season are not as good as during the dry season when farmers show more interest. Maybe consideration has to be given to whether an irrigated crop should be grown during the rainy season.

15a. Mr JENNINGS commented that the problems found in growing/marketing vegetables from an area without a road is a good argument for an integrated approach to rural development, and maybe this should be considered before proceeding further. He also stated that the availability of electricity, considered important/essential by the authors, is 'pie in the sky' for most rural areas of Africa. He wished to know what alternatives to this were considered.

15b. Mr MANDOWA also asked why other sources of pumping water, such as solar pumps, windmills and hydraulic rams had not been tried.

15c. Mr KATEREGGA stated that electricity or a diesel energy source is not the most appropriate means of running irrigation schemes in rural areas due to the high cost. He also wished to know if the use of windmills as an energy source had been considered.

16. Mr STOUTJESDIJK agreed that it was unfortunate that the integrated approach was not part of the project but that it will definitely be considered in a possible second phase from 1988. A 66 Kv power line is under construction parallel to part of the Lake, this will be used for small-scale irrigation developments. If electricity was not available, the use of a big diesel generator and centrifugal or submersible pumps would be recommended as other alternatives (windmills, ram) are not feasible for this type of communal irrigation, mainly because the scale varies between 12 and 60 ha. Windmills could only be used during periods with sufficient windrun (July-September) and hence cannot serve as a permanent water supply system. In addition electricity is a very cheap source of energy in Zambia.

17. Mrs SIKANYIKA suggested that the reason farmers have lost interest is that the project from the beginning does not benefit the project holders. She had expected to learn how much of the funds realised from the project go to the people and what remains to keep the project going. She stated that electricity in Zambia is very expensive and to introduce irrigation dependent on it would be costly and necessitate project holders paying for it out of project funds, which would not benefit them. She placed emphasis on the points that in most projects at this level, especially those concerning water, women should be more involved and the project should be cheap and acceptable to the people of the Gwembe Valley. This area is a suitable place for sunflower and cotton: women's groups have ventured in this area and generated some income. She also questioned the Gwembe irrigation scheme being a pilot project when it involves such a lot of money.

18. Mr STOUTJESDIJK replied that a pilot scheme is usually more expensive than subsequent development because experiments take place and experiences are gained. He added that the project can only benefit the farmers after construction and that it is obvious that relatively high investments have to be made before the benefits come. The money input for the project is limited after construction as a system is built up whereby the scheme will be run by farmers themselves. He confirmed that cotton and sunflower are grown in the Gwembe Valley under rain-fed conditions and are therefore not considered in the cropping pattern at this stage.

19. Mr MBUGUA made the following quote:- 'Remember what costs nothing is worth nothing'. He stated that the authors had indicated that everything in the project is done by FAO, i.e. all funding for the construction, because the people are poor. He questioned whether this approach will tend to prove to the community that the solution to their problem is beyond their economic ability. In addition, if management is still under the FAO or Central Government does this provide further proof to the community that Management is also beyond their ability. He asked the authors whether such an approach leads to the development of a self-reliant and self-perpetuating development or whether it kills such ability.

20. The authors replied that as the community is poor, it cannot pay for the capital costs, thus the Government or an agency has to assist in order to improve the living standards of the farmers. Only then should farmers be carefully taught how to run the scheme. It was thought that this approach should not kill the community's ability to manage the scheme.

21. Mr MSOLOMBA expressed the opinion that in this part of the world (East and Southern Africa) inhabitants constantly suffer from the omission by consultants/specialists of investigations into either failures or successes of similar projects carried out in the

area by other consultants/specialists. He wished to know if the authors had tried to identify problems encountered by others carrying out similar irrigation schemes in the Southern Africa Region and if they had subsequently avoided problems previously encountered.

22. The authors answered that, although it seems that problems and successes are well known they cannot always be transferred to other areas which have their own specific problems. They added that whilst always trying to avoid problems, as mentioned in the paper, only the actual implementation of a pilot project can teach lessons.

R A LAMBERT and OTHERS
MICRO-SCALE IRRIGATION IN AFRICA

P HOTCHKISS and M BELL
DAMBO RESOURCES USE IN ZIMBABWE

Questions and comments on these two papers were taken together.

23. Mr MWAKIKUNGA commented from the Chair that in the dambo areas farmers were already motivated and, in some instances, using applied/appropriate technology as illustrated in the two presentations: Dambo development was an example of greater utilisation of resources.

24. Mr SIGDA expressed his curiousity as to what research had been done with regard to the causal relationships between increasing agricultural production and household food security, especially with regards to sexual division of labour. He cited the example that in Tanzania a surprising association had been noted between those areas which produce the greatest amounts of cereals and infant mortality rates, i.e. these areas had the highest rates. In addition it had been found in irrigation regions that feeding frequency was the most important factor determining child nutritional status, and that this was directly related to the amount of time a woman had to return home and cook for her young children.

25. Miss HOTCHKISS replied that detailed studies of 40 families had been made over the period of one year. Data had been collected on labour time, food consumption, water use and harvest and agricultural income. Most of this data had yet to be analysed. In addition children under five years of age had been weighed each month but the sample size was too small to be statistically significant. However all children, whether they had a garden or not, were generally at the higher range of weight for their age. She commented that establishing proof of causal relationships between one factor (such as increased labour time) and another is very difficult and, again, would require a much larger sample. Miss HOTCHKISS thought that Mr SIGDA's comments were interesting and should perhaps be investigated further.

26. Mr CHIMIMBA wished to know if 40 families taken as the population (statistically) of Zimbabwe was sufficiently representative to come to any conclusions.

27. Miss HOTCHKISS replied in the negative adding that this was not the intention anyway.

28. Mr SUTTON informed participants that dambos in Western Province, Zambia are areas which are extremely sensitive to both long term and seasonal water level fluctuations. He asked to what extent do these variations occur in the dambos described and what was the likely long-term effect of such variations on the rural development process and vice versa.

29. Mr LAMBERT stated that dambos, being dependent on groundwater levels, are obviously affected by changes in these levels. Seasonal levels were well understood by dambo cultivators and, in fact, affect dambos far less than they do surrounding dry lands - hence the value of dambos for dry-season cultivation. Long-term fluctuations in ground water levels would obviously affect the utilization of dambos and hence the development process. He did not think this was a particular worry in the study area.

30. Mr SHELA thought that it was good to encourage micro-irrigation and that, in fact, many towns and cities in Southern Africa were flooded with vegetables during the 'Dambo' micro-irrigation period. He added that some vegetables do not find a market. He questioned whether Zambia or Zimbabwe had looked at preservation techniques and market identification as an incentive for increased production of vegetables under irrigation.

31. Miss HOTCHKISS explained that since people grow vegetables year-round in their own gardens they are not so concerned about learning new preservation techniques. For example, although a canning factory was built in an area where many people grew tomatoes, the people still sold crops at the markets in Harare instead of to the factory. The authors had studied markets in Zimbabwe, where horticultural production is increasing and is being encouraged by the Government. They found that farmers were very good at selecting the correct crops to sell at the right time, hence flooding of the market was not usually a problem.

32. Mrs GEAKE expressed the opinion that the development and cultivation of dambos could result in problems of drainage and falling groundwater levels, as well as increased erosion and the incision of a streambed channel, since they are areas likely to be sensitive to land-use changes. She wished to know if there was any evidence of this from the research in Zimbabwe.

33. Mr LAMBERT stated that drainage of dambos, aside from superficial flood-water removal, should be avoided. He thought that falling groundwater levels would not be a problem because of the way the dambo and its catchment operates hydrologically. He explained that the dambo is a result of groundwater seepage from the much greater area of the upper catchment. He added that incision of the streambed was indeed a problem in dambos but that it is related to land-use changes on the catchment as a whole, of which the dambo rarely forms as much as 30%. Overgrazing appeared to be the major course of stream channel incision. The research had shown clearly that sheet erosion on dambo gardens was well within safe limits.

34. Mr SIAKANTU wished to know if there was any scientific justification for the limit of 30 m distance from the dambo being prohibited for cultivation.

35. Mr LAMBERT replied that the 30 m limitation applied to the stream bank, not to the dambo. He said that the overriding consideration seemed to be simplicity. The justification was the prevention of stream bank erosion by flood waters - a much greater risk if cultivation is allowed near the streambank.

36. Mr SIAKANTU wished to know the type of dambo, in terms of hydro-physical properties, being researched in Zimbabwe. In Zambia, especially in the high rainfall areas in the north where soils have been heavily leached, the soils were acidic and nothing could be grown easily on them.

37. Mr LAMBERT explained that the dambos researched were sandy organic ones, situated on a granite or gneiss bedrock. The dambo occupied a little less than 30% of the catchment involved.

38. Mr KAFUNDO said that the paper by HOTCHKISS and BELL referred to a 'Water Act' restricting/regulating water use so that the primary use is not exceeded by secondary use and that permission was needed for secondary use. He wished to know how this was done and how was the water quantity measured.

39. Miss HOTCHKISS denied saying that primary use must not exceed secondary use: there is no measurement of primary use of water. As explained in the paper, the use of water in dambo gardens in communal areas is considered primary use, therefore it is not measured.

40. Mr TAREMBA asked the authors if the papers were intended to stimulate/raise discussion or were they part of a problem-solving study. He intimated that this was not clear and that he hoped that it was not just another academic discussion. It was his opinion that the authors should have addressed themselves to problems faced by the Zimbabwe Government, i.e. land pressure and over-population in the communal areas. It did not make sense to him to come up with a clear cut policy on use of dambos before the over-population question/problem was resolved.

On dambos as a resource he enquired as to whether study or experience elsewhere in sub-Saharan Africa had been used. He suggested that the authors could possibly have looked at the causal effects of dambos drying up, maybe as a result of too much pressure on the local resource by overgrazing or too many gardens. In addition he suggested research into the question of land ownership and its influence on dambo development or the problems of encouraging dambo development could have been made. He cautioned against assuming that dambo cultivation had no problems. Finally he wished to know what recommendations and what possible solutions to the government's ambiguous policy the authors had made.

41. The authors confirmed that the papers were intended to stimulate discussion and not to present research results. The land question is a serious one which is being addressed by numerous other people in Zimbabwe, but the use of dambos in a safe manner is one way of helping to relieve that pressure.

The authors had looked at use of dambos in other parts of Africa, but, given the limited time available, did not address this question at the conference. They had also considered the issue of land allocation and its effects on dambo use from which they made recommendations. In the conference forum they wished to share the opinions of others on these issues. Finally the questioner was informed that a 150-page report (plus appendices) on this research included answers to these questions and that if he consulted the actual papers presented at the conference he would find an outline of the problems relating to dambo cultivation.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Choices in pit latrine emptying

Chris Williams

ABSTRACT

This paper reviews the types of mechanical pit emptying equipment available, the effect of increasing travel distances on a pit emptying service and options for pit latrine sludge disposal.Data is presented for the Maseru urban area where the BREVAC LA equipment has been tested.

1. INTRODUCTION

Since 1980 the Urban Sanitation Improvement Team has been encouraging the building of VIP and VIDP toilets in urban and peri-urban areas of Lesotho. Due to a clay soil horizon we have found that the contents of the resting pit of a VIDP are often very wet and would not be easily emptied by hand - there is also the question of pathogenic contamination of wet pits - see also Makhetha (ref.1). Because of this we have moved towards recommending single-pit VIPs with mechanical emptying.

Over the past few years, a number of different technologies have been developed to empty pit latrines and to load the sludge into a tank unit (ref. 2). The problems of disposing of the sludge and the costs of the service are now the major issues. An analysis of haulage costs with distance and disposal alternatives will help us to make rational decisions on the level of service to be provided in to areas remote from the disposal point.

2. EMPTYING EQUIPMENT CHARACTERISTICS.

There are two basic categories of pit emptying equipment - those in which the pit latrine sludge (PLS) is loaded into a tank which is then driven to the disposal pond (non-transfering systems) and those in which either the sludge or tank from the emptying machine is reloaded onto alternative transport (transfering systems) e.g. ALH (ref.2). To date not much work has been done on transfering systems except a few experiments - there is room for more investigation.

Present non-transfering systems can be divided into those which use a combined pump and tank unit like the BREVAC machines used in Gaborone and Francistown in Botswana, and the BREVAC LA System as used in Maseru where the pump and tank units have independent motive power. These categorizations are shown in Fig. 1.

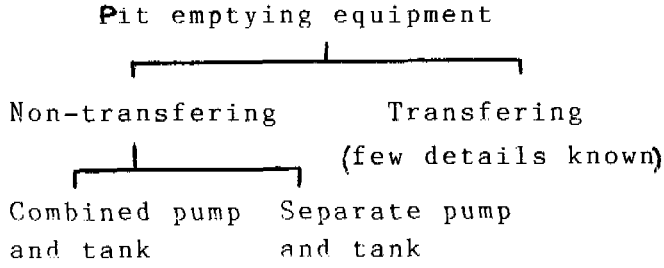

Fig.1 Classification of pit emptying equipment

The separate system is obviously more expensive to run if there are only a few tank units and hence the equipment will be operating basically as a tank and pump unit, but requiring 2 drivers and two fuel and maintenance bills. However, if the pump unit can be stationed in one area and a shuttle of tankers run to the disposal site costs should be reduced.

With both transfering and non-transfering systems, one key factor is the size of the payload. The larger the size the fewer trips will be needed to the disposal point. If the disposal point is quite distant this could provide savings on fuel and travel time. It also means that there is less likelihood that multiple trips will be needed to empty any oversized pits. The disadvantage of a larger tanker size is the difficulty of access - this can to some extent be overcome by the use of long hoses, although the setting up time and capital costs can be relatively high. In Botswana tests have shown that the BREVAC tanker could pull PLS 64m and the ROLBA tanker slightly less (ref.2).

In Maseru the access difficulties are indeed greater than in Botswana but it is likely that a full size BREVAC type machine with around 30m of hose will be able to empty the pit in over 95% of cases.

Systems based on septic tank emptiers have the disadvantage that they cannot empty all pits due to the relatively low air flow produced by the pump - hence they must work in a fleet with machines that are capable of pulling heavy sludges.In this case some apparent cost reduction will have to be balanced against a loss of flexibility.

3. TRAVEL DISTANCE AND COSTS

Costs for pit emptying services have been calculated in the past, notably by Carroll (ref.3) who obtained £4.73 per cum. of PLS after considering fuel, labour, maintenance, general overheads and vehicle replacement costs. Schulz (ref.4) obtained US $ 6.66 (= £4.62) per cum. PLS exclusive of vehicle replacement. Both these figures exclude disposal costs.

A large BREVAC type machine should be able to leave the yard (or disposal point) and pick up sludge at a number of pits before going to the disposal point. Hence we can obtain an average distance travelled per pit. In the study by Carroll (ref.3) in Gaborone this is somewhere around 4km.

Clearly costs go up with travel distances. This is basically due to the fact that spending longer travelling between pits or the disposal point means fewer pits can be emptied per day and hence the fixed costs can be divided between fewer customers. An analysis of travel time data shows that we could expect 2220 cum. of PLS to be emptied per year if the travel distance is 4km.,1805 for 8km. and 1311 for 16 km., assuming 185 working days (75% vehicle utilisation) and that 1 cum. PLS is removed from each pit. Ron Carroll and Geoff Ashall of the Building Research Establishment (UK) (private communication, 1987) have estimated that the total annual cost of the service is £16,247 , so this would imply costs of £7.31,£9.00 and £12.39 for 4, 8 and 16 km. travel distances respectively - see fig.2.These calculations should be regarded as order of magnitude rather than highly accurate. In Maseru we have an average pit to pit distance of about 13km - this is partly because there is a steady but not high demand for services, so grouping by area is difficult.Interpolating from fig.2 we would expect the cost in Maseru to be £11.00 per cum. of PLS.

Carroll and Ashall further estimate that the total annual cost for a large BREVAC is divided up as follows - capital 54%, fuel 11%, labour 12%, maintenance 15% and general overheads 8%, assuming an interest rate of 14% p.a. Since the major element is capital cost, it could be useful to obtain a low interest loan or use aid funds for the first vehicle and then finance its replacement from revenue.

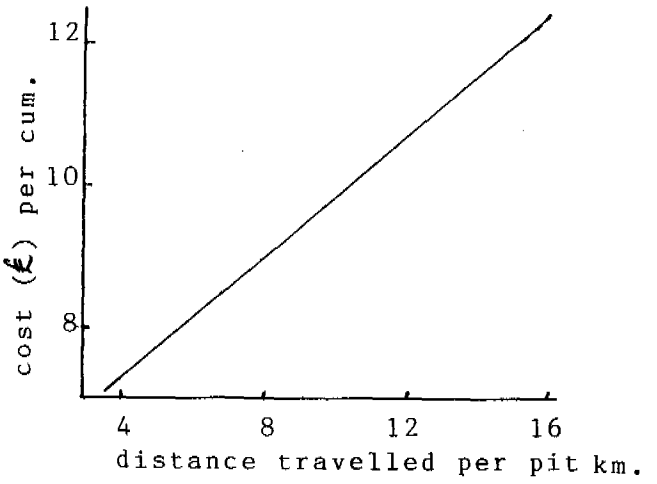

Fig.2

The kind of amount demanded is large in terms of clients' ability to pay a lump-sum in Lesotho - it could be paid in "rates" or some installment system payable before emptying.One cum. of PLS represents around 4 years accumulation for a household of 5, so the cost is effectively spread over 4 years.

It should be noted that in the early years of establishing a service it may be underutilised, as the number of pit latrines is building up.This will make the service more expensive during this period.

4. DISPOSAL OPTIONS

We are discussing the disposal of sludge from single pit VIPs so pathogenic waste will be present. The options for PLS disposal include dumping in sewage treatment ponds, trenching, sludge digestion, composting and discharge to sewers.

4.1 Ponds

Ponds could either be specially constructed for PLS (similar to nightsoil ponds), or have mixed use with a sewerage system. A simple apron with screened outlet leading to the first pond and washing-down facilities are the only special structures needed.

The question of BOD loading from PLS then arises. Schulz (ref.4) claims that on average 90% of excreted BOD has decayed in a normal pit latrine.The bottom layers are usually fully decayed and the BOD content is found in the upper 'fresh' material. Assuming an accumulation rate of 50 l/c/yr, 1 cum of pit latrine sludge represents 20 person years accumulation. At 30g excreted BOD per day, this would imply that 20 x 30 x 365/1000 = 219kg BOD have been excreted, and therefore 21.9kg BOD should be found in 1cum of PLS. More experimental determinations of the BOD of PLS should be made. The decay of organics in the pit means that there will be a higher non-biodegradable content in PLS than nightsoil, so the silting up of ponds will be more serious.

Disposal to ponds is used in Gaborone and Maseru.

4.2 Trenching

PLS could be disposed of in a similar way to nightsoil by trenching. In Maseru our experience has been that mechanically emptied PLS is rather liquid and this means that it is difficult to cover over the trenches with soil after dumping due to the splashing of PLS on the workers. Hence a public health nuisance is created through the uncovered sludge. However, in well drained soils or with less liquid sludges this may not be such a problem, and trenching has the advantage that it can be a local disposal solution in remote areas - this could be particularly helpful in rural institutions like schools.

4.3 Sludge Digestion

As pointed out by Droste (ref.5), anaerobic sludge digestion must be evaluated against three criteria namely hygienic excreta disposal, biogas production and fertilizer production.

The system envisaged would consist of one or more digesters with inlet works and sludge drying beds.If there are pre-existing sludge digesters, either at a sewage works or for domestic biogas production then this choice seems quite feasible. The installation will require pumps and hence a power supply, making it more complex than ponds or trenching.The management of a digester is also more difficult than the previous two options.

4.4 Composting

Composting is an attractive alternative because of the potential for reusing resources - Shuval et al.(ref.6) have recommended the Beltsville Aerated Rapid Compost (BARC) system for composting nightsoil in developing countries . However, one problem with PLS is its relatively low organic content - this would mean that mixing with other materials would be necessary to obtain a good compostable mixture. The moisture content of sludge for composting should be between 40 and 60% (ref.7). Although the moisture content of PLS given in Carroll (ref.8) of 55% falls within these bounds, in Maseru our sludges tend to be too wet and dewatering would be necessary - this could be done by mixing with 'dry' materials like sawdust if they are available.

It should be noted that in Africa people are often unwilling to handle what was once excreta, so the supposedly useful final product (compost) may not be utilized (ref.9). The compost may also be of limited use in urban areas, and transport to agricultural land difficult or expensive.

4.5 Discharge to sewers

The screened discharge of PLS into sewers seems quite feasible, particularly if it is done near pump stations where a macerating effect is achieved. Alternatively there may already be facilities for emptying septic tank emptiers to cut down on haulage distances. This reduction of haulage distances to a central treatment works could mean that greater penetration of areas remote from the disposal point is possible. It may be necessary to add water if there is not a sufficient flow in the sewerage reticulation system at the disposal point. The PLS will either be treated in ponds or generate primary sludge in a 'conventional' STW. If it is felt that a 'shock load' could result, for example on trickling filters, then holding tanks slowly pumping the PLS into the sewers could be used. This would not be a problem with ponds.

4.6 Disposal costs and choices

A PLS disposal facility will incur capital and recurrent expenditure in its operation. Obviously the treatment unit costs should affect the choice of the disposal option, although many other factors such as land, capital and labour availability, the nature of the terrain and foreign exchange controls can also affect the decision (ref.10). It is hard to find much information in the literature on unit costs for the different treatment alternatives given above, so some rough outlines are presented below - land costs have been excluded.

Ponds: In Lesotho the cost of building waste-stabilization ponds was around M70 per person equivalent in 1982 (ref.11), and must be around M100 (UK£31.25, December 1986) by now. In 1 cum of PLS we have 21.9kg BOD (see section 4.1). This is equivalent to 548 person equivalants at 40g BOD/c/d. Hence the capital investment to dispose of 1 cum PLS/day is around £17,125, spread over a 15 year period, or about £6.17 per day (at 10% discount rate). In low-technology options like ponds we expect investment costs to be around 50% of the total costs (ref.10). Therefore the cost of disposing of 1 cum PLS in ponds could be around £12.

Composting: Shuval et al (ref.6) present calculations to show that the BARC system costs around US $50 (=£34.70) per dry ton. In 1 cum. of PLS we have an average 612kg of dry material (ref.8), so the cost of composting could be around £21/cum PLS.

Trenching: It is estimated that it would cost about M10 (=£3.13) to manually excavate a suitable trench for 1 cum PLS. If we double this figure to allow for fencing, tools, mixing materials and other overheads, we find that it should cost around £6/cum PLS to dispose of the sludge by trenching.

Sewer Extension: As a concrete example we consider the Khubetsoana housing estate on the outskirts of Maseru, built with World Bank assistance.There are approximately 1000 pit latrines on this site, so if we assume that 1 cum. PLS is taken from 4 latrines by a full-size BREVAC type machine, then the average travel distance per pit will be about 6 km., which corresponds to £8.15/cum. (fig.2). At present the nearest sewage pump station is 3.5 km. away, downhill.

If the sewer was extended to the housing site, then the distance/pit could be reduced to something like 2 km. - we have to allow for daily travel from the yard. Extrapolating fig.2 this implies £6.60/cum. Hence we would save £1.55 per pit, or £1550 over 4 years.This alone certainly cannot justify the extexsion of the sewer, as construction costs alone are around £20/m (ref.11).

5. CONCLUSIONS

Considering non-transfering systems, it seems clear that the rule is, the bigger the better, and that smaller sized (limited access) vehicles should only be considered when access problems are severe.In this case the transfering systems may be more appropriate, but so far there seems to be little practical experience with running these machines under non-experimental conditions.

It appears as if the cost of pit emptying increases quite sharply as distance travelled per pit increases, implying that careful routing and zoning and the provision of more than one disposal site for large urban areas will be important.

As regards disposal options, the cost comparisons are difficult to work out with much confidence, but disposal by trenching or into ponds where land is available are suggested to be the most economical solutions for the Lesotho data.

Fig.3 BREVAC LA equipment in action

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Single and double pits in Lesotho

S N Makhatha

SUMMARY

More than a thousand Double Vault Ventilated Improved Pit-latrines (VIDP) have been built in Maseru, Lesotho. The largest concentrations of the latrines are in the low cost sites and services areas of Katlehong and Khubetsoana. These latrines have also been promoted widely by the Urban Sanitation Improvement Team (USIT) in the rest of the peri-urban area and many rural people have opted for this type of latrine and constructed it with help either from USIT or the Rural Sanitation Project (RSP). Because of the ingress of groundwater in many of these latrines, it has not been possible to achieve complete separation of the contents of the two pits and cross-contamination has been evident in many of them. USIT has therefore been led to re-consider further promotion of this type of latrine.

INTRODUCTION

VIP latrines of the Double Vault type (PIP or VIDP) have been promoted throughout the developing world as an appropriate, affordable and adequate sanitation option offering, above other VIP types, permanence, the avoidance of the dependence on mechanical de-sludging and possibilities of the use of digested contents as a soil conditioner.

This paper deals with the experience of USIT with the double pit latrines in Lesotho. USIT is a multidisciplinary team in the Ministry of Interior concerned mainly with the development and delivery of appropriate sanitation technology for under-priviledged urban dwellers in Lesotho. Because of the similarity between the peri-urban areas and the rural areas (especially in the lowlands of Lesotho), most techniques have been transfered unchanged to villages. The VIDP has also been adopted for use by many rural dwellers.

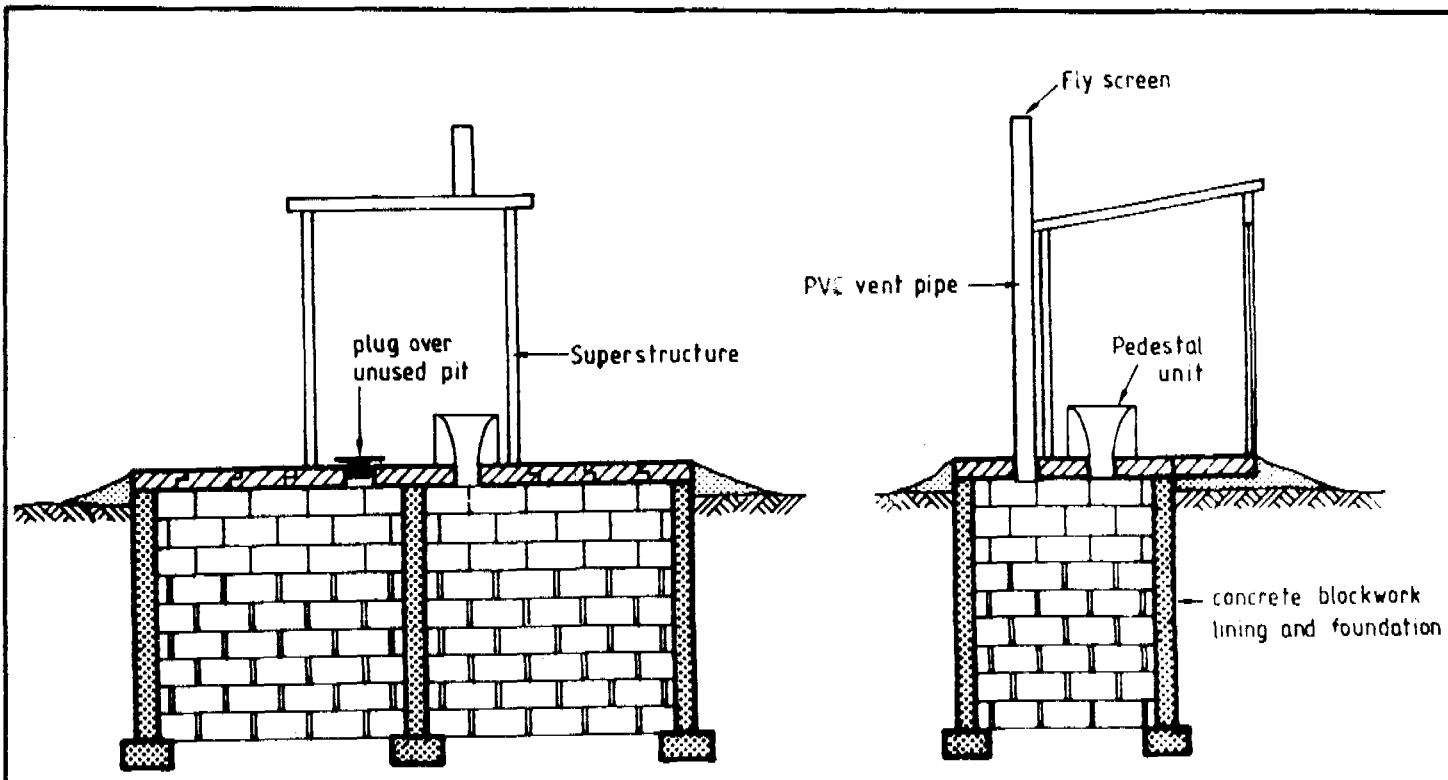

FIG.1. VENTILATED IMPROVED DOUBLE PIT LATRINE (VIDP)

BACKGROUND

The first major thrust in VIP latrines in Lesotho was undertaken in the low income sites and services area of Katlehong in South-western Maseru. The 214 latrines built were both the single and double pit types of concrete block walls and re-inforced concrete cover slabs. The latrines had GRP (Glass Reinforced Plastic) pedestal seats.

Promotion of VIDP Latrines: After the formation of USIT within the Maseru Urban Development Project, VIDPs were promoted widely in Lesotho. In the urban areas they were promoted mainly on the grounds that they would save space by not requiring new pits to be dug each time a latrine fills up. In the rural areas, they were promoted on similar grounds and in addition they would provide digested sludge to be used as a soil conditioner in fields. In both cases there would not be a need for mechanical de-sludging, making the running cost low though at a relatively high capital cost.

Initial Modifications: The first VIDP and VIP latrines in Katlehong were unlined pits with a ring beam. It was recognised at an early stage that due to the soil conditions and the weight of the concrete block superstructure this design was not suitable. The pits were de-sludged and lined. All subsequent pits (903) in Khubetsoana were lined. There were no single pit latrines at all built at Khubetsoana. Gaps were left in the first three to five courses of blockwork in the pit to allow soakage of fluids into the surrounding ground.

COSTS

High Cost of VIDP: It was recognised immediately however that the VIDP latrines used were expensive and were barely affordable by the peri-urban people, let alone the rural people. The first design costs M732 (December 1986 prices, M1= 0.30).

Reducing Costs: USIT immediately embarked on a programme of producing cheaper VIDPs and Table 1 shows the costs of the various VIDP models and approximate times when these were commissioned. The table also shows the cost of the single pit VIPs of similar design for comparison.

OBSERVATIONS OF DOUBLE PIT PERFORMANCE IN MASERU

Misuse of latrines: One of the commonest problems of double pit latrines stems from lack of understanding of the working principles of the latrine. In many cases people have been observed to have been using both pits simutaneously and in schools this is a major problem.

Quality of construction: In order to ensure that the contents of the two pit remain totally separate, the dividing wall between the pits has to be built to a high standard. Such building standards are usually not maintained by local builders and this creates a problem of cross-contamination.

Wet pits: Many of the double pit latrines observed in Maseru had contents of both pits wet. In many of them, water in the unused pit, had risen to the level of the contents of the pit in use even before changing over. Table 2 is an extract from pit emptying records for November, 1986.

TABLE 1 Cost of Various VIP latrine Models used in Maseru

Model Type[2]	Year	Cost in 1986 (M)	
		VIDP	VIP
Lehco-op	1979	732	542
Albert	1983	600	-
Mapoteng	1983	474	372
USIT/RSP[2]	1986	563	477

1. The costs are for peri-urban areas for concrete block latrines with reinforced concrete floor slabs. In rural areas the use of local materials, especially the abundant rock available, reduces cost significantly.

2. The Model Type notation used here is one used by USIT to differentiate the Models and may not be compatible with references elsewhere.

3. The Model was adopted not for further cost saving but for standardization of components countywide and for simplicity of construction.

TABLE 2 EXTRACT FROM PIT EMPTYING RECORDS, November 1986.

Date	Plot NO.	Chamber Type	Free Water			Nature of Sludge
			Lots	Little	None	
3/11/86	970	VIP			x	Thick
4/11/86	965	VIP	x			Wet
11/11/86	School	VIDP	x			Very liquid
14/11/86	-	VIDP		x		Wet
14/11/86	-	VIDP	x			Wet
18/11/86	887	VIP	x			Very liquid
19/11/86	-	VIP	x			Mostly water
20/11/86	1	VIDP	x			Wet
20/11/86	2	VIDP	x			Wet
20/11/86	3	VIDP	x			Wet
21/11/86	4	VIDP	x			Wet
21/11/86	1851	VIDP	x			Very liquid
24/11/86	1496	VIDP	x			Very liquid
26/11/86	901	VIP	x			Very liquid
27/11/86	1064	VIDP		x		Thickish
27/11/86	962	VIP	x			Liquid
27/11/86	1492	VIDP	x			Watery

N.B. Site Nos 800 - 1000 at Katlehong, (S.W. Maseru); Nos. 1001 upwards at Khubetsoana (North Maseru); and Nos. 1 - 10 at Qoaling (Maseru South).

The table shows that most of the pits had wet contents and the sludge had not thickened enough to be handled manually.

Smells and looks: Most of the wet latrines emptied had smelly contents in both pits. The contents also looked offensive and could not be handled by people. The problem was similar even with school latrines. Contents cannot therefore be used as soil conditioner and people object to handling them in any way.

Cross Contamination: In many cases, emptying the contents from one pit led to a subsidence of the contents of the other. This phenomenon showed there was movement of water or wet sludge from pit to pit. (At the time of writing this paper, bacteriological tests are being conducted to determine the extend of cross contamination.)

SOIL CONDITIONS

Duplex soil conditions exist in most of Lesotho's lowlands with a band of stiff clay overlain by a thin layer of permeable soil, usually less than one metre deep. Water below a depth of one metre will generally not be absorbed into the ground. In the wet season, water flowing at the interface of the two soil layers gets trapped in the clay lined pit and can only flow out again through the upper soil layer.

Rock outcrops are common all over the country with the depth to rock averaging less than one metre in most of the settled areas (villages are traditionally sited on land unsuitable for agriculture) This complicates the problem of construction of deep pit latrines even further, however VIDP latrines need not be deep and, if fully lined, can even be built partly above ground. VIDPs built over rock are less likely to be wet provided the latrine construction is of good quality.

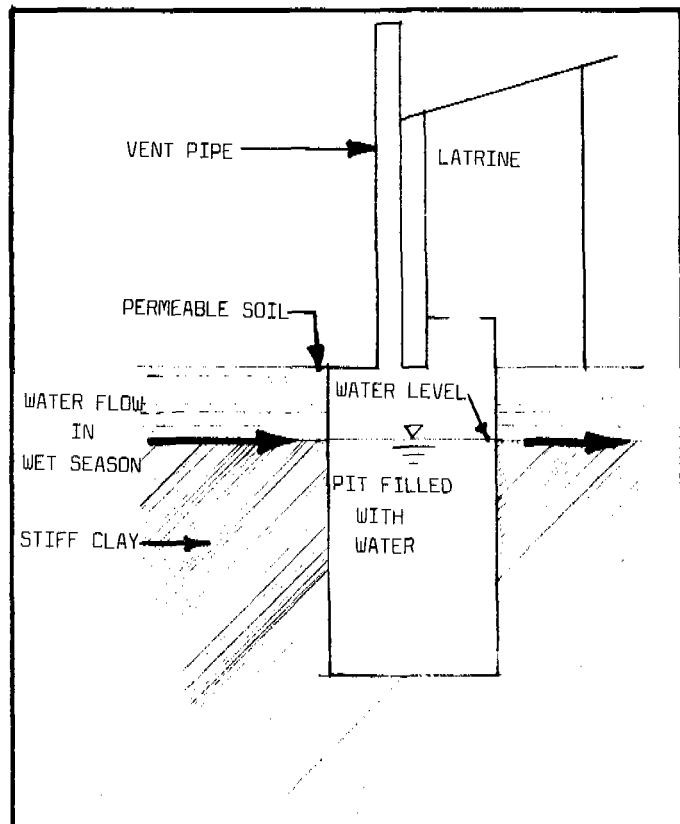

FIG. 2. WATER TRAPPED IN THE LATRINE PIT IN DUPLEX SOIL.

PRESENT USIT APPROACH

As a result of the problems encountered with VIDP systems in Maseru, i.e. because of wet pits, USIT has had to reconsider further promotion of these latrines. In peri-urban areas USIT recommends the construction of de-sludgeable single pit latrines. The proposed sites and services areas in Mafeteng and Teyateyaneng (which are both small district towns) will be provided with de-sludgeable single pit VIP latrines. A mechanical pit emptying service is being developed and one system, the BREVAC LA, is currently being tested. This approach is not feasible in rural areas due to high cost of operation aggravated by the inaccessibility of many villages.

In rural areas USIT recommends the use of single pit latrines of cheap superstructures and unlined pits. The zinc sheet superstructure is the most widely used and USIT has promoted this through the "Upgrading of Local Latrine Manufacturers" project. The superstructure can be moved from pit to pit saving replacement costs. USIT and RSP also promote the use of locally available materials to ensure cheap latrines. A package of slabs and a vent pipe is available from USIT or RSP depots for people to buy and use for VIP latrines in villages. The package currently costs M46.00. On-site slab casting is also being promoted. Most rural people are encouraged to build from local materials. When the pit is full, the householder simply demolishes the superstructure and re-builds it over a new pit. However, several villagers have opted for a VIDP because of its permanence.

CONCLUSION

As mentioned before, over a thousand double pit latrines have been built in Maseru and more in other areas of Lesotho. The comparative cost of these units have been high and household resources could have been saved by the construction of single pit VIPs since a pit emtying service is going to operate in Maseru and other urban areas. The fact that these latrines are reported to have worked well in other places should not be used as a basis for universal adoption in all countries and even from region to region.

Mechanised pit emtying is not viable everywhere and is expensive, therefore the construction of emptiable single pit VIPs may not be a solution that is feasible in all cases.

Proper soil investigations should be made and pilot latrines built to assess performance before large schemes are undertaken. Because of the limited resources available in rural areas it is even more important to ensure that the double pit latrines are built only where they are bound to work well. Single pit latrines of cheap construction, requiring a new pit to be dug whenever they fill up may be a better solution in most cases in rural areas.

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Low volume flush wc design

R H M Wakelin, J A Swaffield and R A Bocarro

ABSTRACT

Water usage by w.c. flushing can represent a major portion of the total water use in a dwelling and may be sufficient to prevent the introduction of such sanitary facilities in developing country applications where water is in short supply. The work reported has concentrated upon the development of a low cost 3-litre flush volume w.c. suitable for use in developing countries and has been funded by the UK Overseas Development Administration (ODA). This paper presents the team's approach to the problem of low water use w.c. design, in terms of the modifiable variables such as trap volume, water seal depth, cistern to bowl water distribution etc. Laboratory trials are reported to support the design decisions taken in respect of trap seal depth and volume. In order to both reduce bowl cost and provide the bowl with a pour flush capability, the bowl is rimless. The solution to the water discharge to the bowl and subsequent surface cleansing problem chosen is a water spreading nozzle connected directly to the cistern discharge and positioned at the rear of the bowl. Development of this "spreader bar" flow device is reported. Site evaluation in Botswana and Lesotho during 1985 and 1986 is also discussed.

INTRODUCTION

In January 1983 a research programme at Brunel University was initiated to design, develop, test and manufacture a low volume pour flush and cistern operated w.c. primarily for use in developing countries. The research is funded by the UK Overseas Development Administration. The design and testing of the model w.c's took place at Brunel University, with close consultation with Twyfords Limited to ensure the practicality and economy of the designs. Twyfords were also responsible for the production of various prototype models based on the design and development work at Brunel.

The Drainage Research Group at Brunel University have for some time been actively involved with water conservation design, both as it affects appliances and also in terms of its effect on long drainage pipelines (refs.1,2). Work was also undertaken on low flush volume w.c. design for the UK industry (ref.3).

LOW FLUSH VOLUME W.C. POTENTIAL AND DEVELOPMENT

As part of the research programme it was intended that site trials of some 200 of the final model w.c. would eventually take place in one or more developing countries. A study tour of Lesotho, Botswana, Zimbabwe and Kenya was undertaken in April 1983 to investigate the feasibility of water conserving w.c. designs. In all of the countries visited, the rural population were in general discounted as not being suitable for the provision of flush toilets. For many rural villages the flush toilet was simply not economic or practical. Cheaper, but nonetheless hygienic, alternative excreta disposal systems such as the ventilated improved pit latrine (ref.4) were to be recommended instead. Generally speaking, the flush toilet was considered suitable for the middle and higher income urban population, a group which represented 10-20% of the population in all the countries visited. This group could afford the costs associated with providing a w.c. and all its fittings, plumbing and running expenses. In this group, in particular, if the flush toilet was affordable it was by far the most popular means of excreta disposal and cheaper systems were not acceptable. A number of important factors emerged from studying this group. Though a minority of the urban population, this group were often responsible for the majority of the urban domestic water consumption. For example, in Gaborone, the capital of Botswana, it had been estimated by the Water Utilities Corporation that domestic water consumption in this group accounted for 80-90% of the total urban consumption. The flush toilet typically accounted for 40-50% of their total domestic consumption.

In Lesotho and Botswana there was strong local interest in the future use of w.c's that require 4.5 litres of water or less for flushing, rather that existing w.c's using 12-15 litres. There was concern that the rapid urbanization of towns like Gaborone and the subsequent increase of water consumption associated with it could lead to a future shortfall in available water supply. In particular, Botswana could benefit from the adoption of w.c. systems that place a low demand on the water supply system, as it is also affected by periodic droughts. By the end of the 1983 study tour, sites for 50 w.c's in Maseru, Lesotho and 100 in Gaborone,

Botswana had been identified as suitable for installation of the Brunel prototype w.c's in 1985/86. It had been intended to carry out site trials of pour flushed prototype w.c's in Malawi or elsewhere, but this subsequently proved impossible due to lack of suitable sites. Having established some initial design criteria based on choosing Lesotho and Botswana as locations suitable for low flush volume toilets, the development of the w.c. pan could commence.

The initial development work at Brunel University concentrated on two main themes: to minimise the volume of water required for flushing (flush volume); to develop an upgradable pour to cistern-flush operated w.c. The initial research was concerned with establishing the effect of the key w.c. design parameters on the efficiency of the w.c. pan, that is its ability to flush out solids, at reduced flush volumes. Based on the results of earlier research carried out at Brunel University (ref.3), it was decided to concentrate on four main w.c. design parameters: trap seal volume; trap seal depth; water surface area; minimum passage size. These parameters are illustrated in Figure 1.

The modelling was carried out on an existing production w.c. manufactured by Twyfords which had been modified for Brunel University. The w.c. was supplied without either the flushing rim or the ceramic back plate used to form the trap seal. Plasticine was used to reprofile the inner surfaces of the w.c. and reduce the trap seal volume. Perspex plates were fitted to vary the trap seal depth. The apparatus used for carrying out tests on the model w.c's is shown in Figure 1. A bucket was used to simulate the pour-flush operation, ie. the action of tipping a bucket to flush the toilet (ref.5).

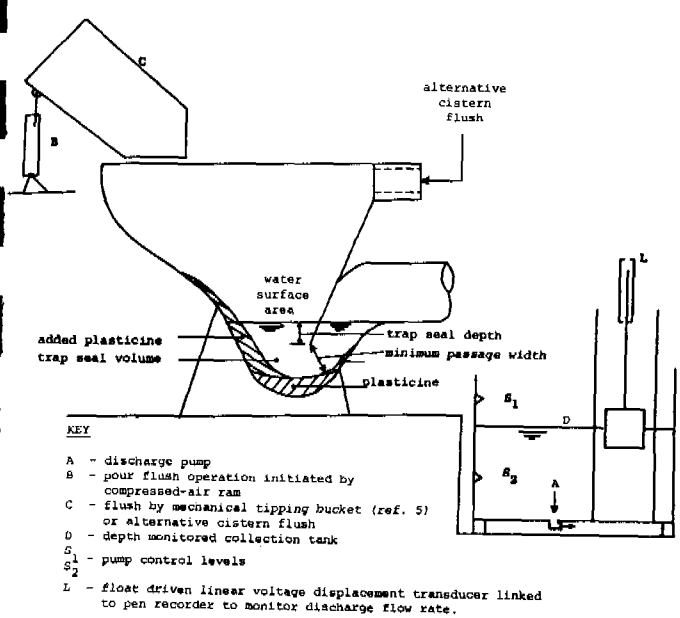


FIGURE 1. Initial trap modifications using plasticine, and schematic diagram of pour flush/cistern flush and discharge monitoring test apparatus.

The tests used to determine the effect of the w.c. parameters on reduced flush operation were: British Standard Ball; Single Density (0.83-1.1 specific gravity) Multiple (50) Ball (20mm diameter); Residual Trap Concentration; Solid Transport (refs.1,2).

It was confirmed (ref.3) that the efficiency of the w.c. pan, at flush volumes tested in the range 1.5-4.0 litres, was affected by the key w.c. design parameters by the following functional relationship:

$$\eta = \phi \left\{ \frac{\text{Flush Volume}}{\text{Water Seal Vol.}} \times \frac{\text{Min. Passage Size}}{\text{Trap-Seal Depth}} \right\}$$

From all the data collected, it was recommended that a minimum flush volume of 3.0 litres could be adopted. From the above equation, it is apparent that to obtain maximum efficiency, factors such as keeping the trap seal volume and the trap seal depth to a minimum, are necessary.

In the early development work, it was decided to omit the flushing rim. The omission of the flushing rim has the potential to significantly reduce the unit cost of the w.c. In addition, if the w.c. is used in its simplest form, as a pour-flush toilet, a flushing rim would not be kept clean by the regular discharging of the cistern. The next problem to solve was how to flush the w.c. when used in its upgraded form. A flushing rim performs two functions. Firstly, the water must thoroughly wash and clean all surfaces in the w.c. The second function of the flushing rim is that it ensures a sufficiently high flow rate to remove all solid and liquid contaminants form the w.c. bowl in a single flush. A device, eventually termed a "spreader bar", was developed as an alternative to the flushing rim, which would perform these two functions. The finalised Mark V design is illustrated in Figure 2. The spreader bar consists of two main parts, the holder and the flow diverter, which were machined from PVC rod. The spreader holder is pushed over the end of the flush pipe and the flow diverter fits into the holder. The

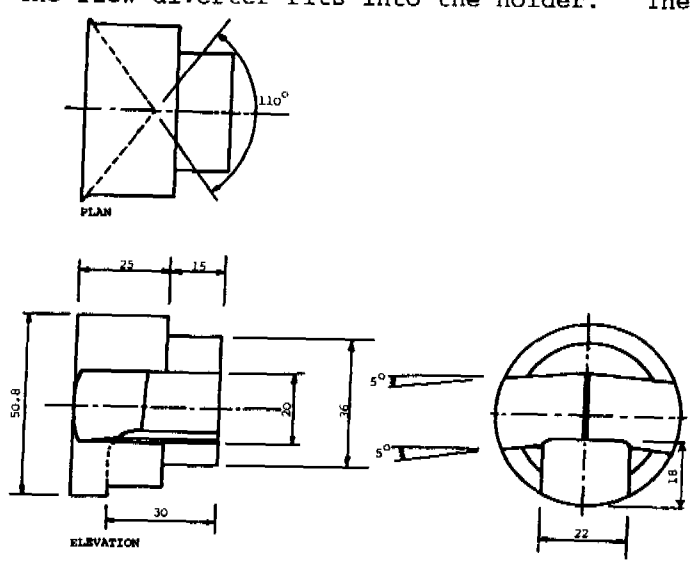
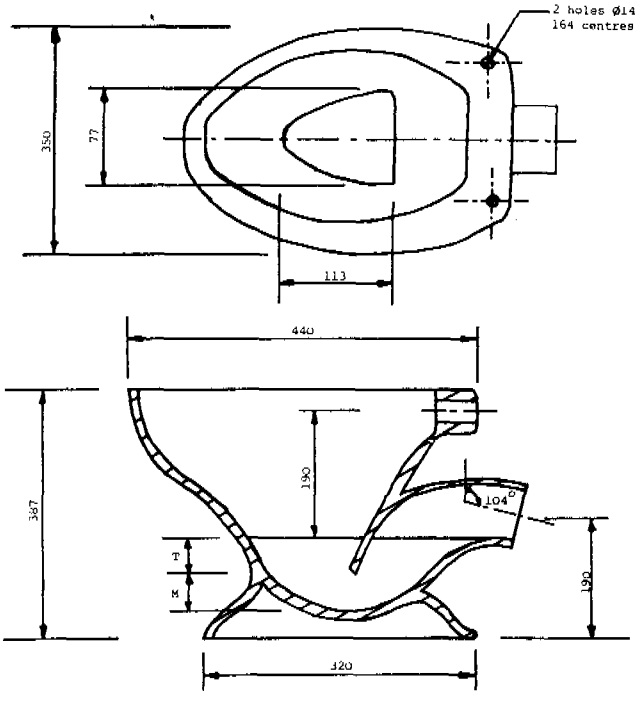


FIGURE 2. Mark V PVC Spreader Bar, all dimensions in mm.

flow diverter has a total of three slots used to guide the jets of water around the sides of the pan. There are two side slots milled at a relative angle of 110° in plan which ensure that the sides of the w.c. are washed thoroughly. The slots are also angled down at 5° to stop the water from splashing over the sides of the bowl. The bottom slot ensures that water is directed towards the back surfaces of the w.c. to ensure cleansing and to enhance momentum transfer of solids from the w.c. bowl.

The final Mark III model w.c. from which 220 were subsequently manufactured is shown in Figure 3. The w.c. has a 104° p-trap, rather than a horizontal outlet as advocated in BS 5503 (ref.6). The 104° p-trap is still adopted by South African w.c. manufacturers and thus was necessary for installation in Lesotho and Botswana. Significant changes, relative to BS 5503, were also made with respect to the hydraulic design parameters as summarised in Figure 3. The w.c. shown in Figure 3 was fully tested with the Mark V spreader bar, Figure 2, and a Geberit - manufactured drop-valve cistern. In figure 4, a comparison between the prototype w.c. and a conventional Twyfords washdown pan, both with the same cistern, is shown for the specific gravity 0.877 Multiple Ball Test. The prototype w.c. with a 3 litre flush volume matched the performance of the Twyfords w.c. pan set at a flush volume of 9.0 litres. The concentration test was also carried out. The 3-litre prototype gave an average residual concentration of less than



KEY W.C. DESIGN PARAMETERS

DETAIL	BS 5503	MARK III
Trap seal volume (litres)	1.8 measured	0.86
Trap seal depth T (mm)	52 minimum	35.5-36.5
Min. passage size M (mm)	75 minimum	63
Water surface (mm)	150 X 100	113 X 7

FIGURE 3. Mark III low flush volume w.c., final prototype design. Not to scale, all dimensions mm.

half that of the 9-litre flushed Twyfords pan. Obviously an efficient w.c. design should remove as much of the trap seal water contamination during the flush as possible, for hygiene reasons.

Having completed the laboratory tests, which confirmed the optimisation of the Mark III design of the w.c. and the Mark V spreader bar design, an installation was carried out on the Brunel University campus. This unit flushes with 3.0 litres from a drop valve cistern and has proved successful in the 24 months to date, requiring only marginally over one flush per visit.

BOTSWANA AND LESOTHO SITE TRIALS

The design and development phase of the research programme was completed in July 1985. By the end of the month, Twyfords had manufactured 220 of the prototypes. A local firm in Uxbridge manufactured 220 of the spreader bars for the prototype w.c's. To minimise transport costs it was decided to use locally available cisterns and fittings. A locally manufactured cistern was modified by drilling a lower water inlet to provide a 3-4.5 litre flush. Marley S.A. have provided, free of charge, a recently developed drop valve and inlet valve, for which due acknowledgement is gratefully recorded. In August 1985 the installation and site monitoring phase of the project commenced.

A total of 103 low flush volume toilets have been installed in Botswana: 63 in a self contained development of detached low income housing built in September 1984 in Gaborone West, where existing 9-12 litre flush toilets and cisterns were replaced in March 1986 with low flush volume w.c's flushing with 4 litres; 26 in a new low income housing development occupied since August 1986 in

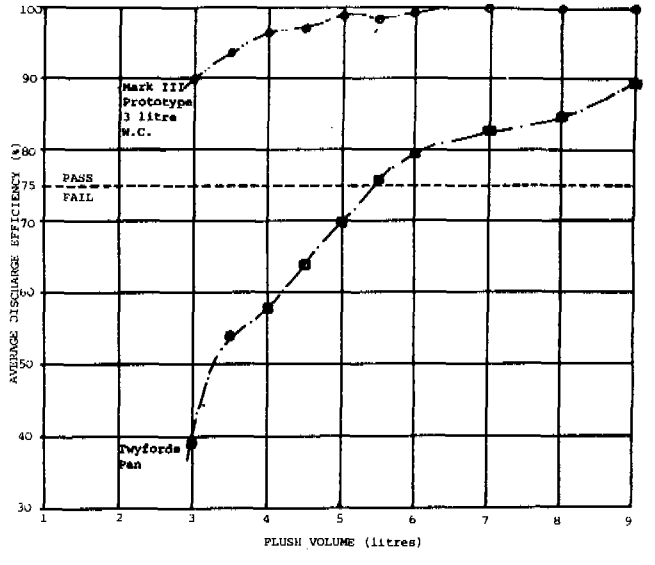


FIGURE 4. Single Density (specific gravity 0.877) Multiple Ball Test comparison between the low flush volume Mark III prototype w.c. with Mark V spreader bar and a Twyfords B.S. pan with conventional flushing rim, both flushed by a Geberit drop-valve cistern.

Broadhurst, Gaborone; 4 in the new Botswana Housing Corporation, Gaborone office block; 2 in a refurbished private house; and 8 retrofits in a secondary school in Gumare, discharging to a septic tank/soakaway. With the exception of Gumare School, all the low flush volume w.c's are sewer connected. The principle of the Botswana installations has been to prove: the reliability and operation of 3-4.5 litre flush; user acceptance of low flush volume w.c. operation in a broadly similar income and social group; any adverse effect on the drainage networks serving large housing developments fitted or retrofitted with 3-4.5 litre flush w.c's. No drain blockages, solid deposition problems or adverse user reactions have developed to date. There have been w.c. blockage problems at Gumare School, and these are being investigated.

In Lesotho, 53 low flush volume w.c's were installed during the period February to August 1986. The principle of the Lesotho installations has been to include a variety of sanitation disposal methods: 17 sewer connected; 11 septic tank/soakaway connected; 24 conservancy tank connected; 1 to a converted VIDP latrine. One installation at Semonkong is pour flushed with 2 litres. A variety of residential and institutional buildings have been fitted with 3-4.5 litre flush w.c's: 27 flat/house owner occupied; 17 flat/house tenant occupied; 4 in offices; 4 in schools; 1 in an hotel. Flush volumes have generally been set to 4 litres for institutional use and 3 litres for residential use. All installations are flushing efficiently and there has been no adverse user reaction.

In both Botswana and Lesotho, several leakage problems have developed due to misalignment of the drop valve relative to the cistern lid centre pull or incorrect fitting or faulty inlet or outlet valves. Site monitoring of all the low flush volume w.c's, and various conventional installations to provide a control for comparison, will involve: house water meter readings; readings of w.c. water meter where fitted; drain checking; conservancy tank emptying frequency where appropriate; and user reactions.

The existing ODA research contract jointly with Brunel and Heriot-Watt Universities, which ends at the end of March 1987, will probably be extended for a further six months to allow longer term monitoring of the low flush volume w.c's.

CONCLUSIONS

Research funded by the UK ODA at Brunel University, in conjunction with Twyfords at Stoke-on-Trent, has led to the development of a low cost w.c. pan which in general flushes as efficiently with 3-litres as a British Standard w.c. with 9-litres. The 3-litre w.c. has been designed to optimise the relationship between flush volume, water seal volume, trap passage size and trap seal depth within the constraints of a functional w.c. capable of low cost manufacture. A site trial at Brunel University has indicated no adverse user reaction and no significant reduction in bowl cleansing performance.

Site trials in Lesotho and Botswana have proved the potential for a low flush volume w.c. in a wide range of applications from sewer connected systems to septic tank and conservancy tank connected systems. Early indications suggest a reduction in overall household water consumption of 15% due to the installation of a low flush volume w.c. Site trials in Botswana and Lesotho incorporating tipping tanks (ref.7) are under way to increase the potential of the low flush volume w.c. to longer drain and sewer connections.

The 3-litre w.c. itself has a wide potential including any country which is prevented from adopting flush w.c's due to water usage restrictions and any location where foul discharge is restricted.

ACKNOWLEDGEMENTS

Funding of the research reported, including the continuing site trials in Botswana and Lesotho, by the UK Overseas Development Administration is gratefully acknowledged.

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SESSION 2 - DISCUSSION

Chairman: Professor John Pickford, OBE
WEDC, University of Technology,
Loughborough, LE11 3TU, UK.

C WILLIAMS
CHOICES IN PIT LATRINE EMPTYING

S N MAKHETHA
SINGLE AND DOUBLE PITS IN LESOTHO

Questions on these two papers were taken together.

1. Mr TAREMBA suggested that there was scope for improvement of VIDP latrines. He recommended the use of locally available materials e.g. bricks, aggregate stones, sand and labour. From experience in Zimbabwe vent pipes were placed on the northern side of the VIP. On the problem of odour, he wished to know how this was avoided when doors were not facing the windward side so that air could come through the entrance, down the squat hole and up through the vent pipe. He opined that the question of privacy was not answered in the VIDP, given that women and men do not want to share the same facility. In addition, he thought that use of materials other than tissues for anal cleansing, e.g. mealie cobs, stones or sticks, could block the sophisticated equipment used for emptying the pits. Finally he questioned the use of zinc and iron roofing as it affects the performance of the VIP: he suggested cement slabs as a cheaper alternative.

2. Mr MAKHETHA agreed that VIDP latrines could be improved but this may not solve the problem of water in pits. As regards local materials, they are usually more porous than concrete. In Lesotho, latrine doors are as far as possible made to face away from the sun which does not necessarily coincide with the windward side. In any case the wind direction varies tremendously in Lesotho. The question of men and women not using the same latrine is not a problem at all in Lesotho: public latrines are separate for security. The point made on the use of zinc sheet VIP's was valid, however Lesotho is not a continuously hot country so the problem is therefore intermittent.

3. Dr WAKELIN wished to know if USIT had considered the use of an overflow pipe, from the single or double pit fitted with a dip tube to below average water table level and discharging to a shallow soakaway dug above the average water table level.

4. Mr MAKHETHA replied that French drains have been used with success to divert water from latrines. As the cost might be prohibitive it is better to build VIPs with cheaper or reusable superstructures than to put French drains on an already expensive structure even if this were feasible.

5. Mr BHAIJI questioned the necessity of the high standard of centre wall, especially of the thickness constructed on the USIT programme.

6. Mr MAKHETHA explained that the basic necessity of the wall is that it should ensure no transportation of materials and liquids from one pit to the other. Any wall that can achieve this is adequate. The USIT programme has successfully used 100 cm (4") walls. The problem of quality control comes mainly from the mortar and mixes used by the local builders.

7. Mr MAKUMBA expressed the thought that the high desludging rate increased the cost of the system. It seemed to him that as it was infiltrating water that was responsible for rapid filling of latrines, they should be made watertight. He referred to VIP latrines constructed locally, that had not filled in 10-15 years. From calculations on the accumulation rate per capita per year, he understood why the locally constructed VIPs, which are watertight, do not fill up as quickly as those in Lesotho.

8. Mr WILLIAMS replied that the filling up of pits with water up to the soil horizon is not regarded as a serious problem, except in the case of VIDPs where cross contamination can occur. It had also been found that training local builders to construct watertight tanks was very difficult.

9. Mr MAKHETHA commented that, as they had problems ensuring the builders make a single sealed wall, it is impractical to adopt a sealed pit option universally. Even with wet pits, as long as there is no cross contamination between pits, then bailing out the sludge with buckets would be practical.

10. Mr CHOLA asked how shallow wells were designed for rural water supply when VIPs did not have sealed walls and where there is a high incidence of ground water contamination.

11. Mr MAKHETHA informed participants that shallow wells are not used in Lesotho for rural water supply. The soil profile shown in the presentation explains why shallow wells are impractical. The water filling up the pit is not groundwater from the groundwater table but flow at the interface of the two soil layers, filling the pit from the top.

12. Mr KULAH put the following questions to which Mr MAKHETHA replied.

(i) To what level are villagers aware in using latrines in Lesotho?

The Rural Sanitation Project as well as USIT are engaged in programmes to motivate and educate the villagers in the use of VIP latrines. The response is good and the demand is high.

(ii) Do you have the social problem where men and women do not agree to use the same latrine?

Although this is voiced several times, in practice people in Lesotho have a long tradition of one latrine per household.

(iii) How many people out of the population in a particular village use the pit latrine and what are the social problems associated with this?

We, as a matter of policy, do not provide communal pit latrines in villages and hence the social problems associated with these are avoided. (Answered after discussion with Mr KULAH.)

R H M WAKELIN, J A SWAFFIELD and R A BOCARRO
LOW VOLUME FLUSH WC DESIGN

13. Mr MAKUMBA asked for the authors opinion of the effects of the 3-litre-cistern system. In sewers with particular reference to the following points: (i) as the sewers were designed for 9-10 litre cisterns and the advocated 3-litre cisterns would be welcomed by users and municipalities, sewers may become blocked as a result of running under capacity. The higher BOD valves, brought about by the decreased water volumes, may increase sewer corrosion.

14. Dr WAKELIN explained that part of the monitoring programme included monitoring drain and sewer deposition of solids and hence potential blockages. He thought that sewer blockage was less likely than drain blockage and so far no evidence of increased drain deposition had been identified. The drains and sewers relevant to the studies were UPVC, clayware and concrete which are not affected by corrosion or changes in increased BOD: The problem of corrosion will require separate evaluation. The authors are carrying out parallel investigations into the use of tipping tanks; trials are in progress in Botswana and Lesotho. Tipping tanks can be used to overcome drain or sewer blockage problems, but provision will only be required in exceptionally poor drainage systems.

15. Mr POLELA commented that from the conclusions of the paper, the real cost-saving element seemed to be water consumption. Whilst understanding that the tests were taking place in Lesotho/Botswana where there are water problems , he questioned why the tests were not taking place in the UK where there are at times water problems. He expressed suspicion of the Twyfords' linkage in the exercise and had the impression that it was a marketing exercise.

16. Dr WAKELIN commented that clean, potable water is a valuable and essential commodity in any community and should not be wasted. He thought that the potential for low volume flush toilets will be greater in those areas where water is in short supply. Research had already been carried out to reduce WC flush volume in the UK and this is in the process of being reduced by legislation. This experience has been utilised in this research programme funded by ODA (Overseas Development Agency). Brunel University and ODA have no commercial interest in low-volume flush toilets. Twyfords have only been involved in prototype production and are unlikely to exploit their involvement for commercial benefit. In fact potential manufacturers for the low volume flush toilet were being investigated and a Zimbabwean firm is developing a prototype in fibreglass.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Natural coagulants in water clarification

G K Folkard, J P Sutherland, W D Grant

ABSTRACT

Powdered seed suspensions of the Moringa oleifera tree have proved effective as a primary coagulant to clarify a stable kaolinite suspension. Acting as a cationic polyelectrolyte optimum minimum dosage to achieve maximum turbidity removal have been determined over a range of initial turbidity values (50-550NTU). The weight ratio of seed dosage to clay concentration appears independent of initial clay concentration. A field usable dissolved air flotation system has been developed. This technique, when applied to a kaolinite/bentonite model suspension, produced clear water in minutes as opposed to hours for conventional sedimentation. Topics for further investigation are outlined.

INTRODUCTION

Recent figures from the World Health Organisation reveal that when population growth is taken into account, more people will be without access to safe drinking water in 1990 than at the beginning of the decade. Of the 2000 million people currently without safe supplies, some 80% live in relatively small rural communities. In such situations many people draw water for drinking purposes from surface derived sources. For a riparian population in the rainy season, these sources are highly turbid and on occasions exhibit indicator bacterial concentrations similar to weak sewage.

Against this background, household treatment systems have an important role to play in providing aesthetically acceptable and bacteriologically safe drinking water. Individual communities suitably motivated, educated, trained and convinced of the benefits of applying basic water treatment practices will advance, perhaps centralising to a degree their individual efforts at achieving a wholesome water.

The use of chemicals is not generally considered to be appropriate to rural water treatment in developing countries. A proven alternative, however, is the use of indigenous plant derived materials to effect destabilisation of the suspended material. Rapid, effective destabilisation of the colloidal material with its associated bacteria followed by subsequent removal of the formed floc is of primary importance.

MORINGA OLEIFERA AS A PRIMARY COAGULANT

A remarkable number and variety of natural materials have been examined for their coagulating properties spontaneously and systematically by village inhabitant and research worker alike. Suspensions of seed powder from the tree, Moringa oleifera Lam. have been shown to be particularly effective as both a primary coagulant and as a coagulant aid for water clarification over a wide range of turbidities. A native of the sub-Himalayan regions of north west India, M.oleifera is now under cultivation in the tropical areas of Asia, Africa, Asia and South America as a valuable multi-purpose tree (ref.1)

Although much work has been done it is difficult to cross correlate results from the various studies on the use of natural coagulants in general and M.oleifera in particular. Individual studies have been conducted on very specific raw and synthetic test waters with many important parameters unstated. This paper reports on preliminary findings of a three year research programme with the overall objective to optimise the use of natural coagulants to remove suspended solids and associated indigenous bacteria. The programme includes laboratory work using chemically defined water and extensive field studies at mid term on natural waters.

Experimental Work

The work presented is based on model suspensions of kaolin (BDH, grade light) in deionised water with stated additional constituents. This clay mineral is commonly found in weathered tropical soils. The use of synthetic turbid suspensions based on kaolin are well established yielding treatment characteristics which are similar to river derived samples (ref.2). Treatment trends can be established under controlled conditions with interfering components of natural waters introduced in subsequent tests.

Pre-dried and weighed quantities of the clay were wetted for 24 hours and stock/working solutions prepared daily by dilution and rapid mixing at 6000 r.p.m. Figure 1 shows the relationship between turbidity and suspended solids concentration for the test water.

Apart from the origin and physical size of the suspended mineral particles, chemical constituents of the water influence the surface electrostatic stability of the particles. In particular the presence and subsequent adsorption of the divalent ions of calcium and magnesium may destabilize a suspension. In contrast, the presence of humic substances have been reported to increase the stability of certain substances (ref.2). Table 1 indicates the stability characteristics of the test water.

Seed suspensions are prepared by crushing preweighed kernel material with a pestle and mortar. Approximately 15mℓ of deionised water is then added and the suspension agitated.

The active fraction of the M.oleifera seed effecting coagulation has been determined to act as a cationic polyelectrolyte having little or no effect on residual pH and alkalinity (ref.3). For a range of initial turbidities viz. 50, 250, 400 and 550 NTU the optimum minimum seed dosage to achieve maximum clarification was achieved by a series of standard jar tests (rapid mixing for 2 minutes at 200 r.p.m. followed by slow mixing for 10 minutes at 20 r.p.m.) Samples, carefully extracted from a depth of 25mm below the water surface were subjected to turbidity measurement (Hach 2100A).

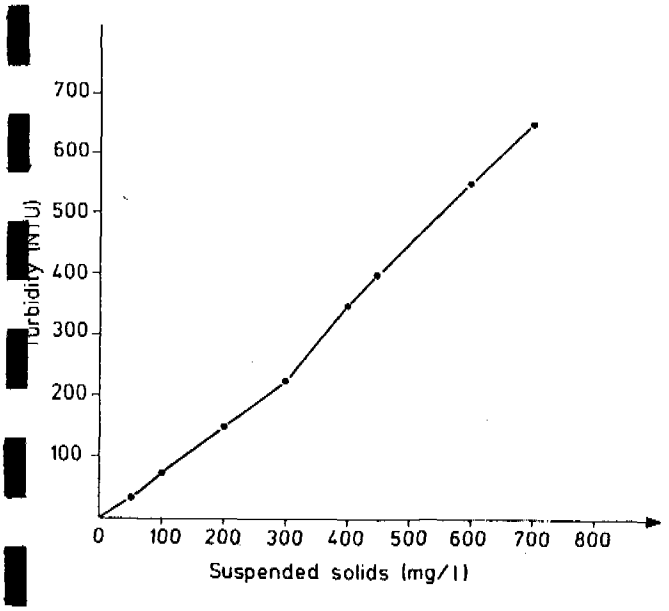

Figure 1 Correlation between suspended solids concentration and turbidity for the model kaolin suspension.

Figure 2 shows results of the 550 NTU initial turbidity samples. Data points represent average values of replicates. This takes into account the inherent variability in the nature and preparation of the seeds.

This typically shows that the minimum residual turbidity is maintained over a wide seed dosage range. Proprietary cationic polymers generally exhibit a more distinct and restricted optimum dosage range with larger or smaller dosage giving incomplete removal. However some raw waters have not shown such "overfeed" problems (ref.4).

Figure 3 indicates the stochiometric relationship obtained between minimum optimum seed dosage and clay concentration through the range studied. The weight ratio of seed dosage to clay concentration appears independent of the initial clay concentration. A similar relationship has been reported using a proprietary cationic polymer to destabilise a far more dilute kaolin suspension in the range 15-80 $mg\ell^{-1}$ (ref.5).

TABLE 1. Stability characteristics of the model kaolin suspension

Suspended Solids concentration ($mg\ell^{-1}$)	Sample turbidity (NTU) at time 0	after 1 hr.	after 2 hrs.	after 3 hrs.
50	35	35	30	30
100	75	70	70	65
200	150	130	125	125
300	225	225	200	200
400	350	350	350	325
450	400	375	400	400
600	550	525	475	450
700	650	650	650	625
800	1000	900	850	800
Chemical Addition	**Sample turbidity (NTU) at time 0**	**after 1 hr.**	**after 2 hrs.**	**after 3 hrs.**
CONTROL	550	550	500	550
$400mg\ell^{-1}$ $NaHCO_3$	550	500	450	500
$40mg\ell^{-1}$ Ca	550	50	30	30
$10mg\ell^{-1}$ Ca	550	55	40	40
$400mg\ell^{-1}$ $NaHCO_3$ + $40mg\ell^{-1}$ Ca	550	150	100	100
$400mg\ell^{-1}$ $NaHCO_3$ + $10mg\ell^{-1}$ Ca	550	450	350	300

If a similar relationship can be established for a natural raw water then this may prove to be a valuable treatment guide. In the field situation, suspended solids concentration could be cross correlated by simplified turbidity measurements.

DISSOLVED AIR FLOTATION

The application of dissolved air flotation (DAF) as a unit process for the developing world may at first seem incongruous. However figure 4 shows a low cost working system with a plastic carbonated water bottle acting as the saturator vessel.

At 20°C, with the saturator pressurised to 5.5 atmospheres using a bicycle pump, almost 6 times the volume of air is in solution compared to that at 1 atmosphere. This volume is released in the form of microscopic air bubbles when the flow enters the flotation vessel under atmospheric pressure. The bubbles enmesh with the light floc, reduce the apparent density and a relatively high upflow separation velocity results.

A compact, free-draining sludge layer quickly develops on the top surface of the flotation vessel. Figure 5 gives results of applying DAF in conjunction with M.oleifera seed suspensions to a synthetic raw water (kaolin/bentonite mix in distilled water) of initial turbidity 100 NTU. DAF yielded a residual value of 3.5 NTU after only 10 minutes compared to 20 NTU after 60 minutes of sedimentation. Figure 5 also indicates that it may be possible to achieve clarification at reduced seed dosages.

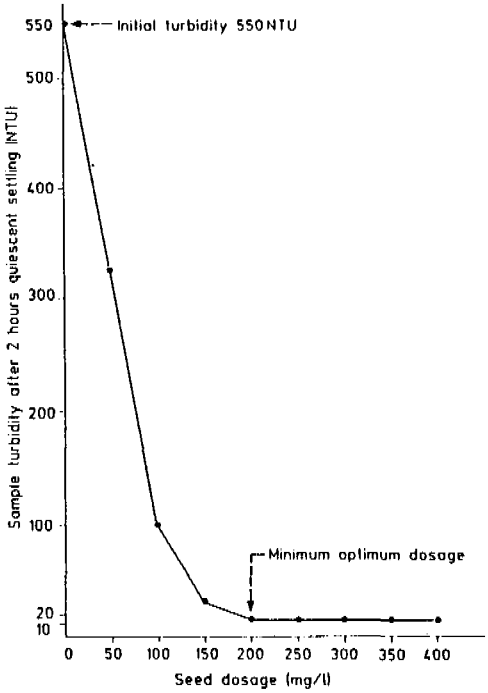

Figure 2 Relationship between applied seed dosage and residual turbidity after 2 hours settlement

FUTURE WORK

Under favourable conditions, clarification by natural coagulants can be regarded as a complete treatment measure in its' own right. However investigations of the removal of bacteria have yielded disappointing results since the total count of indigenous bacteria in treated waters is initially reduced, but does not decrease thereafter concomitantly with turbidity. Waters seeded with indicator organisms show a similar trend in respect of decrease of the indicator bacteria (ref.6).

The failure to completely remove bacteria may be due to secondary bacterial growth on nutrients in the seed preparation or may be due to the failure of small flocs to readily sediment unaided. Alternatively, bacteria may be released from larger flocs with time. Furthermore, there is no information as to the behaviour of viruses in so treated waters, and in view of the established transmission of certain viral diseases in drinking waters, knowledge of the fate of viral particles in treated waters is equally important. These aspects will be examined.

Alternatively coagulation could prove to be an effective low-cost pretreatment stage to household slow sand filter installations as reported (ref.7). Filter runs could be maintained when raw water turbidity exceeds 10-15 NTU.

Apart from slow sand filtration, other appropriate final disinfection options to be

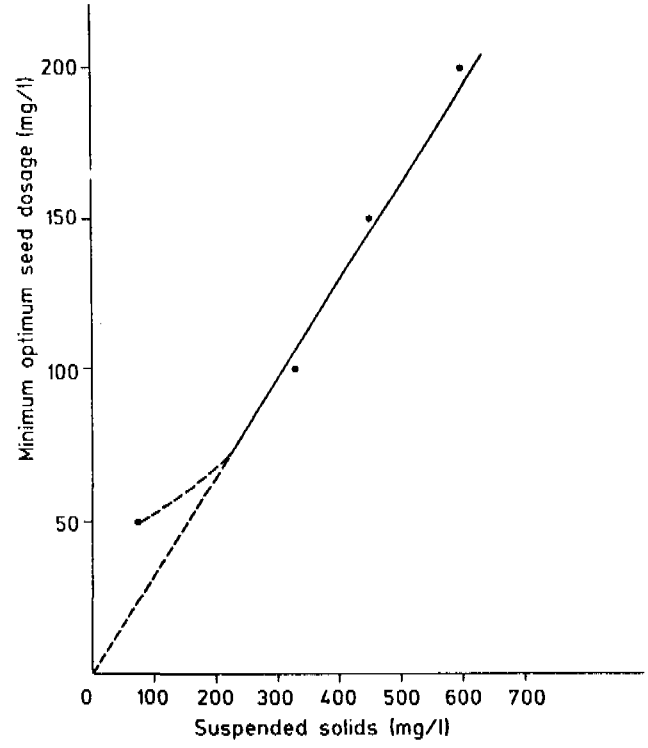

Figure 3 Correlation of clay concentration with minimum optimum seed dosage

nvestigated include exposing the clarified water to solar radiation and the inclusion of metallic copper element in the storage essel.

ACKNOWLEDGEMENTS

his paper reports on the initial findings of a three year research programme funded by the verseas Development Administration.

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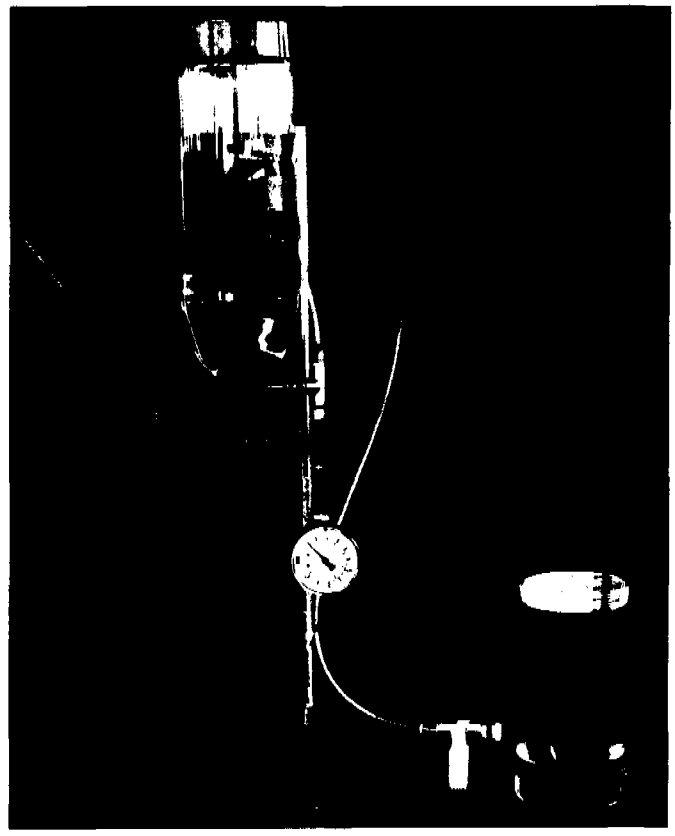

Figure 4 The low cost dissolved air flotation system

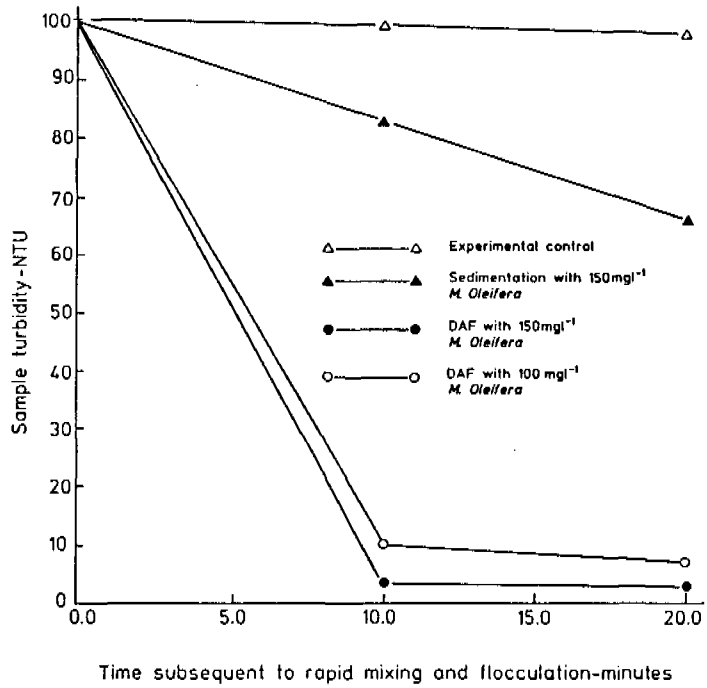

Figure 5 Comparison of dissolved air flotation and sedimentation for a kaolinite/ bentonite model suspension

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Guidelines for extraordinary earth dams

T F Stephens

INTRODUCTION

Embankment dams for water storage are simple, inexpensive structures ideally designed for use in localities where dry season agriculture is desirable and cheaper sources of water are not available. On good sites a well constructed dam using high quality earthworks material with properly designed slopes, spillways, outlets, etc. will last for many years, require low maintenance, resist earth movements and cost a fraction of an equivalent concrete or similar more sophisticated structure.

The design and construction procedures for earth dams are reasonably well documented (ref 1 and 2) and it is beyond the scope of this paper to detail them. For embankments on technically more difficult sites where the priorities of water storage out weigh the increased risk and expenses, dams can be successfully constructed but with some modification to normal procedures. Brief details for the more common problematical sites follow:

EARTH EMBANKMENTS ON ROCK FOUNDATION

A weir may be a better alternative but where an embankment is required the construction techniques are basically straight forward as long as the points below are adhered to:-

1 The rock available must be solid throughout its length and of sufficient width (not necessarily as wide as the dam base) to provide a good foundation. Minor cracks should be cleaned and loose material removed.

If the dam is of sufficient size in both embankment and storage, the extent of the rock should be ascertained to ensure good seepage cut-off and bearing strength.

2 A key wall should be constructed on the prepared rock base along the proposed wall line (usually at or near the centre of the embankment) to a width and height of 0.75m. Before the bricks, stone or concrete are placed, the rock foundation is prepared with a cement wash (cement and water mixed to a cream consistency) to assist anchorage (anchor bolts and/or cutting of a key trench into the rock is often essential). This wall should wall should not be 100% solid - at regular intervals, gaps should be left that will not structurally weaken it but allow for passage of seepage water.

3 A hearting or central core is now laid (usually by hand) each side of the wall (alternatively this can be placed first to the wall height and a trench excavated in it to rock for the key wall). Following normal techniques, the best clay soil should be used and laid in compacted layers 50-75mm deep. Once the hearting has reached above wall height, placement can continue using machinery and the embankment be constructed as normal.

4 If settlement of the embankment is likely (ie in a high dam or poor earth-works material, differential settlement can fracture rigid key walls) some re-inforcement may be required. Fencing mesh or reinforcing wire placed in the key wall is usually sufficient.

EARTH EMBANKMENTS USING POOR EARTHWORKS MATERIAL

If reasonable clay soils are not available, an embankment can be constructed safely if certain design modifications are followed:-

1 The central core should be placed using the most impervious material available. Antheap can be used as a last resort but must be chemically treated before and during back-filling. Cracking or swelling clays can also be used but it may be advisable to mix them with a coarser soil and then compact properly. In this case the dam owner should be instructed that the dam should be kept as full of water as possible and not allowed to fill up too quickly if the core has dried out, to allow any cracks to seal up.

2 The embankment must have as flat slopes as possible and no steeper than 2:1 for the down-stream side and 2.5:1 for the up-stream. The coarsest material should be laid in the down-stream section of the wall. Settlement allowa-

nce must also be increased at time of construction from the normal 10% to 20% or more.

3 Seepage is always a problem in this sort of dam and risks of damage to the wall can be reduced by installing gravel drains below the downstream face and if, necessary, by "puddling" a clay type "blanket" (100-150mm thick) on the upstream side of the embankment and in the immediate basin area.

Continual maintenance and inspection is essential and most emphasis on this is placed in the first few months after filing up and at subsequent emptying and filling times.

BULLDOZER DAMS

Not recommended as sound and long-lived structures, "dozer" dams can provide cheap and useful ways of storing small quantities of water for purposes of stock watering, water planting, fish farming, garden irrigation, domestic uses and so on.

When using a buldozer, the pushing up of a wall of soil across a water course is not advisable. *The better dozer dams are constructed as follows:*

1 Maximum height 2.0 m

2 Minimum base width (for above) 11.0m and includes a crest width of 3.0m

3 Foundation cleared of all organic material and top soil to minimum depth of 150mm

4 Material pushed by bulldozer from basin side only and spread in layers up to maximum 150mm deep over complete length of wall.

5 Each layer is compacted using best means available (cattle, tractor tyres full of water, labour using poles, etc.)

6 Side slopes must be no steeper than 2:1 (flatter is better).

If water is expected to spill over the wall, special importance should be given to establishing a good creeping grass cover and maintaining a truly horizontal crest to avoid concentration of floods on any one section.

The "Keying" of dozer dam walls to boulders or anthills is not recommended - seepage and poor anchorage results and termites soon spread into the wall and rapidly cause problems.

Maintenance is again a continual factor and regular inspection, especially after heavy early rains and/or floods, is essential

When dry season water supply is required, the excavation of a deeper section of the basin is a better alternative than raising the wall due to stability problems. Any basin excavation should occur in an area at least 5m from the upstream toe of the wall .

MASONRY CENTRE SPILL DAMS

Centre spillways are normally required when there is no alternative but to spill flood water over the dam wall. For most embankments, the centre spill structure can be based around a gravity weir on rock foundation with headwalls each side to key the spillway to the embankment and safely channel the flood water.

Spilling should be done on rock and suitable provision made downstream to minimise erosion in the streambed. River training through use of stone pitched or concrete channels and gabions may be necessary in extreme cases.

DAMS IN LOW RAINFALL AREAS

Because of climate it may be difficult to establish and maintain a grass cover that is necessary on any earth embankment and spillway to prevent erosion. Therefore, the spillway, if not rock, should be stone pitched throughout with large stones, well wedged on a gravel bed with the long axis of each stone at 90% to ground surface. Any spaces between stones can be filled with a soil-cement mixture or with top soil and planted to a creeping grass if irrigation is possible in the dry season.

The embankment could also be similarly pitched but it may be more economic to stone-pitch places of high risk such as the ends of the wall and wave action areas and then place loose stone or rock on the remainder of the wall. Flatter side slopes should also be adopted at the design stage.

REMEDIAL AND MAINTENANCE PROCEDURES FOR ALL EARTH DAMS

Immediately following construction it is possible that a dam is to be found in its best condition and to prolong its life as much as possible it is vitally important that regular and competent inspection and maintenance of all aspects of the embankment are initiated. Such insepctions should be established on a time-table that will allow for a minimum of one visit a month in the dry season and one visit fortnightly in the rainy season with need for visits immediately after heavy rain or flooding in the first years after construction.

The following points should be made clear to the farmer/owner:

1 Fences

Stock must not be allowed to graze on the embbankment, the spillway or its outfall. The dam should be fenced off and all fencing kept in good order.

2 Grass Cover

Short, creeping grasses must be established on the embankment and earth spillway(s) before the rains have the opportunity to erode newly constructed bare earth surfaces. Any bare spots that occur subsequently should be replanted to similar grass.

Long tufted grass should be avoided as they must be kept short and they may conceal the workings of termites and vermin.

Trees and shrubs and their roots must be removed from banks because they can cause leakage, attract termites and, if old and well established before they die, can leave voids in the wall as the roots decompose. Often, if a large tree is allowed to grow on the wall it is better to leave it than attempt to kill and remove it.

3 Erosion

a) Embankment erosion after the first rains is impossible to avoid. It, and erosion in later years must be rectified by ramming grass sods and soil into rills and gulleys as they form.

b) During floods, spillways must be regularly (almost daily) visited and any erosion immediately attended to.

Estimating correct slopes and levelling off of low spots in the dry season, especially in the first few years is essential if the spillway is to perform properly and avoid erosion.

4 Settlement

The crest level should be frequently checked in the early years of its life and at least annually thereafter to ensure that it remains horizontal and that the correct freeboard is being maintained.

Settlement cracks are common after construction and if small should be filled in. Large cracks can indicate movement of the foundation and, with cracks that extend transversely below the water line, should receive expert attention as a matter of urgency.

5 Seepage and Drainage

Virtually all earth dams leak to some extent and seepage only becomes a problem if serious or likely to endanger the embankment.

Any leak should be treated on the upstream side. Puddling clay in the basin or laying a "clay blanket" on the lower upstream face (covered with topsoil to reduce erosion) can assist in reducing seepage.

A sudden leak can be treated by dropping manure and/or wood ash into the water at the suspect location, but again if large should receive expert attention.

Leakage effects on the downstream face can be minimised by drainage in the wall, below it and in the ground immediately downstream. Waterlogging of this section can lead to slumping and, eventually, failure, if the mass is so reduced that it loses its stability.

If at any time seepage water is seen to be flowing out of the downstream face and is dirty it means that piping is occurring in the embankment (i.e. soil is being carried away, in suspension, in the water) and requires urgent and expert treatment.

6 Termites and Animal Burrows

Regular inspection and short comprehensive vegetation cover are essential to keep ant and animal workings under control. Any ant workings found should be suitably treated with a recommended fumigant, dug out and the excavation back filled with good material and chemicals to prevent the return of any termites. All back filling should follow the procedures laid down already with layers no more than 50 to 75mm thick being well compacted and, if the excavation is large, keyed into the surrounding embankment.

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SESSION 3 - DISCUSSION

Chairman: L G Hutton
WEDC, University of Technology,
Loughborough, LE11 3TU, UK

K FOLKARD, J P SUTHERLAND AND W D GRANT
NATURAL COAGULANTS IN WATER CLARIFICATION

1. Dr ROBERTS opined that the development of traditional plant coagulants seemed a potentially important avenue for water purification . He asked the authors for information on how widely Moringa sp. seeds are used already in traditional societies.

2. Mr LEWIS asked if the author seriously considered this form of treatment appropriate at the household level in rural Africa.

3. Dr FOLKARD replied that natural coagulants are indeed currently in use at the household level in rural Africa - and very successfully. Reference 3 of the paper provides full details.

4. Dr ROBERTS asked if the author envisaged Moringa sp. being distributed /sold in seed form or the tree being grown as part of multi-purpose afforestation programmes.

5. Dr FOLKARD replied that if the M.oleifera tree was not an indigenous species then it would have to be introduced as part of a cultivations programme - perhaps being promoted as a potentially valuable multi-purpose provider, its effectiveness as a coagulant having previously been demonstrated and accepted. He thought that it was conceivable that subsequent availability may then expand.

6. Mr LEWIS wished to know if the author had studied the effect of natural coagulants on filter beds. He informed participants that Rand Water Board had experimented with Flocutan, an extract of bark: they reported complete clogging of the filter beds due to bacterial slimes which cemented the sand grains.

7. Dr FOLKARD replied that so far he had not conducted experiments whereby slow sand filters would be used as a second stage of treatment. He added that the effective and immediate removal of the preformed floc would, however, be of prime significance to the potential regrowth of bacteria in the filter.

8. Mr KANYENDA wished to know the cost-benefit in use of the natural coagulants versus use of already established artificial coagulants such as Alum.

9. Dr FOLKARD explained that the use of natural coagulants is promoted for communities who do not have access to regular supplies of alum or the necessary expertise to dose such coagulants. The eventual cost to the villager of obtaining such commercial coagulants would be very great whereas tree cultivation may, in addition to coagulant, provide other benefits to the community.

10. Mr KANYENDA wished to know if any research had been carried out on the toxicity of natural coagulants as some chemicals used in water treatment, such as chlorine, when reacting with amines form carcinogens.

11. In response, Dr FOLKARD stated that no research had been reported on the potential to form organo-chlorine compounds through the presence of free chlorine. In addition, if natural coagulants are being used, then it is most unlikely that chlorine would be available. Alternative disinfection processes which could be considered include slow sand filtration, storage in copper vessels and exposure to solar radiation.

12. Dr YOUNG wished to know how disappointing had the results on bacterial removal been and whether there was reason to believe nutrient regrowth is likely to be a significant problem and hence subsequent filtration be an invariable requirement.

13. Dr FOLKARD reported that studies on bacterial removal rates are not extensive, but that they do indicate an initial reduction in excess of 90% was followed several hours later by a subsequent regrowth. He suggested that this may be due to bacteria remaining in suspension or to possible leaching from the settled floc. In acting as a cationic polyelectrolyte, seeds of M.oleifera should be a most effective coagulant for bio-colloids. He repeated that rapid and immediate floc removal is of prime importance, adding that some form of final disinfection was considered essential, whether it be slow sand filtration or some other appropriate measure.

T F STEPHENS
GUIDELINES FOR EXTRAORDINARY EARTH DAMS

14. Mr HUTTON agreed with the emphasis placed on the need for good maintenance and operation of earth dams. He questioned whether the growing of clover was to act as protection against erosion.

15. Mr STEPHENS confirmed that this was the purpose of growing clover on the embankment adding that any plant material that binds the surface layer is suitable providing it is short enough to enable maintenance workers to see what is underneath it. The choice of plant will depend on the climate of the area.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Low-cost rural water supply in Africa

Saul Arlosoroff, David Grey, Otto FLangenegger and Robert Roche

An estimated 1,800 million rural people will have to be provided with improved water supplies in the fifteen years to the end of this century if developing countries are to approach coverage targets of the International Drinking Water Supply and Sanitation Decade (IDWSSD). In Africa, present progress rates may leave at least half of the rural population still without safe and adequate water supply by the year 2000. Accelerated progress is hampered by financial, technical and institutional resource constraints faced by many African countries. The problem is also aggravated by the growing number of completed projects which are broken down and abandoned, or functioning well below their potential capacity. Attempts to increase the pace of providing improved community water supplies have often been frustrated because the technology used is impossible to sustain under village conditions.

THE SYSTEMS APPROACH

To make a lasting impact, rural and community water supply strategies must be based on sustainable and replicable technologies and management systems. Such systems must involve a combination of hardware and software technology and institutional/organizational elements. Global experiences show that the systems approach to rural water supply implementation involves consideration of a number of key issues, each individually important:

1. Direct involvement of the community in the design, implementation and maintenance of the water supply systems, and later in the financing of planned improvements, with promoting agencies providing technical assistance and support services as needed. Community needs and wants have to be reconciled with the national and regional capacities as well as with the willingness to pay for the level of service planned.

2. Provision for full maintenance cost recovery, with support of construction costs for basic supply to poorer communities offset by full recovery where higher service levels are provided.

3. Maximum feasible involvement of in-country industry in the supply of end products, services and materials for project construction and maintenance. Quality control and reliability must be assured. Local industry which has no competition, is protected and produces low-quality products may be as harmful as importing the wrong technology.

4. Technology chosen to match the financial and human resources available in the region or country.

5. Institutional and human resources development programs matching the needs of the planned water supply system.

6. Parallel programs in health education and sanitation improvements to assure long-term health impact.

Choices may have to be made between surface water and groundwater as the source of supply, and between handpumps and mechanized supply via public standpipes or yardtaps as the method of distribution. Groundwater in Africa has significant advantages over surface water as a source for rural water supply improvements for the great majority of the expected future population, the main advantage being that no treatment is generally needed to produce safe water durin either the rainy or dry spells. The resource demands (financial, logistical and human) of water treatment plants needed for reliable surface water sources are beyond the reach of most rural communities.

As stated, the three main technology options represent progressively increasing service levels, and call for increasing financial and technical resources for their implementation operation and maintenance. The costs involved in the trucking of diesel fuel and in the maintenance of diesel engines and piping networks, as well as the potential water wastage, create prohibitive conditions in many cases for public tap or yardtap options. Isolated groups may be served by gravity systems; however, they represent a small percentage of the total number in need

Capital costs of the three main systems generally range from US$ 10-30 per capita for wells equipped with handpumps to US$ 40-60 per capita for motorized pumping and standpipes and US$ 80-100 per capita or more for yardtap services. For Africa, cost

Estimates for meeting rural water supply needs to the year 2000 therefore range from US$ 10,000 million to US$ 50,000 million depending on the choice of technology system. Where financial resources are scarce even for the basic option, rapid progress in meeting basic needs can be achieved only if a large proportion of the rural population in need initially receives services at the lower end of the cost range. Potential upgrading is then available as affordability increases. Clearly the significant difference between handpump-based projects and those based on piping networks is the capability of moving to mechanized pumping. This leads to the consequent need for dependable power/fuel supplies and skilled mechanics.

THE HANDPUMPS PROJECT

In 1981, as one of the activities in support of the IDWSSD, the United Nations Development Programme (UNDP) through the Department of Global and Interregional Projects (DGIP), and the World Bank initiated a Global/Inter-regional Project for the testing and technological development of designs and implementation strategies to improve the reliability, sustainability and replicability of schemes based on point-source supplies, primarily groundwater and handpumps. These schemes are managed by the communities and therefore replicable on a large scale. Since its initiation, support for and promotion of the Handpumps Project has been provided by UNICEF, WHO, UNEP and leading bilateral agencies in the sector.

The Project has conducted laboratory tests in the UK and field trials in 17 countries on a total of 2,800 handpumps representing approximately 70 different models and has carried out extensive tests on 45 different models of pumps. The interim results, which have led to significant improvements in the equipment on the market, are already assisting governments of developing countries to provide improved, more reliable water supplies to their rural and urban-fringe populations in need.

From the beginning, the Project has promoted the concept of VLOM--Village-Level Operation and Management/Maintenance--as a means of overcoming some of the major obstacles to sustainable and replicable water supply systems. It is now recognized by most experts in the sector as the fundamental principle of handpump design and rural water supply project planning. The VLOM management concept seeks to avoid the high cost, long response time, unreliable service and other operation difficulties in the repair of handpumps through central and mobile maintenance systems. Many past failures of rural water supply systems can be blamed on the inadequacies of central maintenance, in which a water authority dispatches teams of skilled mechanics with motor vehicles from a base camp, often serving a large district, to respond to requests for repairs or to carry out routine maintenance. Instead, maintenance should be a community responsibility, and this in turn means that the pump design has to be suitable for repair by a trained caretaker or area mechanic with basic tools, and that spare parts should be affordable and readily available to the community.

The Project staff in Africa strongly advocates the delegation of pump maintenance to village committees. Government policies and manufacturers must therefore focus on pumps more suitable for village-level maintenance and/or maintenance by an area mechanic with a bicycle contracted by the community. This is a significant departure from previous practice, particularly in Africa, where unsuitable pumps have often been brought in through donor assistance and recipient agencies have taken on unmanageable maintenance commitments depending on public sector mobile maintenance teams.

Few rural water supply system failures can be blamed solely on the pump. Other major causes identified have been (1) inadequate or unrealistic provisions for maintenance; (2) poor well design or construction, allowing sand to enter and damage pumping elements; and (3) the corrosive effects of groundwater which are much more extensive than had previously been assessed.

Policy recommendations as conclusions of the Project's Phase I for the planning and implementation of rural water supply projects using wells equipped with handpumps are as follows:

1. Community Involvement. The highest potential for sustainability is achieved when the community is involved in all phases of the project, beginning with the planning stage.

2. Community Management of Maintenance. Under the recommended system, the community organizes and finances the repair and routine maintenance of the handpump. Work is carried out by either a designated community member with basic training and basic tools, or an area mechanic covering several villages or pumps.

3. Aquifer Analysis. Competing demands for other water uses, such as irrigation pumping, have to be taken into account when evaluating aquifer potential for handpumps-based projects. Much of Africa's basic rock aquifer is adequate for low-cost discharge

manual pumping and is limited for high-discharge irrigation pumping.

4. Well Design and Construction. Wherever the rock formation is not fully consolidated, screens and filter packs are essential to prevent sand and silt intrusion. Supervision of the drilling operation is essential to achieve the necessary reliability.

5. Handpump Selection. Quite a number of factors influence handpump selection, in addition to the cost of the pump itself. Among the most important are the suitability for the intended maintenance system, durability and discharge rates. Pump choice will depend on the required lift and the planned number of users per pump.

TODAY'S HANDPUMPS

The standard test procedures used in the laboratory and field trials revealed many shortcomings in existing handpump designs. Manufacturers responded well, by modifying their products and introducing new models, and there are now many more pumps on the market which are durable and which allow for substantial involvement of villagers in pump maintenance. Manufacturers from industrialized countries are also being encouraged to combine with enterprises in developing countries to manufacture pumps under licensing or joint-venture agreements. Local manufacture strongly improves the likelihood that spare parts will be available when needed, and facilities standardization on pump types in a country to simplify caretaker training and stocking of spare parts.

Encouraging as these development are, there remains a scarcity of handpump models which can be described as VLOM and are suitable for lifting from depths of more than about 25 meters (though the majority of the rural population lives in regions where the water table is not so deep). The depth of installation and heavy pump construction make removal of downhole components difficult. An added problem is that, due to the high cost of the well, deep pumps tend to serve more people per well and so suffer rapid wear.

For low lifts (up to about 12 meters), direct-action pumps have a number of advantages. Elimination of the bearings that are part of lever- or flywheel-operated pumps reduces maintenance needs, and the pumps can be manufactured in developing countries at a relatively low cost. They make extensive use of plastic materials, which make the pumps light-weight and corrosion-resistant. Direct-action pumps have the great advantages over suction pumps that they can lift from more than the 7-meter limit for suction (important since groundwater levels are falling in many parts of the world) and that they do not need priming and therefore avoid the risk of contaminating the well with polluted priming water.

For high lifts (down to about 45 meters), a below-ground design which allows extraction of the piston (and footvalve if desired) without removal of the cylinder and rising main appears to be the most promising VLOM design. However, low-cost, durable and corrosion-resistant VLOM designs for below-ground components have only been used successfully in preliminary tests for lifts of up to 25 meters. Development of VLOM pumps below 25 meters remains an important task for the next phase of the Handpumps Project -- and for manufacturers and implementing agencies.

Attempts are also now being made to develop designs in which some of the same components can be used for pumps operating in different depth ranges. In East African development work, for example, a standard 50mm diameter cylinder with the same piston, footvalve and pumprod is being tested with different pump-head configurations for the whole range of lifts from 0 to 45 meters. For low lifts, the below-ground components are connected to a T-bar handle to be operated as a direct-action pump; at higher levels, a lever handle is used, with the handle length varying (two options) depending on the lift.

It is clear that some pumps are much more suited than others to conditions in developing countries, and that as pumping lift increases, the number of pumps suitable for village-level maintenance declines rapidly. Nevertheless, the Handpumps Project has shown that, even from the pumps presently on the market, it is possible to design a handpump-based water supply system for the vast majority of conditions prevailing in developing countries, which can be sustained in reliable operation without dependency on a significant level of support from a central authority.

THE FUTURE

The need to accelerate large-scale implementation of rural water supply schemes to meet the urgent needs calls for a more systematic evaluation of past and proposed strategies. Detailed guidelines for implementation at the regional and possibly the country level should be prepared. Lessons and conclusions about the implementation, operation and maintenance of comprehensive handpump-based community water supplies may have to be implemented initially through demonstration projects in specific regional conditions. The demonstration projects will also include evaluation of

measures to enhance the benefits from rural water supplies, to develop recommendations on the synchronizing of related health and other interventions with water supply improvements. The proposed comprehensive rural water supply package therefore includes:

1. Community participation in planning, construction and management of maintenance;

2. Adequate well design, construction and development;

3. Implementation of projects with VLOM handpumps;

4. Selection and training of caretakers, establishment of incentive schemes and an increase in the role of women in the community responsibility of water supply;

5. Spare parts supply and distribution;

6. Implementation of sanitation components;

7. Health education;

8. Cost recovery by the community to cover at least recurrent costs;

9. Measures to reduce capital and recurrent costs; and

10. Non-domestic water use, such as micro-irrigation and cattle wherever applicable.

A joint effort is needed by donors and developing country governments to initiate demonstration projects on a large enough scale to permit development and analysis of country- or region-specific ways of implementing relevant items of the package. There may, for example, be several different ways of organizing spare parts supply and distribution, which make best use of private and public sector activities in particular countries.

From the demonstration projects, guidelines on implementation of each package element will set the stage for large-scale implementation of rural water supply schemes at a comparatively low cost to the public sector, managed by the users at affordable cost -- in other words, schemes with a good chance of providing a satisfactory service for many years to come.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Rural water development experience in Malawi

W Kennedy

ABSTRACT

The paper considers the process by which Malawi has achieved considerable success in its implementation of rural water schemes - in particular recent experience in the development of the dug-well and bore-hole programme. The paper maintains that an appreciation of the steps which led to significant breakthroughs, and the problems which had to be solved are just as important as the final mix of factors which contribute to a viable programme. Without proper appreciation of the development process involved it is considered that the dissemination of the 'Malawi experience' elsewhere is questionable. The paper highlight the problems which Malawi had to face and how by changes in its administrative structure it achieved its present implementation strategy.

INTRODUCTION

In comparative recent years the significant developments in rural water programmes in Malawi has gained the country a reputation of success in this area of development. The first significant breakthrough in Malawi was in the field of gravity-fed piped water schemes - these started from a small beginning in 1968 to the possibility of about 25% of the rural population being served by such schemes by 1990 (this being about the practical limit unless extensive water storage and/or treatment is considered).

Today, Malawi features prominently in the UNDP/ World Bank Handpump Development Programme and in the development of low-cost rural water supplies under its 'integrated ground-water project' concept. This concept involves the complete provision of ground-water supplies in one area at a time by a project team whose task is to assess a defined area of the country with regard to the potential for dug-well, and/or boreholes and to implement an integrated project. In 1980 the incorporation of the various rural water programmes under one Government body - the Department of Lands, Evaluation and Water (DLVW) allowed the proper consideration of the alternatives and paved the way for the 'integrated project' approach.

The problem with any success is that as far as the outside world is concerned the crucial steps in the development process which led to breakthroughs are only too often ignored or not fully appreciated in the focussing of attention onto the final mix of factors which contribute to a viable programme. In this way theimportant lessons learnt and the significant factors which enabled the all important 'embryonic stage' to be nurtured are often not publicised. The author maintains that an understanding of the background to a successful rural development programme is crucial if the development experience and programme is to be properly understood and disseminated in other countries.

The experience in Malawi has shown - particularly with the rural piped water schemes - that for rural development programmes to take root they must expand at a controlled rate. Any attempts to speed up the development process beyond what might be termed the natural pace of development is probably doomed to failure. What are the limiting factors? Naturally, the technology must be appropriate and satisfactory. In the case of the piped water schemes the technology was simple, proven and dependable - although its introduction to Malawi had to proceed in a careful and measured way so that the necessary materials, techniques and training were perfected. This involved three distinct phases - the pilot project phase; the consolidation phase and an expansion phase. Success in the rural piped water schemes can be attributed to an appropriate government organisation which enabled:

(i) adequate field organisation/supervision and training coupled with good overall project management;
(ii) significant community participation at the implementation stage of the programme and, to some extent, in the initial planning stage.

An outline of Malawi's experience in rural piped water supplies is given in another paper (1). A detailed evaluation of that programme has also been documented (2).

MALAWIAN EXPERIENCE IN GROUNDWATER DEVELOPMENT PRIOR TO 1980

A successful rural water programme does not emerge without considerable in-country development experience - some of which is bound to be far from satisfactory. The mix of factors required to initiate a successful programme - administrative, socio-economic,

echnical, organisational, etc - have all to be in place if a significant breakthrough is o be achieved. It must also be appreciated hat any meaningful rural development involves phases through which the project must progress before a viable programme - capable of expan- ion throughout the country can be realised. uch a task cannot be achieved quickly - a measured pace of development has to be sought which is compatible with the actual situation eing dealt with. The situation in Malawi rior to 1980 indicated that several problems were inherent in early attempts at groundwater evelopment. It is instructive to outline hese prior to the consideration of the steps taken to improve the situation. The problems which were identified in the early groundwater rogramme were:

- uncoordinated programme administration
- inadequate professional input and poor borehole site selection
- poor borehole design
- field supervision/management problems
- an inappropriate handpump with poor maintenance structure
- lack of community involvement.

These problems may be outlined briefly as follows:

(a) The bore-hole and dug-well programmes were initiated and implemented separately without coordination. Until early 1980 the two principal Government agencies involved were in different Ministeries. The rural piped water scheme and dug-wells programme were implemented by the Ministry of Community Development and the bore-hole programme was the preserve of the Department of Geological Surveys. There was no coordination between these bodies.

(b) Bore-hole sitings were traditionally carried out by geologists rather than hydrologists with negligible reference made to existing geophysical or construction data. Both siting and construction were carried out with little understanding of the occurrence of ground water. There was little consideration given to the most appropriate abstraction methods for local conditions. Boreholes were sometimes drilled where water levels were within 2 to 3 m of the ground and dug wells were started where water levels were deep. Borehole design was the same whatever the eventual use and yield requirements (Boreholes were drilled to a depth of 45 to 60 m).
It should also be noted that there was no professional geological input to the dug wells programme.

(c) The borehole design was the same whatever the eventual use and yield requirements of the borehole. Boreholes were drilled to a depth of 45 to 60 m and lined with 168 mm O D mild steel casing, or left as 'open-hole' in consolidated formations. Slotted casing was generally set at the bottom of the hole, regardless of the geological section. The annular space between the 168 mm steel casing and borehole was filled with 6 to 12 mm crushed roadstone as a gravel pack. This material was much too coarse to prevent the inflow of fine material into the borehole. As a consequence the pump components - particularly cup leathers and cylinders were damaged and had to be replaced frequently. Drawing in silt and sand also led to the borehole silting up which meant that many boreholes were either abandoned or required frequent cleaning.

(d) The widely dispersed activities of both the borehole and the dug well programmes led to considerable difficulties in overall management of the programmes and in day-to-day supervision. As a result neither sound technical practice, timely decision - making nor efficient operation were easily achieved.

(e) As regards the existing borehole maintenance, repairs were required very frequently mainly due to very poor borehole design as indicated above. On average cup leathers needed to be changed about two or three times each year - more frequently in alluvial areas (up to eight times per year). The high frequency of breakdowns and the length of time required for each repair meant that maintenance units could only cope with breakdowns. The desirability of a preventative maintenance scheme was not possible.
The existing borehole pumps were heavy difficult and costly to repair. A 5 or 7 ton truck with a winch was necessary to lift the pump for even the most basic repair to downhole components. So maintenance problems originated not only from borehole design but also the handpump. This situation meant that borehole maintenance costs were very high - with transportation and associated expenses accounting for about 60% of total costs.
As far as the shallow-wells programme was concerned a maintenance system had not been properly established. On average the existing shallow well pumps required repair once every 6 to 12 months. The plunger, footvalve, bushes or adaptor unions were the components which usually needed attention. The author was involved in a shallow well field survey at an early stage of pump development work in Malawi and concluded that the maintenance requirements were attributable to both poor well design and construction, and inherent pump design problems. It was concluded at that time that just as much effort should be directed to well design

and construction as to handpump development.

(f) There was no involvement of the community at any stage of the borehole programme. Even at the crucial siting stage the villagers were not consulted. A geophysical siting team visited villagers on a routine manner according to a list submitted by the District Development Committee to Central Government. Little contact was generally made by the siting team with the village. Some time later a drilling team would arrive to drill a borehole at the specified site. Later a pump installation team would arrive to install a handpump. Sometimes it has only been at this point that the village has been aware of what is happening.

The problems outlined above (present at the beginning of 1980) showed the considerable improvement which was necessary to even begin to bring the situation to one where the Water Decade goals could be realised. A full appraisal of the situation was urgently required. At the start of the Decade in Malawi that is exactly what transpired.

RECENT GROUNDWATER DEVELOPMENTS IN MALAWI

As noted above a full assessment of the borehole and dug wells programmes revealed many problems which had to be dealt with if Malawi was to make any headway in terms of the UN Water Decade objectives. From this assessment a new approach to groundwater development was conceived - an integrated project for rural ground water supplies. The various considerations and the steps which were taken to solve the problems identified were:

(a) In April 1980, the existing uncoordinated borehole and dug wells programmes were brought together under one body - the Department of Lands Valuation and Water (DLVW). This facilitated the concept of an integrated groundwater project with the complete provision of groundwater supplies in one area at a time by a single project team.

(b) A detailed evaluation of existing hydrogeological data suggested the existence of an extensive, shallow weathered rock aquifer throughout much of the 'plateau' area of Malawi. The importance of this aquifer had largely been ignored in the past. This meant that a borehole completed in the weather zone aquifer need only be 20 m deep rather than 46 to 60 m as was common previously. This permitted the use of lightweight and inexpensive drilling rigs which could be towed by a small vehicle. A further consequence was the greatly reduced need for sophisticated siting procedures. The importance of the hydrologist as a key person in the integrated project was emphasised.

(c) The important components of the borehole, screen and gravel pack were subjected to careful hydraulic design. Locally available materials were sought to replace imported items. Locally extruded and slotted PVC casing replaced the imported mild steel casing. This facilitated a hundredfold increase in open area resulting in a considerable improvement in yields.

A survey for correctly graded gravel pack material which would prevent the movement of fine sand and silt into the boreholes was sought. This located beach sand from Lake Malawi which had the characteristics of a perfect gravel filter.

At the start of the integrated project in Malawi it was noted that there was no design criteria for dug wells and that a reliable dug well was not actually easy to construct. Both with boreholes and dug wells evidence was growing that the single biggest cause of handpump breakdowns was borehole/well design. It was clear that if dug wells were to play a major part in the integrated project then further work on their design would be necessary.

In parallel with the consideration of borehole design was the question of the most appropriate means of borehole drilling. It was appreciated that the one item of equipment in rural groundwater supply programmes that caused the most problems in selection was the drilling rig.

A study of the various drilling methods - from the large multi-purpose rotary rig which can drill in almost any formation with great speed and efficiency but which will have been imported at high cost, to the low-cost hand operated drilling equipment showed that there was no simple answer to the question - 'What drilling method is best for rural ground-water supply boreholes?'

The assessment of drilling rigs in Malawi specific to the integrated project concept led to the idea of an integrated project rig. The requirement in Malawi is for 200 mm diameter holes to a depth of 30 to 50 m (upper limit 80 m) in unconsolidated and semi-consolidated formations for which cable tool drilligg is possibly more appropriate. However, for similar depths in hard rocks a small air-flush rotary rig is needed. A strong light-weight combination cable tool-percussion rig with a 'swing-in' mechanically driven rotary facility (mounted on a two-axle trailer) would suit the Malawi requirements. The numbers of similar requirements elsewhere in the world justifies the development of purpose-built rigs rather than using off-the-shelf

equipment designed for a range of tasks.

(d) An essential prerequisite for the success of an integrated rural development project is suitably trained and well-motivated staff coupled with good project management. With the previous uncoordinated and widely dispersed programme the question of effective management and supervision had to be addressed. In Malawi there was alrady considerable experience in this area with regard to the rural piped water schemes. In the final analysis the most important factor which contributed to the success of that programme was its organisation and management - both at central Government level and especially at the field level. The experience in Malawi with the piped water schemes showed that after the pilot project stage of development it was crucial to have a 'consolidated phase' which enabled a team of well-trained and motivated field staff to be developed together with the review and development of the organisational infrastructure at central/district level and in particular the management procedures at the field level. This phase was essential in order to ensure the continued expansion of the programme.

(e) The successful establishment of a new maintence structure was dependent on the development of a new pump. Prior to the integrated project the heavy, imported pumps had to be lifted by a truck mounted winch in order to carry out even the most basic repair. The most important feature of the new pump was the facility for the down-hole components to be removed through the pump head which remains in position over the borehole. This eliminated the necessity to use a winch and made it possible for the villagers to play a part in handpump caretaking and maintenance. A preventative maintenance programme involving a village caretaker and village pump committee was drawn up. Particular attention would have to be given to this important level of maintenance, together with the necessary district/regional back-up.

(f) The maximum involvement of the villagers in the selection of their own water point sites is essential - preferably through the democratic process of an elected Water Committee - to assist in the creation of a sense of waterpoint ownership. It was considered that during the preparation phase of the project the community should be alerted about the project. They should have formed Water Committees in each village. It is important that the Water Committee, and through them the whole village, are involved in the selection of sites. Well in advance of the planned construction work in a village the Project hydrogeologist visits the village (a second visit) to inspect all sites chosen by the community. Once a village approved site has been ratified by the hydrologist the community preparatory work can be started. This involves the cleaning of the site by the community, preparation of the access to the site; and for a dug well, the start of digging.

CONCLUSION

The experiences of rural water development in Malawi has emphasised that in the context of the present UN Water Decade and as a necessary prerequisite to a viable programme it is crucial to ensure that the proper administrative and management structures are in place and that a full appraisal of present programmes are conducted. Sound implementation strategies and viable programmes can only be devised on the basis of a candid appraisal of present in-country practices. The Malawi experience shows a country willing to learn from its experiences and one where rural development has proceeded at a controlled rate.

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Economics and rural infrastructure provision

Richard Franceys and Peter Barker

Rural Infrastructure

An integrated development programme aiming to improve the quality of life in the rural areas requires a level of physical infrastructure to support and complement the other development activities. For example, feeder roads, improved water supplies, sanitation systems, community buildings (medical and educational), grain storage, flood relief or land drainage schemes, soil erosion prevention and power supply are all normally required in varying degrees.

Economic analysis can be used to indicate the scale of provision of these goods, the standard of provision, the price which will be socially optimal and the resulting financial consequences. In examining these issues it is useful to distinguish between private goods, public goods and merit goods.

The allocation of private goods

Most economic goods and services are allocated to consumers by the rationing device of price. In free enterprise economies these prices are determined by the forces of supply and demand. When the demand can be met profitably suppliers will endeavour to meet it. Thus prices both ration what is available between buyers and signal what is required to sellers.

Given that individuals have different incomes, tastes and preferences they will consume specific goods in quite diofferent amounts. When such different consumption levels are possible markets can operate to allocate goods between consumers. Such goods are called private goods and they have two characteristics. Firstly it is possible to exclude non-payers from their consumption. Secondly one person's consumption reduces the total amount available to others. The fish I consume is not available for other consumers. Private goods are therefore characterised by excludability and are 'rival' in consumption.

Public or collective goods and development

In contrast to private goods there exists a class of goods and services which are both non-rival in consumption and non-excludable. The former characteristic means that one person's consumption does not subtract from that available to others and the latter means that for economic, technical or institutional reasons the good is available to all once it is provided for any one person.

Many of these goods and services such as feeder roads or flood protection occupy an important place in rural development and are termed public or collective goods.

Merit goods

A third class of goods are merit goods. These are goods or services which could in principle be left to the market to supply and which could be sold at market prices. They are, thus, excludable and rival as previously defined. Water provision, innoculations and education are examples. However, free market provision of these goods would result in less than the socially optimal amount being produced and consumed. Whether provided at the central, regional, or village level, provision of these goods shows the 'paternalistic role' of government. In effect the government is saying it knows better than individuals how much of these goods and services should be provided and consumed.

This paternalism may be justified on the basis of superior knowledge of government or recognition that individuals may fail to see the benefits of higher consumption. Thus government may identify the community health benefits of higher water consumption or more hygiene education. To the economist these considerations are called externalities which in these cases are estimated to be significant.

There may also be a reduced demand for merit goods below the socially optimal level because of low incomes and therefore low affordability. Even though the people may recognise some of the benefits to be gained by a particular development they require some form of support to enable them to overcome their shortage of income.

Public goods and free-riders

An important finding of public goods analysis is that even if it is recognised that a public good is socially beneficial independent voluntary action may well not result in its supply. Consider investment in a public good, say a flood relief scheme which will confer benefits on two landowners, A and B.

Cost of scheme=1000, benefits to A=600, benefits to B=700

If individual A pays all the costs, net benefit to A=600-1000=-400, net benefit to B= 700-0=700

If individual B pays all the costs, net benefit to A=600-0=600. net benefit to B = 700-1000=-300

If the costs are shared equally between A & B, net benefit to A=600-500=100 and to B=700-500=200

These results may be transferred to a pay-off matrix:

		Individual B	
		Pays	Does not pay
Individual A	BENEFITS	A B	A B
Pays		(100,200)	(-400,700)
Does not not pay		(600,-300)	(0, 0)

General conclusions may be drawn from this simple example:

i) Neither individual is likely to independently and voluntarily assume the costs of implementing the project. This is despite each individual recognising the project is socially beneficial

ii) Whenever one individual pays, the other individual finds it beneficial not to pay ie. the temptation to free-ride and hope that somebody else will pick up the bill is strong.

iii)A better outcome for both would be for each to pay. But for independent and voluntary contributions this would require a degree of trust in each other.

iv) If the example was enlarged to include other individuals it would be seen that when the number of potential beneficiaries is increased the individual may well feel that his own decision not to contribute will go unnoticed. Free-rider behaviour may be a function of numbers.

The socially efficient output and price of a good A major branch of theoretical welfare economics is concerned with the determination of rules which if implemented would result in an efficient allocation of resources and goods. The chief finding of welfare theory is that the socially optimal level of provision of a good is where the price is equal to the marginal social cost of provision.

Figure 1 below shows the marginal social cost to society which results from the production of good X and is a composite of marginal financial cost and marginal external cost (for example pollution) imposed on society. The market demand curve shows how much society would pay for each extra unit of consumption. The term marginal refers to the extra cost resulting from each extra unit of production. The negative slope indicates that society would be willing to pay more for the initial units of consumption. Satisfaction declines as consumption increases.

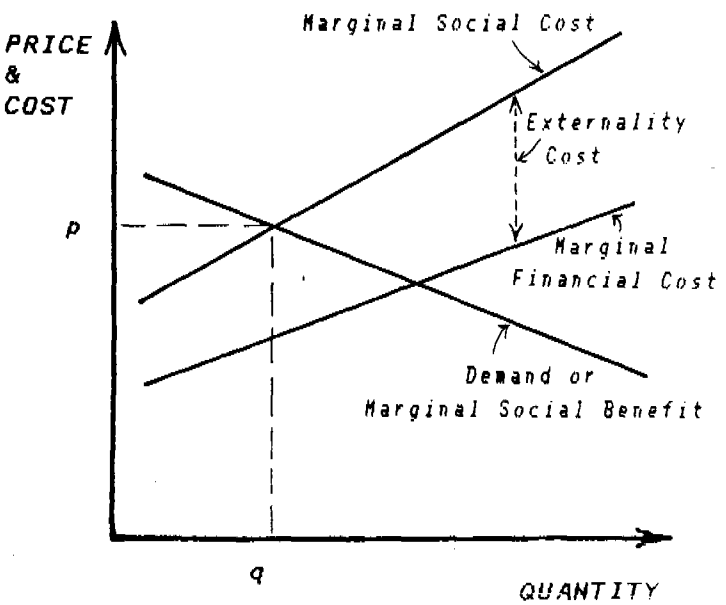

FIGURE 1

The socially optimal output is 'q' which can be sold at 'p' given the demand conditions ie. where price equals marginal social cost. The logic holds irrespective of whether the good is a private, public or merit good.

Problems of scale, consumption and subsidy

The discussion of public and merit goods suuggests that market forces will either not provide or at best will provide sub-optimal amounts of important items of rural development. Collective action will thus be required. At a practical level the following issues need to be determined:

a)the socially optimal level of service standards

b)the level of provision, that is the standard or quality of service of the infrastructure in the absence of support or subsidy for the investment

c)the subsidy required to achieve optimal consumption or standards

d)a mechanism to discourage free-riding whilst enabling communities to make best use of a subsidy

To take an example, the people may decide individually or collectively that a closer, safer and more reliable water supply would make for a better life. Better because the resource cost, that is the operating cost and opportunity costs such as time spent in collection, inconvenience, lost output and illness costs would be reduced. The demand curve (marginal social benefit) in figure 2 represents the social benefits derived from extra consumption. It includes not only the perceived benefits to individuals but also the benefits of which individuals may be ignorant.

Normally a marginal cost and benefit curve shows increasing production and consumption of extra items of the good in question. When related to rural development, increasing demand has to be seen in terms of increasing quality of, for example, drinking water at a closer proximity to the home in addition to increasing quantity. Similarily for a feeder road, increasing standards of running surface and extra width have to be considered rather than increasing numbers of roads.

Considering the question of optimal levels, provision should be expanded as long as the demand (benefit) is greater than the cost. As described above the socially optimal level of service is where demand equals supply. In practice this is achieved by cost benefit analysis.

However lower per capita incomes will constrain demand below the ideal demand, marginal social benefit level. Considering a 'marginal affordability curve' as illustrated, without assistance the community level of consumption would be below the th level to which the community aspire as well as being below the social optimum.

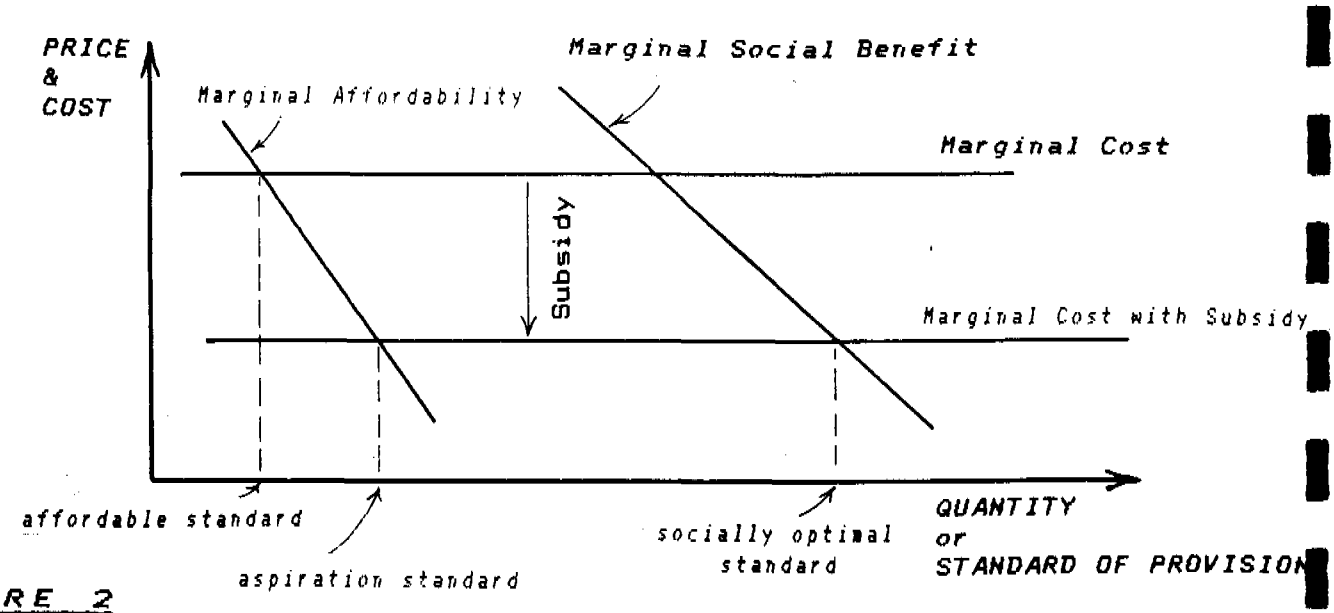

FIGURE 2

Demand is constrained by two factors:

i) low per capita incomes ii)ignorance of the social benefits of higher consumption.

To tackle i) a subsidy to production is required which is sufficient to reduce the cost to consumers. Through the involvement of the people a level of consumption aspired to by the community may be determined. This is a level of service at which the people understand the implications and required social changes and are therefore likely to realise the expected benefits. Figure 1 shows this aspiration level in relation to the actual demand or marginal affordability curve.

Without any subsidy, at the marginal cost shown, if consumers are charged a price reflecting cost the resultant low standard is all they are able to afford. Thus the level of subsidy must be sufficient to lower the marginal cost line to the subsidised level which by reducing cost allows the aspired level of consumption to be reached.

The second constraint (ii) may not necessarily be removed by subsidy. Where health or other education has not been effective and people are not aware of the benefits to be gained by an improved standard of service, even where that service is provided it will not be used effectively in a way that brings the desired health improvement. For example, the demand for clean water by any community is normally specified in terms of quantity and proximity rather than quality. However, much of the resource cost can be justified in terms of improved health.

To that extent it is possible to consider a 'perceived' social benefits curve representing what the people would like to do if they could afford it, to the level where they know they will be receiving benefits.

The initial level of subsidy will then be the difference between the marginal affordability curve and the perceived social benefit curve. This would be less than the socially optimal level but would represent the limit of present community understanding. To go beyond this level immediately would not realise greater benefits and therefore would be a wasted investment. Any development scheme should thus be designed to allow communities to upgrade their levels of service as their understanding improves upto a maximum where the marginal social benefit curve crosses the marginal cost curve.

The problem of free-riders demands some form of community participation which encourages maximum cooperation and involvement of all levels of the community. If a government agency were simply to provide the facility without any user participation there would be no difficulty. However the vital benefits of involving people at all levels of infrastructure provision can be summarised as:

i) the significantly improved use of the facility and therefore enhanced benefits when people have been fully involved in all aspects of the planning and construction, ii) more effective operation and maintenance of the completed facility which may not depend upon outside assistance iii) reduced overall project costs and iv) an enhanced ability to undertake further community development work without external assistance.

Using the techniques of economic analysis outlined above it is possible to determine the socially optimal standard of service to aim at, the minimum level of subsidy required to begin the development process and the maximum efficient extent of the subsidy in order to facilitate a programme of infrastructure development through community participation.

A simple organisational mechanism is then required to deliver the subsidy in a flexible manner which discourages free-riders. One approach to consider is the use of performance related disbursements. The community is given total control of the project within the bounds of appropriate technical feasibility and an agreed level of subsidy is paid on completion of measurable sections of the project, with only specialised tools or materials given in advance. If a representative development committee of the community is used as the channel for assistance then the community is free to develop its own methods of control according to its own traditions.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Low-technology sanitation affecting groundwater quality

Amanda Geake

INTRODUCTION

Groundwater is increasingly being used in developing countries for potable water supplies, as it is usually the cheapest and safest source. It is commonly derived from large numbers of simply-designed boreholes and dug wells exploiting relatively shallow unconfined aquifers, which may be vulnerable to pollution from the land surface. Sanitation is often being improved at the same time, by the construction of latrines or simple wastewater stabilisation lagoons, sometimes with effluent reuse for irrigation in arid regions. The impact of such schemes on groundwater quality has received only limited investigation, although in certain hydrogeological conditions they can present potential pollution hazards. This paper presents the principal results from detailed field investigations beneath a low-technology wastewater reuse scheme in Peru, and discusses their relevance to the aquifer types and different hydrogeological conditions which occur in Africa.

WASTEWATER REUSE SCHEME, LIMA AREA, PERU

Background and hydrogeological setting

Lima is situated on the extremely arid coast of Peru where rainfall is almost negligible, and groundwater from the alluvial aquifer is a major source of potable water supply. The sediments are mostly highly permeable, unconsolidated sands and gravels, which are recharged by rivers from the Andean Mountains and their associated irrigation schemes. The aquifer is overdeveloped, with groundwater levels currently falling at 2-4 m/a, and the acute shortage of water resources is leading to the recycling of wastewater for agricultural production.

The San Juan de Miraflores wastewater reuse scheme was constructed in 1964 and is located on the outskirts of Lima. It comprises a series of 21 simple, unlined, stabilisation lagoons excavated in the sand, each only 2m deep with a design retention time of 5-10 days. The complex receives 360 l/sec domestic sewage from neighbouring low-income housing areas, about half of which passes through the lagoons. The effluent and remaining raw sewage is used to irrigate 400 hectares of cultivated land and woodland at average rates of 5-10 mm/d. The area is underlain by highly permeable sands, and there is significant leakage from beneath the lagoons (10-20 mm/d) and excess irrigation beneath cultivated land (average 5mm/d) which recharges groundwater. The unsaturated zone is 20-30m thick.

Research Investigation

Eight cored boreholes were drilled in 1984/5 in the bases of specifically drained lagoons and beneath cultivated land irrigated with effluent, to investigate the water quality in the unsaturated and saturated zone of the underlying aquifer (ref.1). Sand samples were centrifuged at 3000rpm to extract porewater for chemical analysis, and replicate samples were cultivated directly for microbiological analysis. Some of the boreholes were completed with slotted lining tubes to allow subsequent groundwater sampling, and unsaturated zone suction samples were installed in others to monitor the quality of infiltrating water.

Table 1. Water Quality at San Juan de Miraflores Wastewater Reuse Scheme

determinand	raw sewage	unsaturated zone porewater beneath lagoons (below 5 m)	secondary lagoon effluent	unsaturated zone porewater beneath arable land (below 5 m)
EC (µS/cm²)	1080	991	1050	1245
Cl	115	182	116	168
Total N	46	10	31	21
NH_4-N	29	8	20	0.6
NO_3-N	<0.1	1.7	<0.1	20
SO_4	240	29	231	196
Ca	302	45	318	121
Mg	80	17	69	26
Na	64	90	61	85
K	15	20	15	14
P (total)	4.4	nd	3.3	nd
P (soluble)	3.1	bdl	1.4	0.9
TOC	170	5.5	110	5.5
ABS detergent	1.6	2.0	1.7	0.3
Feral coliform	10^{7-8}	20	10^{5-6}	10^2
Feral streptococcus	10^{6-7}	10	10^{4-5}	10^2
Salmonella	10^{3-4}	bdl	10^{0-1}	bdl
Human Rotavirus	10^{3-5}	bdl	10^{2-5}	10^4

chemical analyses expressed in mg/l except EC in µS/cm²
microbiological concentrations expressed per 100 ml or as equivalent
bdl below detection limit

Unsaturated zone profiles

The raw sewage and lagoon effluent are quite saline (table 1) and their character controls the quality of water in the unsaturated zone. Chloride profiles under cultivated land show the effect of evaporative concentration (fig.1), a mass balance calculation giving the recharge as about 5 mm/d.

Nitrogen in the raw sewage and effluent is in the organic and ammoniacal form. Under the lagoons ammonium concentrations are similar to those in raw sewage in the top 2m, but decrease steadily with depth by adsorption on clay mineral surfaces, and are very low beneath 10m. The cation exchange capacity appears to have reached saturation in the surface layers and this will advance down the porewater profile with time. The presence of ammonium with only low levels of nitrate confirms that conditions in the unsaturated zone are anaerobic as expected. The nitrogen load reaching the water table is quite low at present. Under cultivated land ammonium is negligible as soil aeration between flood irrigation events promotes oxidation to nitrate. Excess nitrogen to crop requirements is applied, and about half (400kg N/ha/a) is leached in the excess irrigation water. The nitrate concentrations are high in relation to the WHO guidelines for potable supply (10mg NO_3-N/l).

Sulphate profiles have much lower concentrations than raw sewage due to precipitation of sulphides or bacteriological sulphate reduction, particularly in the anaerobic environment in the sewage sludge at the lagoon base.

Phosphate is not very mobile and is precipitated as calcium phosphate at the base of lagoons or adsorbed beneath them.

Detergents used in Peru are mainly relatively non-biodegradable alkyl benzene sulphonate (ABS) which was detected at quite high concentrations beneath lagoons and at lower though significant levels beneath cultivated land.

Fecal pathogens and indicator organisms decrease by one or two orders of magnitude as they pass through the lagoons. Infiltration through the basal sludge results in further elimination by mechanical straining and adsorption; nevertheless high concentrations of both bacteria and viruses penetrate into the upper part of the unsaturated zone (fig.2).. There is rapid elimination within the top 3m and populations below this depth are generally below the detection limits. Beneath cultivated land irrigated with waste water, populations of fecal indicator bacteria are as high in the surface layers despite lower incident concentrations in secondary effluent. Irradiation and dessication between irrigation events lead to die-off, but although they decrease rapidly over the top 3m, there are positive counts of these and the hardy human rotavirus throughout the profiles right down to the water table at 20-25m depth. The reduced elimination, when compared with the situation beneath lagoons, is probably because of the lack of a sludge mat at the infiltration surface. The ineffectiveness of an unsaturated zone of fine-to-medium sands of this thickness in eliminating these micro-organisms is surprising. The pathogenic bacteria salmonella appears to be rapidly eliminated rapidly in all the unsaturated zone environments.

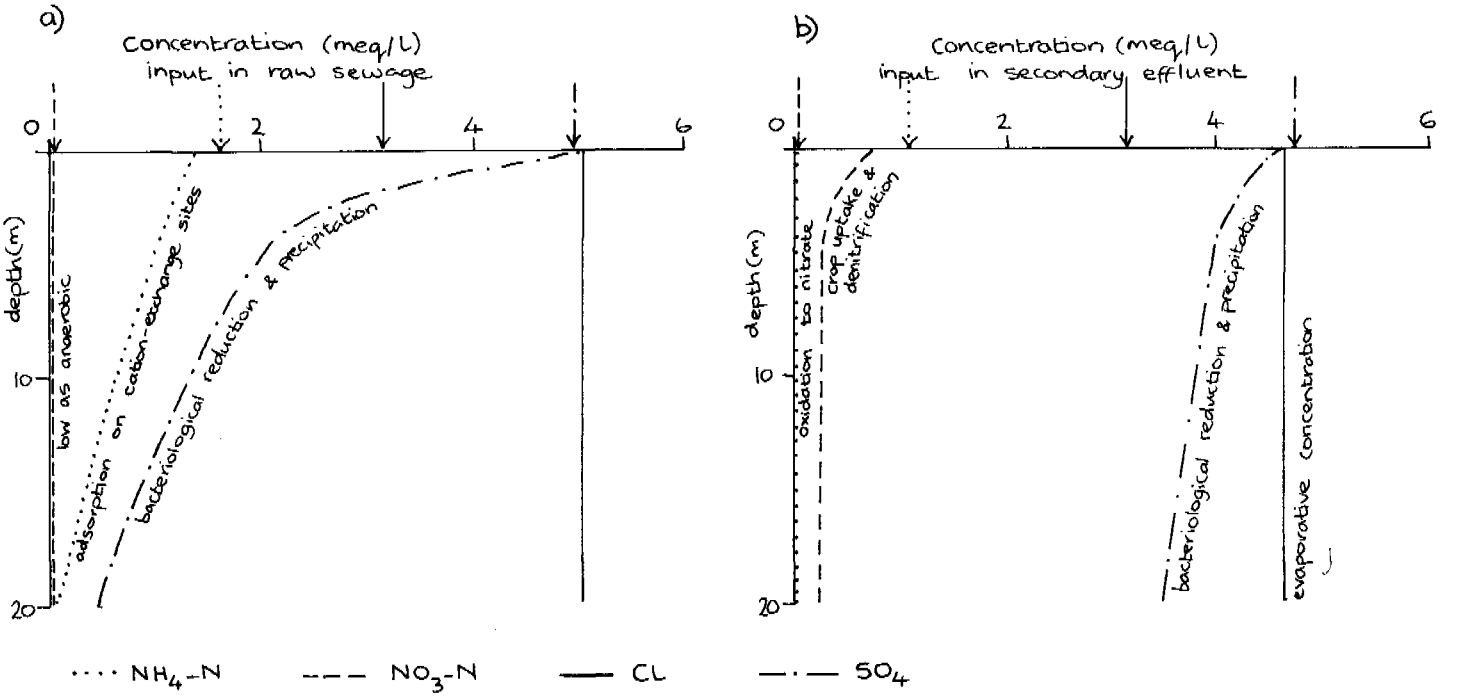

Figure 1: Generalised form of unsaturated zone chemical profiles
a) beneath wastewater lagoon
b) beneath cultivated land irrigated with wastewater

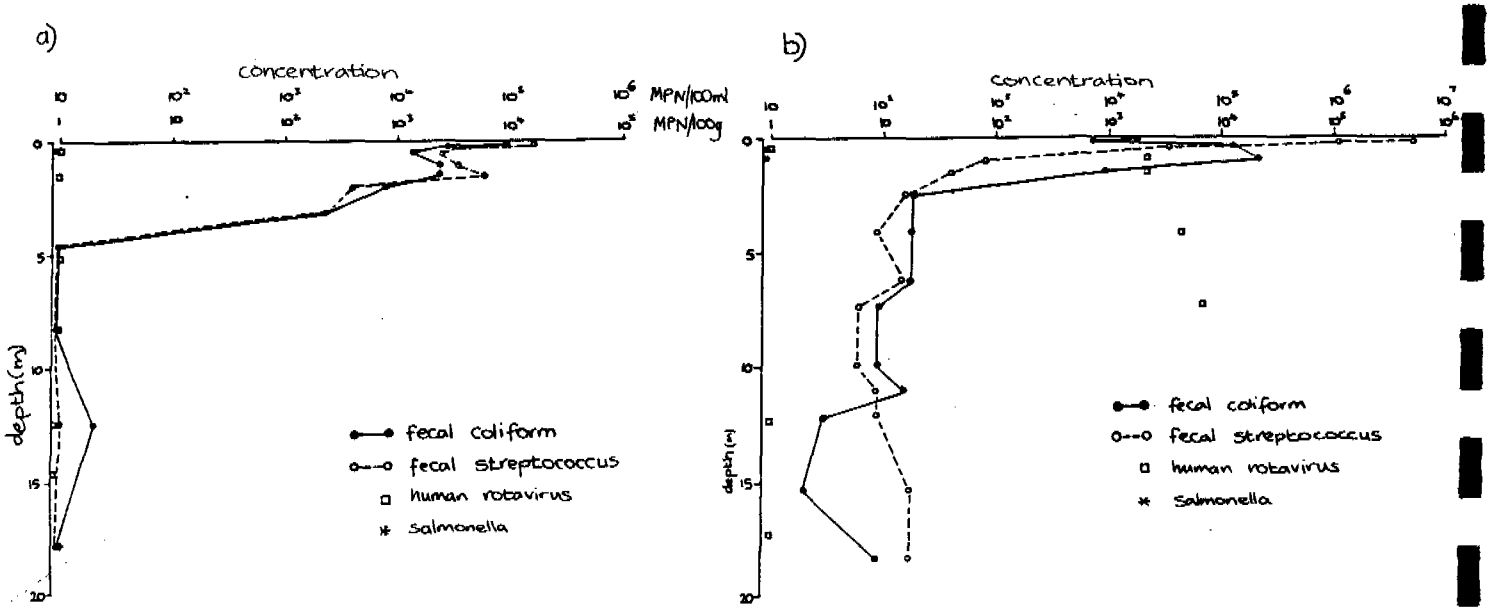

Figure 2: Fecal pathogens and indicator organisms in the unsaturated zone

a) beneath wastewater lagoon

b) beneath cultivated land irrigated with wastewater

Saturated zone

Fecal pathogens and indicator organisms were detected at relatively high levels (up to 10^3/100 ml) in groundwater samples bailed from the investigation boreholes, confirming the evidence of incomplete elimination despite a thick unsaturated zone of unconsolidated sands.

Trace organics migration and attenuation in groundwater systems is very uncertain, but many soluble compounds are believed to be retarded by adsorption and the more readily degradable compounds will probably be eliminated. TOC concentrations of up to 9 mg/l observed in groundwater beneath the lagoons and cultivated land are a gross indicator of organic pollution. Detailed organic analysis of 4 groundwater samples showed generally low levels of polycyclic aromatic hydrocarbons, phenols, polychlorinated biphenyls and the common halogenated solvents with most compounds being below detection limits. However elevated levels of the solvent 1,1,1, - Trichloroethane (up to 58 µg/l) and hydrocarbons (up to 160 µg/l were detected.

DISCUSSION

Groundwater Pollution Threats

The soil and unsaturated zone are an effective wastewater purification system, and are clearly an important first line of defence against aquifer pollution. The relatively slow water movement allows substantial reduction or removal of most of the unwholesome components in domestic wastewater by adsorption, filtration, precipitation or exchange processes, especially in the upper metre or so. The contaminants are further attenuated on reaching the water table, by dilution from regional groundwater flow. Nevertheless wastewater reuse schemes can, and do pose a threat of aquifer pollution from certain nutrients, dissolved salts, pathogens and trace organics. Groundwater recharge from such schemes will not be potable, and even where there is dilution from regional groundwater flow there will be a local need to restrict the use of groundwater to purposes other than domestic supply. The containment of polluted water by interception in drains or scavenger boreholes, although desirable, would be expensive. Close care needs to be taken in siting new reuse schemes, and to avoid siting potable water supply boreholes in the near viscinity.

There will also be a risk of groundwater pollution by the same contaminants from unsewered latrines or septic tanks, although often to a lesser degree because of lower loadings on the aquifer, but the problems will be more widespread. The nitrogen compounds will tend to be rapidly converted to nitrate beneath latrines because the conditions will generally be aerobic. Nitrate contamination will thus be almost inevitable, except where the groundwater system is naturally anaerobic allowing denitrification. Although this presents a less immediate hazard than any pathogens reaching the water table, it will be a persistant problem, especially in arid areas without significant regional groundwater flow (ref.2).

Effect of differing hydrogeological conditions in Africa

The aquifer type is important, unconfined aquifers being vulnerable to pollution from the land surface, whilst for semi-confined and confined conditions the risk is negligible.

The nature of the soil and strata determine the effectiveness of the purification, the greatest attenuation occurring in fine-grained, unconsolidated sediments with high clay contents. The clay-rich surface layers of the weathered basement aquifer for example, which is widespread over many regions of Africa, offer considerable protection against groundwater pollution. The unconsolidated sediments of the younger alluvial basins in Africa would be generally less effective in pollution protection, and more comparable to the Peruvian sands described above. The pollution risk will increase both with the coarsening of the material and the degree of consolidation and fissuring, as the flow velocities could be several orders of magnitude higher (ref.3). The greatest risk, particularly of fecal pollution, is where there is only a thin soil cover over a fissured non-porous bedrock aquifer, for example some volcanic lavas with major cavities and fissures. It should be noted that the upper 2m of the soil profile is biologically the most active and contains the greatest concentrations of pathogen-antagonistic microbes (ref.4); this important barrier is normally removed during latrine construction.

The thickness of unsaturated zone will control the time-lag and degree of purification attained before reaching the water table; obviously this will be least where the water table is shallow. The worst situation arises where latrines discharge directly into groundwater, and the practice of digging them as deep as possible regardless of hydrogeological conditions should be discouraged.

The excess rainfall affects the extent of leachate dilution. In coastal Peru, the rainfall is negligible and the quality of the infiltration beneath cultivated land irrigated with wastewater is controlled by the quality of the latter and the irrigation regime. In the more humid areas of Africa, the recharge would be diluted by excess rainfall resulting in lower salinity.

The aquifer thickness and flow regime affect the potential for dilution in the saturated zone.

The unsaturated zone permeability increases with moisture content, so if there is heavy artificial loading (e.g. beneath lagoons or pour-flush latrines) or high intensity rainfall the flow velocity increases, and the opportunity for pathogen elimination is greatly reduced.

CONCLUDING REMARKS

It is clear that low-cost sanitation schemes can have a detrimental effect on groundwater quality, the depth to the water table and the character of material in the unsaturated zone being the main controls on the degree of penetration of pathogens and biodegradable organics. The extent of dilution from regional groundwater flow, local recharge and effluent liquids (in pour flush latrines) control the final concentrations of nitrate, chloride and persistent trace organics in groundwater (ref.4). Water and pollutant movement in the unsaturated zone is complex, and the risk of groundwater contamination is much greater under some hydrogeological conditions than others. The normally accepted minimum separation of 15m between excreta disposal units and a groundwater supply source may therefore be over-cautious in some situations yet inadequate in others.

Those responsible for planning sanitation schemes need to recognise that a potential pollution hazard exists, and to be aware of the importance of groundwater for potable supplies. It would be desirable for low-cost sanitation and groundwater supply programmes to be planned on an integrated basis, with careful designs to minimise the aquifer pollution.

ACKNOWLEDGEMENTS

The research work in Peru was carried out by the British Geological Survey with financial support from the British Overseas Development Administration.

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SESSION 5 - DISCUSSION

Chairman: G J Chisi
Ministry of Works and Supplies
PB 316, Lilongwe 3, Malawi

R W A FRANCEYS and P BARKER
ECONOMICS AND RURAL INFRASTRUCTURE PROVISION

No recorded questions

A GEAKE
LOW-TECHNOLOGY SANITATION AFFECTING GROUNDWATER QUALITY

1. Dr YOUNG suggested that the deterioration under irrigated land as opposed to beneath the lagoons may be attributed to the application of a mixture of effluent and raw sewage to irrigated land. As the hydraulic regime appeared to be not functioning appropriately, he thought that it would be better to redesign the pond system, although this may reduce the opportunity for research on pollutant transport.

2. Mrs GEAKE explained that the waste water disposal scheme described is a pilot project with the raw sewage being applied predominantly to the irrigated woodland. The research boreholes drilled on the cultivated land were in areas which only received treated effluent hence comparison with those drilled beneath the lagoon is valid. She agreed, however, with the point that it is undesirable to irrigate cultivated land with raw sewage because of the high levels of pathogens.

3. Mr LEWIS asked if the author had any details on faecal indicator bacteria in the saturated zone and if any increased levels had been observed to coincide with periods of heavy rainfall.

4. Mrs GEAKE replied that faecal coliforms and faecal streptococci were detected in the saturated zone at concentrations of 10^2 to 10^3 MPN (most probable number)/100 mL beneath the cultivated land. She added that long term monitoring of the water quality was being carried out by the Peruvians but that the results were not yet available, however, as rainfall in coastal Peru is negligible, the short-term variations in microbiological groundwater quality will be small.

5. Dr FOLKARD noted that the paper reported the detection of the chlorinated solvent 1,1,1-trichloroethane at 58 µg/L at some point in the pond system and he requested further information on this.

6. Mrs GEAKE explained that this chemical was detected in the saturated zone, beneath the lagoons and was probably derived from discharges from small industrial units such as garages.

7. Mr HUTTON stated that there is a need for further investigations to be made on the movement of bacteria and viruses through the unsaturated zone in developing countries. He thought it important to realise that unsewered sanitation systems are sites of potential pollution of the shallow groundwater supplies in many parts of Africa. The siting criteria were not well defined and it is likely that alternative water supply systems may need to be developed to replace polluted groundwater. This is a hidden or secondary cost which needs to be considered.

8. Mr MULLER expressed the opinion that Mr HUTTON's comments that low cost sanitation schemes have hidden costs is fundamentally incorrect. He suggested that any high-density settlement with on-site sanitation, be it formal or informal, will result eventually in nitrate pollution (and poor conditions) and pathogenic pollution of unconfined aquifers. In his opinion it is high density settlements that carry the hidden cost. He thought that the technical question to ask in this situation was "Which is cheaper - off site sanitation or imported water?"

9. Mr HUTTON responded, saying that there is a greater need for cooperation between sanitation implementers and hydrogeologists and water engineers to ensure the control of pollution from unsewered systems. This control cannot be effectively implemented unless there is more research into the movement processes at work in the unsaturated zone.

10. Mr MULLER asked for clarification of da indicating that ammonium levels will rise in the unsaturated zone and inevitably pollute groundwater.

11. Mrs GEAKE explained that ammonium concentrations in the unsaturated zone beneath the lagoons will rise as the cation-exchange capacity reaches saturation until they reach the levels observed in the surface layers. These concentrations will advance down the profile with time. When the ammonium reache the water table it may be converted to nitra if conditions become aerobic further down the gradient.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Appropriate training for water technicians

E G Snape

Appropriate Training for technicians follows quite naturally from the concept of adopting Appropriate Technology for solutions to problems. However we have to be clear in our minds as to the level of training we wish to provide and the client group we wish to provide it to. it has been said elsewhere that in relation to rural development in Africa training is required at three levels. There is a need to reach the rural people themselves - Lele, as long ago as 1975 talked of sensitising the rural people in 'Design of Rural Development - Lessons from Africa' . The field staff and administrators have to be trained in their roles and finally the high fliers - the policy makers and those responsible for its strategic implementation- must be thoroughly trained. Each category requires a different training programme but all three are essential to the success of any rural development exercise. In this paper I have selected the middle group, the technicians, as an example of how a training programme can be evolved.

It is tempting to think of Appropriate Technology as being of a low level with little or no education or training required to implement it and little or no maintenance required to sustain it. Nothing could be further from the truth. Very few items of equipment are maintenance free and even fewer are able to withstand misuse. Unless the people given the task of installing the equipment understand the principles behind its operation even comparatively simple machines will fail to function efficiently. Once installed, the operation of the machine must be in line with its design parameters or it will fail prematurely. We must not fall into the trap of thinking that Appropriate Technology is 'install and forget' Technology - it never has been and it never will be.

Accepting then that appropriate solutions often require a wide knowledge of technology if they are to be successfully adopted what guidelines can we draw from our present courses? Some questions I have been asked by students on the recent courses have been:

- what is the difference between a casting and a forging?
- are there 'different' steels?
- are there 'different' plastics?
- how does a handpump work?
- what is atmospheric pressure?
- why is quality control important?

All questions asked by students with a lot of experience behind them in water related posts, with educational qualifications and with inquiring minds. How then can they have reached such positions without having found the answers en route? Perhaps because they have only received a narrow education in basic skills and thus neglected the grounding in technology that is so important to technicians or perhaps because when they received the information the first time round they were unable to appreciate its significance. Whatever the reason the majority of our students do not possess a wide general knowledge of things technical.

There is then a problem of recruiting staff with the necessary formal educational background for this industry, but in that we are not unique, I believe the Lilongwe Land Development Programme found difficulty in recruiting staff for agricultural training. The answer therefore is to amend the training programme to suit the available resources and build into the training ALL the elements that are thought desirable and to assume no wide technical background. There is a danger that some trainees may become bored and that others will leave after they have been trained but those are problems shared by any successful programme. If the training is structured in such a way that as the trainee matures and grows in experience and confidence then the content of the training also increases in difficulty and expands in range then the training will fulfill two important criteria.
One, it will keep the trainees' interest alive and
two, it can develop alongside the country's own technology and lead to a significant increase in the size of the technician labour market.

A restricted trained labour force from which to recruit can seriously inhibit the growth of local industry. Historically the two have grown alongside one another but where technology is 'imported' into rural areas it can fail beacause of a lack of staff to man

it. Similarly if technician training is given to staff who are then unable to use it or to gain experience with it, that training is also lost. Often training given as part of an 'Agency or Donor Programme' is solely geared to the requirements of that programme with no attempt made to ensure the transfer of any skills learned or knowledge gained to existing local conditions. It is easy to see why the differences between forging and casting are never explained or understood and it is easy therefore to see why so much technology is misused or abused.

Can we then identify the elements that a succesful training programme must have? I believe we can.

i) There must be sufficient background information included so that the trainee can fully appreciate the importance of the decisions made in the core technology.

ii) The programme must include subjects which are normally outside 'Technology' but which have importance to 'Technology'.

iii) The core content must satisfy the immediate needs of the trainee so that confidence is acquired and familiarity with the principles grows naturally.

iv) It must satisfy the students immediate training and educational desires from both personal and professional viewpoints.

v) It must provide a basis for future development initiated both by changes in the technology in use and in the aspirations of the trainee.

The advantages of such a progamme are potentially vast. A well trained and motivated technician labour force able to keep pace with the policy developments proposed by the 'high fliers'. Without such a labour force the implementation of such policy developments will be at risk.

How do existing qualifications fit into this pattern? They have enormous benefits in allowing comparisons to be made and in selecting staff for interview but I question their appropriateness in the present circumstances. They have evolved alongside technology and their present content and level mirrors present day technology. If the technology is inappropriate it is likely that the qualification is similarly so. For example the mathematics level may be geared towards the requirements of electronic control systems whereas only mechanical systems are in use.
Computer literacy will undoubtedly be needed eventually, but not yet and so its inclusion in standard qualifications may lead to the exclusion of more important fundamental principles. If the concept of a single qualification gained at a point in time is replaced by the concept of 'continuing education and training' throughout the working life of a technician - as is beginning to be the case in many professions - it opens up the delivery of the subject. Topics can be left until they become relevant, new technology can be adopted and trained for at any time, new agency training can be grafted onto an existing national programme and the transfer of skills, experience and knowledge can be achieved more efficiently.

The core elements of a course for water technicians can be easily identified. Water Technology itself, Principles of Fluids and the Science of Water are obvious candidates. Surveying, Construction Techniques, Plant, Maintenance and Management would also probably appear in many programmes. I do not intend to discuss here the detailed content of such a course. Each country, each region will have different priorities and should feel able to attend to them in their own way. I will happily continue with a more detailed discussion at a more appropriate time. What I wish to continue with at this point is to consider the wider context.

Education is not just sitting in a classroom receiving instruction.

Education is visiting a relevant works and questioning the site manager and operators,

education is visiting a manufacturer and asking why that component is cast and that one forged,

education is seeing samples taken from production runs and tested to destruction,

education is attending conferences and exhibitions to discuss problems experienced in the field with sales and technical staff,

education is sitting down with fellow technicians and discussing how problems have been solved or avoided,

education is attending training courses offered by various agencies and manufacturers and note I am using education in its widest sense.

These are the reasons why there has to be a residential element to the programme. I know that one of the outcomes of the LLDP was to favour non residential day courses over residential courses but I believe that the necessary organisation for a course including all of the above can only be done on the basis of a 'captive' course. But the residential element should be seen as only part of the whole. A time and opportunity to carry out a lot of group work to each persons own advantage. I sometimes wonder how effective it would be to summon back the members of our course for a weekend to exchange their recent experiences. They would be easy with one another and have the rapport they acquired during their stay in the UK. Far too expensive to put on in the UK but if developed here in Africa in may be the basis for a very effective problem solving network.

Consider for a few minutes the current popular symbol of AT - the handpump. In your knowledge has it changed during the last five years?
Perhaps not in concept but the handpump trials and the emphasis on maintenance at the Village Level have certainly caused manufacturers to introduce design and material changes. Materials which may be new to technicians installing them and designs that may require new installation techniques if damage is to be avoided. The photo electric cell seems to be about to break through a significant cost barrier and become a major source of energy in remote places - it will be another change in technology. I can hear you say that such cells will be bought, used and thrown away when they fail and so people will not need to know much about them. I agree. But think of their uses, they will introduce requirements that our technicians will have to be familiar with. Small electric motors, communications equipment, data logging and remote measuring equipment all become possibilities as well as other devices for which we cannot as yet see a need. So we must include in our training programme regular and formal updating sessions. A one day seminar, a training package sent to the trainee, a demonstration unit sent round the major regional centres or more conventional lectures could all form part of the continuing education of the technician cadre.

Such a programme begins to need a formal control structure but it need not be more than a small administrative unit in each authority or country. It is the will to do it that is important, the means are not excessive.

Training, to be effective, requires that three major conditions be satisfied.

1. The trainers are themselves technically competent
2. The trainers are able to make the subject relevant.
3. The trainers are able to communicate effectively.

If the training was to be done 'in house' then the first two conditions would be met. That is to say we use existing staff to pass on their experience and knowledge. We could be sure then that the subjects were relevant and our previous training ought to ensure that the trainers were competent. Not informally but as part of a long term strategy. We take the present technician and professional trainees and add onto their technical training programmes a short course in education and training itself. I have done this with a few of our trainees and gone through the key elements of the teaching process. A scaled down version of the City & Guilds Further Education Teachers Certificate so that they were familiar with instructional techniques, preparation of training materials and training programmes and some rudimentary knowledge of how to evaluate their efforts. It seems to work and could be an effective vehicle for transferring information, knowledge and experience through all the levels of the industry. Professional staff would be better able to brief their support staff and they in their turn would be better able to 'sensitise the rural population'.

I leave you with one more thought. Through the WEDC conferences you have an excellent method of exchanging ideas, sharing new methods and keeping in touch. When you return home you have to pass on that information to your associates and your support staff. I wonder whether you should not consider setting up an Association within the Developing Countries of Africa to formalise the exchange of technician information, to oversee their training and, most important, to evaluate their training. The Secretary of the Institution of Mechanical Engineers said, as recently as August 1986, that he believed that the future of the engineering profession depended on the maintenance of a sound balance within the hierarchy of engineering.

'The 'Mechanicals' should continue to support the Institution of Technician Engineers in Mechanical Engineering in its efforts to grow and develop'.
Perhaps one of the most important legacies of the Water Decade could be the establishment of an Institution of Water Technicians in the Developing Countries of Africa whose members will ensure that your proposals are carried out and that the targets of the Decade are not forgotten. Indeed those targets could be written into the constitution of such a body.

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Rural development in Africa
Malawi: 1987

Training of labour intensive supervisors

David W Jennings

BACKGROUND

Lesotho is a small African country completely surrounded by the Republic of South Africa. It faces many special political and development problems due to its geographical position and its mountainous topography. 1.5 million tons of soil are lost each year to erosion. 50% of the working male population works in South African mines and factories (constantly under threat of repatriation). Unemployment at home in Lesotho is high. Communication (mainly by road) through the mountains is slow and hazardous.

LABOUR INTENSIVE METHODS

The government realised in the late 1960's that one way of tackling these problems was to utilize the large manpower resources to undertake construction and development projects by labour intensive methods.

Since 1970 in Lesotho many development projects have been undertaken by various authorities using labour intensive methods and food for work. In 1977 the Labour Construction Unit was established under the Ministry of Works, to undertake construction projects, to appropriate engineering standards, utilizing repatriated mine labour for cash wages.

Between 1977 and 1982 the LCU proved that it could compete favourably against machine intensive contractors and authorities in many sectors of construction. The Lesotho government with the support of donor agencies decided to expand the use of Labour Intensive Methods of construction into other government departments using the principals learnt within the LCU.

SUPERVISION

The key to the success of the use of labour methods is the level of supervision, both quality and number. One technician alone cannot supervise the work of 200 labourers; on the other hand 20 supervisors with little technical knowledge give a similarly poor result.

TRAINING UNIT

A review of the staffing of the labour intensive departments in 1983-84 showed that there was a shortfall in quality and quantity of supervisors to undertake the planned expansion of work of this nature.

A training unit for labour intensive methods of construction was set up in september 1984, by the appointment of a Training Engineer attached to the LCU. The aims of the training unit were and are;

1. To train a pool of supervisors in sufficient number and to a sufficient standard to allow the expansion of labour intensive construction within the country at a rate of approximately 2000 labourers per year.

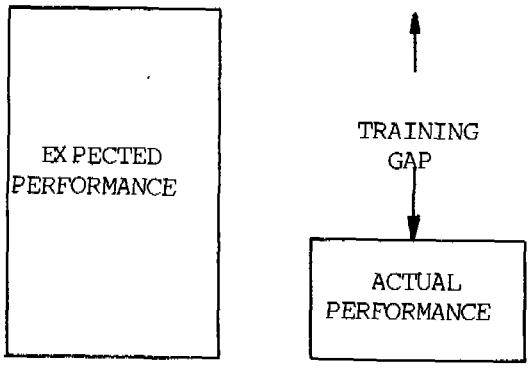
2. To register these supervisors in order that they can be called upon in the event of an employment emergency. (Large scale repatriation of miners and others from South Africa)

This unit became known as LITU (Labour Intensive Training Unit)

FINDING NEEDS The first step for any training programme is to determine, in some detail, the training needs. This was a difficult job in this case involving as it did a variety of government departments working in different sectors & with different staffing arrangements. The training needs analysis was carried out in a formal manner over a period of six months. This exercise involved determining a detailed job description and sometimes a job specification for each grade of technical supervisor in each sector. This was done by investigation and interviews with senior personnel in each department involved. Thus a picture of what would be expected by management of a technician - supervisor at each level in each sector was built up.

The actual supervision work as it was being carried out in the field was then investigated. By observation and by interview with supervisors at all levels on site their actual performance was established.

The 'actual' could then be compared to the 'expected' to find the Training Gap.



Although there were many varied needs between individuals in different sectors certain common key needs were identified at the various levels in all sectors.

VIZ:-

COMMON TRAINING NEEDS

1st Line Supervisors (gang leader).
Supervision techniques, motivation and attitude training, use of tape measure, care of tools & equipment.

Gang Foreman (Technician-Supervisor in charge of 50 men).
Supervision Techniques, Area & Volume measurement, Basic Arithmetic skills. Taskwork theory and practise. Production & Productivity measurement & reporting. Work Planning. Work item organisation and techniques.

Technical officers (Section Supervisor).
Taskwork theory and practise, planning & programming, Setting out, Work item organisation & techniques, Productivity reporting & checking.

Senior Technical Officers (& Engineers).
Basic management techniques, Report writting Planning & programming, Attitude training.

IMPLEMETNATION OF TRAINING

With a clear picture of the training needs a full programme of training was built up including attendance of external and overseas courses for some staff, formal centered lessons and seminars for section supervisors and above, and a decentralised course of on-the-job instruction for all field staff supervisors.

The main thrust of the LITU training was to the decentralised on-the-job training system, since this could reach a large number of staff at the grass roots level. It is on this aspect of LITU's work that I will expand the rest of the work being quite normal to any training programme. The proposal for implementing this type of training was laid down at the inception of LITU and was carried through as follows:-

1. Field staff working in the appropriate departments were selected as potential trainers by their departments.

2. These staff were sent to LITU for a 1 week intensive 'training of trainers' course, at the end of which they were assessed using video aided feedback on presentations given by the potential trainers. 40% of the candidates failed to achieve the necessary standard. The others receieved certificates as trainers and were registered with LITU.

3. Before any department begins its first labour based work the registered trainers from that department return to LITU for training and experience in the basic core requirements of supervising labour based work. This usually includes attachement to LCU sites.

4. The trainer is provided with basic training equipment (flipchart, easle, pens, chalk etc) and specially prepared material in the form of lesson plans & demonstration plans which he has been trained to interperet.

5. The trainer returns to his parent department and works part time as a technician-supervisor on the labour based project and part time as a trainer to train the other subordinate staff.

He does this by giving lessons and demonstrations in a classroom situation and following these up by discussions and critical observations during normal work.

Large projects might have more than one trainer of different grades.

6. LITU senior staff make regular visits to the trainers on site to monitor their performance and the effect they are having on the work of the field staff. This gives LITU not only feedback on the trainer's and field staff performance but also completes the 'training cycle' by giving feedback on the ever changing Training Needs.

By holding 4 training of trainers courses per year the target of training staff to supervise 2000 labourers can be met.

PROBLEMS

The single biggest problem which LITU has met is with the inter- departmental nature of its work. Since LITU is based in the Ministry of Works departments from other Ministries are reluctant to send their staff to LITU for training. They are also sceptical about the appropriateness of the material produced by LITU for use in their departments.

The initial reluctance can only be overcome with full political support for such an enterprise and policy decisions at a high level are required at the very beginning. The problem of the use of material is overcome by ensuring that material is appropriate and adaptable to each departments needs. To do this the material is produced in liason with the trainers and senior staff of the department concerned.

PROGRESS
This decentralised system of training began with the departments which were already using labour intensive methods and has been successful both in LCU (works) and in Civil Works Section (Rural Development) were the system has been adapted to account for the thin spread of staff. Training of trainers for Village Water Supply (Rural Developement) Soil Conservation Division (Agriculture) and Ministry of Interior is underway.

LITU presently has 15 registered trainers working in the field on projects ranging from construction of surfaced roads, and laying of trunk sewer lines to gabion installation for river training and erosion control structures. These 15 trainers are currently training staff who are supervising some 7000 labourers.

DEVELOPMENTS
A Field Training Unit (F.T.U.) has been established by LITU with senior trainers in charge. The project is carried out with training not production as the main objective and therefore costs are somewhat higher than might be obtained an a normal project.

Trainee staff are brought to the FTU for intensive training and work experience for a six week period after which they return to thier parent department. The FTU supplements the on-site training system with good quality work experience under tight control. Thus showing what can be achieved using labour intensive methods in the correct way.

LITU's own staff has increased with the units growth and these staff have been continually trained since 1985 in both training and management techniques. By June 1987 LITU will be completely localised when the consultant Training Engineer hands over to his counterpart who is already performing most of the duties of head of the unit.

It is intended for the future that LITU, now working well and fully established, be relocated under Ministry of Education instead of Ministry of Works thus overcoming the inter-departmental rivalry problems.

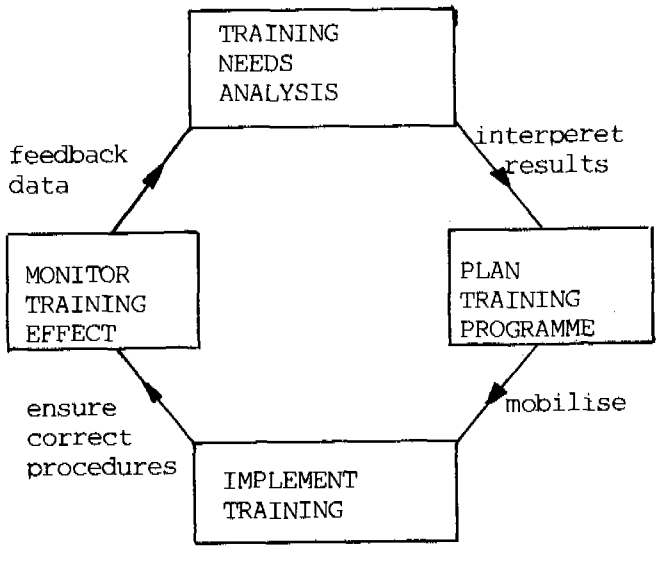
COSTS
The costs of establising LITU and its FTU have been very low. The fact that LITU was able to utilise the existing resources of LCU and Ministry of Works for administrative backup, offices, transport and technical staff helped a great deal.

The overall cost to the donor since 1984 has been;

LITU direct costs (Excluding consultants fees)	$100,000
Cost of establishing a trainer to parent department	$500/trainer
Establishing and running Field Training Unit for 1year	$50,000
Total cost of establishing and training supervisors for 2000 labourforce per year	$155,000

DISCUSSION
The work of LITU has been successful although certain changes and improvements could be made to the system.

The formal method of training needs analysis takes a long time and this delays the start of practical training. Since the whole system is cyclic and changes in material are being made constantly with feedback from the monitoring procedure, the target setting method of analysis giving DIF ratings to tasks performed or required will give quicker results. These can be modified if necessary later after monitoring.



THE TRAINING CYCLE

This could reduce the programme time between inception and start of field training to approximately 6 months instead of 15 months if extra manpower was also utilised for material preparation after the initial analysis.

CONCLUSION

The work of LITU in Lesotho has shown that a systematic approach to training for Labour Intensive Construction work is possible and can be carried out using available resources and modern training techniques to great advantage. The cost of doing this can be kept very low.

Given initially a core of technical staff with knowledge of Labour Intensive method the whole system can be fully run by local staff within a period of three years. This type of training unit can serve the needs of all appropriate government departments as well as the private sector. Appropriate work which can be done by Labour Intensive Methods using trained technician-supervisors includes water supply pipeline, irrigation, sewer installation erosion control and river training works.

The key to successful use of labour intensive methods for civil engineering work is to have the correct number of properly trained technician-supervisors.

This training can be acheived by using similar methods to those described in this paper. One word of warning; No training system or programme can be transferred from one country to another or from one work system to another without the appropriate modifications being done to it .

13th WEDC Conference

Rural development in Africa
Malawi: 1987

Participatory communication for water and sanitation

Susan Laver

INTRODUCTION

Early attempts in health education in respect of environmental sanitation and communicable diseases in the sixties, early seventies and possibly even later, were very much based on passive approaches of 'telling' people what to do. Health Care Providers didactically focussed on the modification of individual behaviour and mostly tended to ignore that communities have a potential resource within themselves to become involved and have control over decisions which affect their lives. There was also a delay in those times to modify political, economic and environmental factors which, with change would have played such a motivating role in the development process. The assumption that communities were ignorant, illiterate, difficult to change and not able to help themselves predominated. Predictably, without true involvement and understanding of the target population, achievement at grass root level was slow.

It was not accidental or by chance that the Alma-Ata Declaration of 1978 or the WHO Global Strategy of Health for All by the year 2000 constantly referred to the need for Governments to embark upon a comprehensive policy for health which would promote active community participation in every sphere of the discipline. Information, education and communication should, it was recommended, play a major role in promoting the concepts of Primary Health Care. It is in this context that we, as Project Workers in the field of Low Cost water and sanitation development face a great challenge today.

PROBLEMS

The high rates of population growth, the multiplicity, nature and scale of needs, the insufficiency of resources and the diverse nature of culture and understanding in developing Africa suggest that, even with recent advances in science and low-cost technology, it will never be possible to grapple with the problems of under-development without the active participation of the people themselves. In this context it is frequently articulated that the improvement of health in our rural communities will ultimately depend on a sound partnership between the people and the implementing agencies. But, we must ask ourselves, how can we seriously promote community participation and self reliance in matters of development without a previous body of knowledge? Can we seriously expect communities to participate in the planning, and the implementation and maintenance of a technology without prior training? Or can we afford to popularise health technology as a fundamental right without developing also a sense of desire and pride in the personal attainment of that asset? Whatever one's sociological theories, the potency of communication, information and education in the development strategy can neither be dismissed nor underestimated.

Not withstanding this, we still find that the approach to health education in many parts of the developing world is paternalistic, didactic, and in the words of a 1983 WHO Expert Committee, 'commandant like' (ref. 1). The view that problems should solved 'individually' and 'professionally' with an unquestioning belief in institutionalised values continues to prevail and it is not entirely uncommon to encounter the belief that our people should be 'the grateful recipients of scientific endeavour'. These misperceptions only serve to remove the communicator even further from the real needs of the target group, reinforcing the belief that health educators are ineffectual.

By comparison however the concept of participatory communication fosters community involvement in every phase of the development process by facilitating, through dialogue, different forms of social communication and media mixes;

* the active involvement of the target in needs identification and problem solving activities
* local representation in project planning
* the setting of attainable goals
* the identification of local information, skills and sources of support at project level
* increased project awareness through appropriate and meaningful information

* the acquisition of new information
* an opportunity for the people to become involved in the maintenance and assessment of project objectives.

There is arguably an urgent need to develop a much wider approach to the communication process and there is no reason why workers in the field of water and sanitation should not heed the call to involve themselves more readily in appropriate information sharing activities.

PLANNING FOR PARTICIPATORY COMMUNICATION IN LOW COST WATER AND SANITATION PROGRAMMES

It is relevant to observe that significantly more project proposals for low cost water and sanitation programmes contain 'educational' and 'training' components than was the case just a few years ago. However, the practitioner committed to a truly integrated approach of communication in this field will face a broader task if he/she is to successfully achieve these objectives. For it is not enough to merely write an 'educational' component into a project proposal without also indentifying the range of activities which can be used to raise interest, activate participation and finally sustain sufficient interest to ensure commitment to the maintenance of the facility at both individual and personal level. These activities need also be intensely sensitive to the perceptual, literacy and social needs of our target groups, and it is for such reasons that it is recommended that a micro-level approach to the planning of communication activities should be adopted. In this way the project worker will be better placed to account for the numerous variables which characterise communities. But, you may ask, where do we start?

In advocating the use of participatory communication in community-based water and sanitation projects, we infer that the project worker should turn his/her attention away from vertical one-way methods of 'telling' (eg. lectures and talks) and rather adopt a selling and sharing approach to communication. The opportunity for this approach occurs throughout the development programme, commencing early in the planning phase and continuing through the mobilisation and implementation phases until project handover when maintenance/user and hygiene education becomes a priority. In this way training and education activities can be integrated with technical inputs, to achieve maximum impact at project level.

Communication activities need not be confined to one or two old tried and tested methods. Indeed many different technologies can be successfully combined to facilitate a continuous flow of programme information. In the organisational phases of the project we recommend for example, that the communicator combines strategies which increase awareness of the advantages of the technology and promote problem solving. In this context psycho-social methods, local drama, on-site meetings, building demonstrations, and visits by the community to other successful projects would be most appropriate.

The next important phase generally concerns the actual implementation of the project, and we find that workers are most in need of simple technical information, eg. how to build a latrine, dig a well, construct a washing slab, fit a pump, etc. This can be provided through simple but appropriate instructional media such as step-by-step construction manuals, reminder sheets, leaflets and other training materials which meet the perceptual needs of the target. On-site training and visits by key leaders to the project are among other activities that will also assist to reinforce these efforts. Communication support of this nature does much to consolidate project objectives and promote community participation, thus bridging the gap between people and technology.

In later stages of the project, information and training will play an important role in promoting a lasting organisational structure for community-based maintenance and user hygiene. Using various activities such as village drama and other forms of social communication, much can be done to facilitate the election and training of individuals/groups to assume maintenance responsibilities and become involved in promoting user hygiene in the community.

In parting, it is also worth pointing out that there is increasing evidence in many countries to show that significant emphasis is now being placed on the use of mass media such as radio and television in different phases of project work, and facilitators will need in future to become much more conversant with its potential in the field of communication.

SPREADING THE COMMUNICATION NET

If we are to shift the dependency for success in low cost water and sanitation projects from mechanics to communities, then communication will undoubtedly have to assume a much greater role in this process. The temptation to provide high level technical information to community-based workers whose needs in no way match such aspirations, will also have to be avoided.

Our communication efforts will therefore need to respond more readily to the key concepts of community participation at project level, so that we can place the practical attainment of objectives within easier reach of our targets. We would therefore urge planners to respond to the need for participatory communication in development projects and to realistically consider the necessity for communicators to spend time in this process. It is also important to recognise that not all communication channels are suited to the sharing of technical information and that a need exists in this context for countries to develop their own media support for community-based programmes. Already developed prototypes could be more widely shared as models which could then be adapted to meet the cultural, social and project needs of participating groups.

Finally it is recommended that concerted efforts are made to convene communication workshops as a practical method of developing and maximising potential in this important sphere.

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13th WEDC Conference

Rural development in Africa
Malawi: 1987

Water Master Planning in rural areas of developing countries - A case study from Malawi

M Burton, M Girling and W Tuck

WHAT IS WATER MASTER PLANNING ?

Water Master Planning is normally required by a government agency in order to provide a basis for the development strategy and long term planning outline in the nature sector. Because of its horizon of around 20 years, a water master plan must be a dynamic tool which needs ongoing re-appraisal and adjustment to take account of changing circumstances. An outline plan however is of immense value, in ensuring that short term planning and implementation is in line with longer term strategies and objectives, and in the planning of an economic and practical phased implementation programme.

Water master planning involves considerably more than just engineering inputs. Typically the following disciplines are involved in the development of a water master plan.

- hydrological
- hydrogeological
- socio-economic
- water engineering
- surveying
- water quality
- water treatment
- planning
- tariff
- management
- economical

The present plan, in addition to presenting the relevant data and recommendations in respect of each discipline, will include an implementation programme over the planning horizon, which has been technically and economically derived as the optimum and which will be subsequently used to identify the following initial stages of implementation.

The collection, verification and presentation of data represents a large part of any water master plan input and therefore computerisation of data handling and analysis is essential.

The authors have been involved in water master planning throughout Africa over the last 20 years with the most recent example being in connection with 44 semi-urban supplies in Malawi. The project is set in a rural environment and takes into account the needs of the rural fringe population in addition to that of the centre itself.

Malawi - 44 semi urban centres.

Background

The 44 centres are distributed throughout Malawi. They range in size from 5000 to 30,000 population at present. In character many are very much rural centres serving as a service centre for the surrounding population and often having agricultural extension facilities.

Around half of the centres have an improved water supply at present but even these are not fully serving the population in most cases. A significant recent development is the incorporation of the supply of rural fringe population of these centres from communal water points. This is increasing the demand from existing and proposed new water supplies for these centres.

Resources

Hydrological and hydrogeological teams visited all centres and investigated the potential sources in the vicinity. Although ground water had proven to be a significant proportion of the existing sources, the areas of the centres now under study were often found to be characterized by poor quality or yields. However with careful siting and development it is still expected that because of cost and treatment benefits, groundwater would represent the majority of the proposed new sources.

Mathematical simulation models were used to analyse potential surface sources where insufficient river gaugings were available.

Socio-Economic

A team of socio-economists similarly visited each centre and carried out in-depth studies in selected centres. A standard questionnaire was used to supplement base data with centre level information.

Aspects that were investigated included development potential, population growth, service level, affordability and tariff. The relationship between a central supply where

consumers pay for water through metered connections and a supply to rural populations which is traditionally free in Malawi, was a complex issue.

Water Engineering

All existing systems were inspected and evaluated to determine the degree and nature of rehabilitation and extension which would be appropriate.

For both existing and proposed schemes an outline of the system was developed from existing mapping as a basis for costing.

Taking into account different water characteristics from ground, lake and streams, standard treatment systems and processes were developed to ensure an acceptable quality at an appropriate operational level and cost.

The layout of the distribution system in outline as a basis for costing, was developed from the interpretation of plans by the socio-economical team. Account was taken of specific or probable plans for institutional and commercial developments and the zoning outlines within each centre.

Costing

A computerised cost catalogue was developed for the project by expanding unit costs into elemental costs for the main scheme components of:

- source
- treatment
- pumping
- storage
- reticulation

By preparing this cost catalogue over a range of signs and types in respect of each component, the scheme costs could be readily compiled in each case.

Costs were broken down into foreign and local cost components and were compiled such that sensitivity studies could be carried out.

Development Programme

The development programme for the project has been prepared taking into account need/cost criteria. Need criteria as evaluated by equating production and distribution shortfalls both separately and combined over various time horizons.

The resultant objective programme was then considered subjectively both by the consultants and clients and a final recommendation of implementation was produced. During development this implementation programme was subject to economic evaluation such that the resultant programme would represent an acceptable investment/revenue relationship.

The iterative process involved in this development was carried out on computer which also gave the consultants the flexibility to try alternative approaches and models to test sensitivity and to ensure that an optimum result was achieved.

A complication in the development of such an implementation programme is the practicality and economic viability of the phasing of different scheme units. For example a trunk supply main is often only economic to develop in one or at most two stages over a 20 year planning horizon, whereas distribution mains, treatment works, pumps and boreholes can be phased in smaller but varying periods. These practical considerations were developed into a model which was in turn applied to the development of the implementation programme.

Financial and Economic Analysis

The financial and economic analysis was carried out at these levels

aggregate profitability analysis of 44 centre projects

liquidity analysis of 44 centre projects

overall financial analysis of District Water Supply Fund (DWSF)

The analyses were carried out on incremental basis both in respect of investments and revenue , and both individually for each of the 44 centres and on an aggregate basis in respect of financial analyses.

Sensitivity analyses on the base financial analysis were carried out to test the effect on the project in respect of

- changing consumption and production levels
- changing investment costs
- changing operation and maintenance costs

SESSION 6 - DISCUSSION

Chairman: R W A Franceys
WEDC, University of Technology,
Loughborough, LE11 3TU, UK

E G SNAPE
APPROPRIATE TRAINING FOR WATER TECHNICIANS

D W JENNINGS
TRAINING OF LABOUR INTENSIVE SUPERVISORS

S LAVER
PARTICIPATORY COMMUNICATIONS FOR WATER AND SANITATION

There were no recorded questions on the above papers.

M BURTON, M GIRLING AND W TUCK
WATER MASTER PLANNING IN RURAL AREAS OF DEVELOPING COUNTRIES - A CASE STUDY FROM MALAWI

1. Mr CHOLA asked if the author had taken care of training of personnel in all aspects of project implementation, operation and maintenance to ensure project success after the executive agencies have pulled out.

2. The authors replied that counterpart engineers were appointed to the study team to involve them more completely in the work and normal liaison of socioeconomists/hydrogeologists with Government personnel. This meant that many of the consultants' techniques and overall approaches to the work are passed on in an on-the-job form of training.

3. Mr MSUYA wished to know if the Water Master Plan took into account other conflicting demands, such as livestock, and if it considered a short-term planning horizon for the project implementers.

4. CARL BRO/KRUGER replied that many of the master plans carried out by both associates cover all aspects of water use/demand. The Malawi Master Plan,however was restricted to semi-urban areas. This, as the name suggests is a long term plan with long horizons. However five-year predictions for necessary immediate work form a natural part of the plan.

5. Mr MSUYA asked how often the 'data base' should be updated.

6. The reply recommended that updating be geared to the pace of development and change but that three to five years would seem reasonable.

7. Mr MBUGUA commented that the main problem is the operation and maintenance of work after the planning, designing and construction have been done by foreigners . He added that in many countries, the top managers, from the director down, are indigenous engineers and that the countries have the political and technical ability to provide adequate institutions necessary for better operation and maintenance. He considered this to be a challenge to fellow engineers to impose and control affairs instead of crying out that the problem is with the outsiders. He cited as an example of failure to do this a Ministry that bought drilling rigs from Japan; the selling Company financed a three-month course in Japan for about 10 technicians. Instead the time was reduced to two weeks and only Top managers went. The sting in the tail being that they came back with gifts of cameras instead of the toolkits for the service engineers. He thought that this illustrated a weakness/problem in that 'we in Africa are not always or fully with donors or those friends who give us these services.'

8. Mr COLBERT wished to know if the team collected data in the field or did they carry out a literature search and if the final Master Plan listed alternative solutions or gave 'the answer'.

9. The authors replied that a desk-based study was supported by/checked against field data on a centre by centre basis. They explained that the Master Plan firstly records all relevant data collected so that changing needs can be re-evaluated in the future. Secondly it considers and compares the alternatives relevant to the present circumstances. Finally it utilises the most appropriate solution at the present time to prepare an overview of the situation in the water sector and a programme for action.

10. Mr COLBERT wished to know if the Plan could accommodate changing economic condition or technology or was it 'engraved in stone!'

11. Mr BURTON explained that each individual water scheme must be re-evaluated when a detailed design is prepared and implementation takes place, but the outline provided by the Master Plan should still be valid.

WATER RESOURCES INVESTIGATIONS FOR RURAL WATER SUPPLY DEVELOPMENT IN MALAWI

by O.N. Shela

1.0 INTRODUCTION

Rural water supply development has to go through a planning stage. At this stage, water resources investigations, inter alia, have to be carried out in order to establish the reliability of the water supply source, particularly a surface water supply source. As it is often the case, these source points do not have readily available water resources data to be used in such investigations. In most cases this information has to be developed through the use of "transfer" hydrological models.

Some hydrological models can be used to transfer information from where it is collected (gauging station) to where it is wanted (point of abstraction). Drayton et al 1980 have attempted to develop regional techniques for assessing the availability, variability and reliability of the streamflows in Malawi. However, due to inherent errors in the data used in the analysis, the above method has proved to be inadequate. It is commonly accepted now to use different methods and compare their results or improve the Drayton's method by employing other methods.

2.0 STREAMFLOW ESTIMATION

There are several techniques which may be employed in streamflow estimation at an ungauged site. However, what influences the choice of one method over the other is the kind of data available and required. In rural water supply perhaps one to ten day minimum flows are more important than 30 day minimum flows. In irrigation and industrial rural water supplies 30 day minimum may be adequate enough. The following hydrological models may be used to transfer (estimate) streamflow data

$$Q_{st} = Q_{gt}(A_s/A_g)$$

where Q_{st} = discharge at an ungauged site s during period t.

Q_{gt} = discharge at gauged site g during period t.

A_s and A_g are catchment areas at site s and g respectively.

This model assumes that the sites s and g are within the vicinity of each other and the discharge per unit area is uniform. The coefficient (A_s/A_g) may be improved by plotting discharge measured at A_s versus discharge recorded at g. The slope of the graph, k, replaces (A_s/A_g). If several gauged sites exist, the above model may be improved by the following one.

$$Q_{st} = Q_{g(u)t}K_{g(u)}W(u)$$

where $Q_{g(u)t}$ = discharge at gauge site u during period t.

and $K_{g(u)} = A_s/A(u)$ is the coefficient k for the gauged site u,

W(u) is a weight factor for gauged site u and

$W(u) = 1$

These models need a good hydrometric network in the project area. The experience in Malawi shows that most of the potential rural water supply sources in Malawi do not have adequate coverage.

3.0 WATER RESOURCES ASSESSMENT

Surface water resources assessment involve the determination of water resources availability and reliability. The assessment of the availability of water resources include the analyses of hydrological data and water resources already committed in the catchment. The Water Resources Board has records of abstractions and effluent discharges which can be used in assessing the existing water resources commitments in the catchment. This information may be supplemented by field visits.

The flow duration curves for different periods of 1, 3, 7, or 10 day for domestic water supply may be used to determine the reliability of the water supply sources. The actual flow duration period used may depend on the tolerance associated with the accepted period under which the accepted period under which the water supply system may fail without adversely affecting its

objectives and goals. Generally, the domestic water supply source should have higher percentage of reliability than industrial and irrigation water supply sources.

Drayton et al (1980) give some equations for estimating quantiles for various percentiles. The 75 per cent quantile for duration period (D) is given as

$Q75(D) = Q75(10) + 0.008\ 5(10)^{0.23}(D - 10)^{1.33}$ for

D<10 days; Q75(10) is obtained from a map.

However, this equation may be used where data is insufficient, otherwise basic techniques are used to derive the necessary quantiles.

Regional methods are regarded as superior to the basic methods especially where data is scanty. However, the hydrological data available in Malawi is not adequate enough to be used in the development of regional methods. Some further processing may be required before the data can be used in a comprehensive low flow regional study.

4.0 CONCLUSION

Water Resources investigations in Malawi employ the regional techniques as well as existing water resources data. The hydrological analyses (regional and basic methods) are utilized in order to establish the availability and reliability of the surface water supplies. Due to lack of adequate hydrological information, interpretation of the analyses are done cautiously. Further work needs to be done on the available data and develop regional low flow analyses methods.

Water resources assessment should also look at the quality too, apart from the quantity and water usage. Water Resources Board keep both water abstractions and effluent discharge records. These may be used in water resources assessment.

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THE LIBERIAN NATIONAL RURAL WATER SUPPLY PROGRAMME:

Problems and Prospects

by James M Yarsiah and Oliver B Kulah

INTRODUCTION

In 1974, the Liberian Government launched the first "Well Drilling and Toilet Construction Programme", with assistance from UNDP and UNICEF. This programme was implemented by the Ministry of Internal Affairs. The United State Peace Corps joined the programme in 1975. In 1978, the hand-dug wells and spring catchment components were incorporated to the programme. The programme has since become known as the National Rural Water Programme (NRWP).

In 1980, the programme was transferred from the Ministry of Internal Affairs to the Ministry of Rural Development, in an attempt to bring together the various rural water projects being executed by Government agencies. Currently rural water supply projects involve only 3 - 4 Government agencies, increasing the possibility of an eventual national coordination of rural water supply activities.

During the period 1974 - 1985, over 1,300 waterpoints (spring boxes, hand-dug wells and boreholes), serving about 260,000 rural inhabitants were constructed by both the Government's National Rural Water Programme, NGOs and other private groups. The maintenance of these waterpoints to date has beeen the responsibility of Government. A centralised maintenance programme has proved, however, to have severe limitations. There is, therefore, a need to work towards implementation of a village-level financed operations and maintenance system.

INSTITUTIONAL ARRANGEMENT

The Government of Liberia (GOL) has organised a water policy-making and coordinating body, the National Water Resources and Sanitation Board (NWRSB), it is chaired by the Ministry of Lands, Mines and Energy.

ON-GOING PROJECTS - RURAL WATER SUPPLY

1 - SOUTHEASTERN VILLAGE WATER SUPPLY PROJECT (SVWSP)

This project was launched in 1984 to provide 360 deep boreholes, equipped with handpumps. Using two rotary drilling rigs, over 150 wells have been completed to date.

Problems encountered in this area include aggressive groundwater, rusting of the galvenised iron pipes used for rising and the poor performance of the Danish - manufactured KNEBEL handpump. An extension of the project is being discussed between the Liberian authorities and the co-financiers DANIDA (Danish International Development Agency).

2 - SOUTHEASTERN RURAL WATER PROJECT - (SRWP)

The target in the initial phase of this project, started in 1986 and co-financed by the EEC, is to dig and drill 51 wells. The project has three local contractors and is supervised by the NRWP of the Ministry of Rural Development. The phase 2 proposal for 75 additional wells has been submitted to the EEC. Phase 1 is awaiting the supply of handpumps for completion.

3 - FOUR COUNTRY RURAL WATER PROJECT

This is the first phase of a GOL/EEC Indicative Aid Programme for Liberia. The target of Phase 1 is to provide 250 wells (150 boreholes and 100 dug wells). The results of this phase will determine the naure of subsequent phases.

OPERATION AND MAINTENANCE

The operations and maintenance of the water-points has up till now been carried out by a centralised maintenance scheme, heavilly dependent on Government mechanics and donor resources.

There have been problems with the availability of spares, vehicles and other supplies to carry out this maintenance scheme.

A possible solution to support the increased number of water-points estimated to be around 1300, is to decentralise the operation and maintenance and to introduce user charges sufficient to cover expenses and hope thereby to reduce the Government's subsidy to this component.

The NRWP has therefore embarked upon a long-term plan for the establishment of a village-level financed and managed operations and maintenance scheme.

In addition, the NRWP has embarked on a nation-wide pump inventory, which will establish the location, type and status of all existing water-points, as they were not all executed by one agency.

HEALTH EDUCATION AND COMMUNITY PARTICIPATION

The role of community health education, community mobilisation and community participation cannot be over-emphasized. In the Liberian context, this multiple soft-ware component constitutes by far the most important aspect of any successful rural water supply undertaking. Reasons for this are that, in Liberia, most rural communities are located near a water source (river, lake, pond, stream etc.), but that rainfall is high for only half of the year. During the 6 months dry season water sources are mainly unreliable so that there is an acute water need in rural areas.

The availability of the traditional water sources further poses a problem: the imporved sources (new water-points) appear to be in a stiff competition with the traditional sources in rural areas.

Further, if rural Liberians are expected to pay, in future, for the operations and maintenance of new water-points, it is an absolute necessity that they be educated and made aware of the health benefits of the new water-point. Nothing short of a sustained programme of education and community mobilisation can guarantee a successful rural water supply project.

Based on these observations, concerted efforts to integrate educational component in all rural water schemes are being made. Expatriate and local social workers and health technicians are now developing a plan of action for health education, community involvement and sanitation activities.

HANDPUMPS USAGE IN LIBERIA

Rural water supply projects in Liberia have resulted in the installation of number of different handpumps with the following experience:-

1. ABI (Abidjan Industries) - Ivory Coast

This pump, introduce into the NRWS Programme following its inception in 1974, needed modifications to the original design to cater for Liberian groundwater conditions. The subsequent increase in price unfortuately discourage further purchase and installation.

2. Consallen - United Kingdom

This is the most commonly used pump in Liberia today, but the lack of an appointed local agent means that the availability of spare parts has become an increasing problem.

A limited number of spare parts are obtainable locally but the prices asked are prohibitive. Consequently maintenance of pumps is affected and the incidence of failure increased.

3. Knebel (Denmark)

Installation of this relatively new pump which is really a much modified version of the India MK II commenced in 1984 on a project being implemented through DANIDA funds. To date almost 200 pumps have been installed in boreholes at setting depths in the order of 20 metres. Unfortunately, performance of the pump to date has beeen far from satisfactory and major modifications will be necessary before the pump is suitable for Liberian conditions.

4. KARDIA (Preusage) - West Germany

The Kardia pump was introduced to Liberia less than one year ago and major defects or problems have yet to materialise. Early field performance is impressive but the high capital cost

as well as low local availability of spare parts may be serious constraints that will restrict the pump's future use.

5. The GOL is procuring over 250 pumps of KARDIA and VERGNET, to be installed in one of our EEC sponsored project areas. Close monitoring of these pumps will be carried out over a two year period, and information on their performance will be useful in arriving at a decision on a standard handpump for Liveria.

Of interest is the performance of the modified India Mark II (or India Mark III) in DANIDA - financed trials in Sri Lanka. The use of PVC rising replacing gi pipes, along with stainless steel rods, if found satisfactory, will be of great benefit to the Liberian Programme, faced with low ph and high iron in the groundwater.

PROJECTIONS AND FINANCIAL IMPLICATIONS

It is anticipated, that the rural and total population will have increased to 1,500,000 and 2,600,000, respectively by 1990 and 2,100,000 and 3.500,000, respectively by 2000 (growth rates at 3% and 4% respectively).

The set target for rural water supply is that by 1990 about 35% of the rural population will have been provided with reasonable access to a safe water supply. On the assumption that each water-point serves an average of 200 persons, approximately 1,600 new water-points will have to be constructed during the next five years. During this period the operation and maintenance system will be redirected toward a village level and revenue collecting system governed by MRD.

The set target for the year 2000 is that same 90% of the rual population will have been supplied: assuming an unchanged number of persons served by each water-point, about 6,900 new water-points will have to be constructed during the 10 years, 1990 to 2000, ie 690 each year. This target assumes that a small percentage of the population will continue to receive water supply points through agencies or organisations other than the National Programme.

By the end of the period, the operation and maintenance system should be wholey decentralised and self-contained at the village level under the overall supervision of MRD.

FINANCIAL ASPECTS

Construction

The required expediture for the construction of water-points varies consideralby depending on a number of factors, the most important being:-

i) the type of water-point
ii) the technology applied
iii) the location of water-point
vi) the level of community involvement
v) access to the site

Using the average unit price given in Table 1, the investment and per capita costs needed for the implementation of the development plans have been estimated and are given in Table 2.

Rural Water Supply Technology	Unit Price for Waterpoints in 1985 - US $ Per Capita
Spring System	6.62
Hand-dug Well	20.60
Borehole (PERCUSSION)	27.10

Table 1 - Average unit prices for rural water supply systems

	1985 - 1990 (5 years)		1990 - 2000 (10 Years)	
	Annual	Total	Annual	Total
	US $	US $	US $	US $
Investment Cost	1,441,355	7,206,775	3,190,875	31,908,750

Table 2 - Estimated investment costs for rural water supply programme

Operation and Maintenance

Operation and maintenance, in the past has been financed mainly from Government funds of the general budget for the Rural Water Programme and donors. In the absence of separate recording, operation and maintenance costs presented in Table 3 are based on the provision included in the planned maintenance, health and sanitation activities of Government which at the 1985 US $ value were 200 US $ per water-point or 1.0 US $ per capita.

Operation and Maintenance Costs at 1985 US $ Value	1985	1990	1995	2000
Nos of Waterpoints	1,000	2,000	6,000	9,000
Operation and Maintenance	200,000	520,000	1,210,000	1,900,000

Table 3 - Estimated operation and maintenance costs

It is recognized that these projections are based on the assumption that support for the water programme will continue at its present level. It is also recognized that the ultimate goal of total user finance may be estremely difficult to achieve. However, this must be the aim if investment in the sector is to continue for no government of a developing or even a developed country can subsidise indefinitely and provide free of charge such an important and vital service.

CONCLUSION

On entering the second half of the Water Decade much remains to be done in Liberia in rural water supply. A planned programme for large-scale coverage will be attempted will be based upon a number of factors, including:

1. An on-going programme of consciousness building and increasing awareness of the enormous benifits of rural water supply among beneficiaries. Education, community organisation and participation will be aimed at throughout the project period.

2. A conscious effort to develop a reliable water-point that is low cost and maintainable by users themselves will be made. Village level operations and maintenance is important for long-term durability of water-points.

3. Standardisation of well designs, especially handpumps is a concern of the Programme. We will keep a tone to the development of a VLOM handpump; the pump above all, which has the advantages of easy maintenance, and eventual manufacture in the African or West African environment. This will hopefully ensure easy access to spares.

4. Encouragement for donor and NGO participation will be pursued, with the long-term objective of developing national institutions manned by Liberians themselves, who can sustain the level of activities of the NRWP of Liberia.

PUBLIC HEALTH CONSIDERATIONS OF RURAL WATER SUPPLIES: USE OF SANITARY SURVEYS

by
Paul A. Colbert

Introduction

There have been many water supply projects implemented during the International Drinking Water Supply and Sanitation Decade. Some of these have been combined with sanitation and health programmes to achieve maximum health impact. Evidence on health impact is sketchy, but indicates that combined water, sanitation, and health education projects realize more health benefits. Since health benefits are difficult to quantify, some agencies no longer consider these benefits to justify rural water supply projects. Although many projects are not justified on a health basis, planners, designers, health officials, and engineers should still consider the public health effects of water supplies and sanitation.

Two basic ways to assess the (potential) health impact of a water supply are: a) laboratory analysis of water samples and b) analysis of health records to determine incidence of water related diseases. The former method is used considerably in the 'North' countries and can be expensive, requiring laboratory facilities, chemicals, and trained personnel. The latter method requires analysis of clinical records (if such exist at clinics close to the water supply) and indicate the problem after the fact.

Sanitary Surveys

One way to reduce the incidence of water-related diseases in rural villages is to establish a system of conducting sanitary surveys to identify sources of contamination and to take measures to reduce or prevent further contamination.

A definition shows how the sanitary survey might be used for this purpose:

> A sanitary survey is an inspection by qualified personnel to identify ways in which water-related disease can develop and be transmitted. It is used primarily for identifying the potential for contamination in water supplies at the source, in storage, and in the distribution system. The survey leads to findings which require corrective action. ... (From: A Manual for Sanitary Surveys of Village Water Supply Including Water-Related Hygiene. Master's Thesis by Paul A. Colbert, Chapel Hill, NC, 1985.)

Reasons for use of Sanitary Surveys

With funding shortages by donor agencies and with the poverty experienced in many rural areas, use of sanitary surveys is a first step toward upgrading the water system. The existing village water system can be surveyed and protected more readily and cheaply than installing a new water system. In many villages, priority may be given to having a water supply, but once that need is met, a safe water supply may be low on the list of priorities. The reduced costs of using sanitary surveys and preventing contamination may allow the village to raise the priority of a safe water supply on its list of needs. It should be realized that most corrective action will only reduce contamination and not prevent all future contamination.

Method of conducting a Sanitary Survey

A surveyor is required to conduct the sanitary survey. This person should understand water-related disease transmission and be able to determine how water systems can be contaminated to transmit diseases. Training can be at a simple level; health workers who know about disease can be trained about water supplies and mechanical operations or the mechanics who work with water systems can be trained about disease transmission.

Steps which should be taken for the sanitary survey are:

1) Training of surveyors
2) Assessment of village:
   a) leadership
   b) technical abilities (artisans)
   c) type of system
3) Sanitary Survey
4) Report to leaders and mechanics regarding corrective action. Assist as required.

Possible ways of implementing programmes

Each country, region, or district will have its own unique situation and there is no one way in which this programme should be implemented. The health, water, or community development departments may establish a group of surveyors to conduct sanitary surveys. Ideally, there would be joint collaboration between the departments on the process and findings. The surveyors would be able to visit the villages, perhaps annually, and achieve basic improvements to the water supply (and, perhaps, sanitation and hygienic conditions). The assessment of the type of water supply and its condition can be used by government departments to decide where they can be involved in upgrading the system. Programming for health education and sanitation can also be made.

Another possible way of using sanitary surveys is through rural clinics. As medical workers notice an increase in the incidence of water-related disease from a village, someone from the clinic could visit the village and perform the survey, overseeing the corrective action.

Although teachers are notoriously overworked and underpaid, it may be possible to increase their workload by training them for this work. Since the surveys should only be needed periodically, it should not pose an undue burden on them.

Summary

Sanitary Surveys can identify potential sources of contamination to a village water supply. If the village takes corrective measures, the potential for contamination and, thus, the incidence of water-related disease can be reduced. The methods of conducting the survey can be varied. The corrective actions can be basic and inexpensive. This process can be used as a cheap alternative to more costly laboratory analysis of water or the more costly and time consuming upgrading of the water system, but should only be used as an interim, first step approach to improving public health.

Discussion Paper

An experiment of upgrading a sanitation system

by R.A. Bocarro and C.K.I. Williams

Introduction

Since January 1983, the Overseas Development Administration have funded a project to design, develop and manufacture a low volume flush toilet (LVFT) for use in developing countries. The main details of this project are contained in the paper by Wakelin, Swaffield and Bocarro (ref.1) also to be presented at the 1987 WEDC Conference.

The purpose of this discussion paper is to present a new idea of sanitation upgrading which was first tried out in Maseru, Lesotho. The exercise consisted of converting a ventilated improved double pit (VIDP) latrine (ref.2) to a two compartment septic tank and soakage trench which collects foul waste from a prototype LVFT.

Location of experiment and existing sanitation systems

In Lesotho, a total of 53 LVFTs have been installed in the period August 1985 to August 1986. This work was carried out with the assistance of the Urban Sanitation Improvement Team (USIT) of Maseru, Lesotho. One aspect of the Lesotho project has been to look at the various excreta disposal systems available for the LVFT in Lesotho; such as piped sewers, septic tanks and conservancy tanks.

One of the key projects was in Khubetsoana, a district of Maseru. The majority of houses in the area were low income and had been constructed as part of a self help housing scheme. Services were limited to an outside standpipe shared with other dwellings and each home had a VIDP. The typical cost of the VIDP latrines was about R400 (£121). However, on the same estate, there are 41 high income homes which are supplied with electricity, individual piped water but with no piped foul sewerage. Piped sewerage in this area was not economically feasible. The high income homes were provided with VIDPs and not flush toilets. Since 1983, USIT had been aware that a number of these clients had installed flush toilets with a conservancy tank to collect the foul waste. Conservancy tanks were illegal in Lesotho, as the local water authority only had a limited number of tankers for emptying and a conservancy tank may fill up in only 1-3 weeks.

In Khubetsoana 2 of the 5 clients with existing conservancy tanks were encouraged to replace their conventional 12 litre flush toilets with a 3 litre LVFT. In this way it was hoped that the volume of foul waste generated would be reduced and thus the rate of filling of the conservancy tanks should also decrease.

New design of a 2 compartment septic tank and soakaway

In Khubetsoana, a number of clients were then identified who were interested in a LVFT. It was originally intended that the foul waste for 3 of the 5 clients should be collected in the VIDP. The VIDP would then be converted to a two compartment septic tank with a soakaway. However, a level survey revealed that relevant sites would not permit sufficient falls for running a drain from the WC to the first compartment of the VIDP. Instead a new septic tank was designed according to Pickford (ref.3). The cost of constructing the septic tank, soakaway and WC installation was R1000 (£303).

The two compartment septic tank is shown in Figure 1. The relatively small size of the tank permitted the use of USIT pit latrine cover slabs. The smaller septic tank was possible due to the tank collecting wc waste only. In addition the volume of foul waste generated by the LVFT is considerably less than for a conventional wc (an LVFT uses about 75-100 litres for a family of 5 per day compared to 300-350 for a conventional toilet). In Khubetsoana, the high income housing was provided with a separate soakaway to treat kitchen and bath greywater. A separate soakaway trench was required for the septic tank (as shown in Figure 2). Note that the depth of the trench does not exceed 1m.). Locally, the permeable layer of soil was restricted to a depth of only 1-1.5 metres and below that the soil was impermeable.

Upgrading a VIDP to a 2 compartment septic tank

One of the high income homes proved suitable for carrying out a conversion a VIDP. Figure 3 shows the original VIDP and Figure 4 shows how the VIDP was converted. The cost of the conversion was R600 (£182). This cost included a soakage trench identical to the type shown in Figure 2. The conversion was carried out in August 1986.

Prior to the conversion, only the first compartment of the VIDP had been used and was only 3/4 full. It may be necessary in future conversion to empty the VIDP with a BREVAC or similar tanker before the inlet and outlet pipes can be fitted within the VIDP.

After conversion, the superstructure was retained, in addition to the fibre glass pedestal seat over the latrine slab. This allowed the client to have an alternative privy in the event of a drought when the LVFT could not be used.

Note Figures 1 to 4 will be handed out at the conference.

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LESOTHO'S NATIONAL RURAL SANITATION PROGRAMME: TECHNICAL ASPECTS

by L. Matjama

SUMMARY:

One of the main objectives of the Technical Development and Training Unit during the pilot phase of the National Rural Sanitation Programme was to design low-cost pit latrines which would be suited to the cultural, social, and cultural conditions in rural parts of Lesotho. Emphasis was placed on acceptability, ease of maintenance and minimum environmental pollution.

In order to fulfil these objectives, the technical inputs should enhance such inputs as:-

- Arrangement for the construction of protypes of various designs, in order to enable the project beneficiaries to express preference and to ascertain their suitability and cost.
- Exploration of and testing of different methods od undertaking construction, including:
  - Self-help with nominal assistance
  - Self-help with appreciable assistance
  - Through assistance to local builders, by imparting latrine construction training courses.
  - Through on-going development programmes
- To provide technical advice, training and support to other rural development programmes which have funding for rural sanitation.
- To train local builders and extension workers in VIP latrine construction methods.

BACKGROUND

The pilot phase of the Rural Sanitation project was started in late 1983, with the arrival of the international staff, and ended in December, 1986. It was stated that during the pilot phase of three years, 400 latrines should be constructed by both trained local builders and the technical team. The pilot phase of project was financed by UNDP, UNICEF, USAID, Government of Lesotho and executed by World Bank.

It was agreed that the ventilated improved pit latrine, or V.I.P. was the most suitable type of latrine for Rural Lesotho, as was already adopted in other countries of Southern and Eastern Africa Regions.

There are basically two types of latrine currently adopted in Lesotho Rural Sanitation Programme, namely, the single VIP latrine, and the double pit or alternative pit latrine. The basic pit covers are made of reinforced concrete slabs. There is a ventilation pipe and the latrine shelter that can be made out of different locally available materials, these include:-

- Corrugated iron sheets and timber,
- Stones with corrugated iron roofing,
- Mud blocks with corrugated iron roofing,
- Hessian/chicken mesh wire on timber frameworks rough casted with mortar,
- Mud and wattle,
- Cement and sand building blocks,
- Burnt clay bricks.

The choice of building materials is left to the home owner, with advice from project staff, according to financial affordability. The project is composed of three components, or sections. The management component, Socio-cultural component, which deals with monitoring and evaluation of the programmes implementation activities, the Health education component, all which are based within the Ministry of Health, and lastly the technical component, which is based in Ministry of Interior, Chieftainship Affairs and Rural Development, under Village Water Supply section. Thus we can see that the design of the programme is to ensure that both water supply and sanitation programmes work closely together.

The pilot project was evaluated in December 1986 and it was observed that it had succeeded very well in achieving most of its objectives with more than 650 latrines constructed. Hence, in January this year, the Government of the Kingdom of Lesotho declared the launching of the country-wide National Rural Sanitation Programme. At present, four out of ten districts are being covered. The three districts in the North being financed by British Government. More districts are hoped to be covered before the end of this year, with financial support from international organisations and Governments.

LOCAL LATRINE BUILDERS TRAINING PROGRAMME

Main focus:- Transfer of VIP latrine construction technology from Government expert team to local village artisans, so as to make it as simple and as accessible as possible to the villager.

Model two-week training courses have been developed during the past three years of the RSP pilot phase.

Participation:- about 20 selected village builders

Selection:- A village gathering called "pitso" is called two weeks before start of course, and villagers (builders and Village Health Workers) are encouraged to enroll for the training course. The villagers are briefly informed about the importance of constructing VIP latrines for their families. The chief being the central figure of administration in the village, is the one who really encourages and enrols the builders, with the help of village development councils. The final selection of the suitable builders is done by the project technical team a week before the starting of the training course.

COURSE SYLLABUS

Mornings during the first week are normally committed to theoretical classroom lectures, with more practicals concentrated to the second week. Trainees are actually involved in pit digging and latrine construction, with technical supervision from the Government technical assistants.

Normally four to five demonstration latrines are constructed, with at least one Double Pit latrine. These are constructed at vital community centres, like the local court, the chief's place, the clinic, and at the home of one of the village Health Workers, or at the home of some prominent or exceptionally needy people in village development.

END OF COURSE

Certificates of participation are issued to trainees, and are endorsed by District Sanitation Coordinator, District Medical Officer, District Secretary.

But before receiving certificates, trainees are required to sign "latrine construction contracts which basically binds the trainees that they should be faithful in their costs of construction of latrines for the fellow villagers at certain construction rates stipulated by the project authorities. This is a measure to ensure that latrines are constructed at a cost as low as possible, while keeping in mind that the builders should also get a reasonable pay in exchange for their services. The validity of the contracts remain in the hands of the chief and the village development council.

There is a follow-up technical supervision, for at least 6 months, in each area of programme, immediately following the training, to make sure that trainees improve their quality of construction..

Certain construction materials which are not available locally are sold the homeowners by the project, so as to speed up construction (these include:- reinforcing steel rods, vent pipes + flyscreen).

Step-by-step builders manuals are issued to every builder in the village, after the course, plus other Health education materials.

OTHER SANITATION RELATED PROGRAMMES

- Lesotho Urban Sanitation Improvement Team (USIT), which deals with low cost sanitation in urban and peri-urban areas. There is very close collaboration between USIT and the Rural Sanitation Programme. Similar latrine designs and a standard set of basic components are used by these programmes.

- CARE LESOTHO

- UNICEF-funded Basotho women in Development Programme, and others.

FUTURE EXPANSION

The approach by RSP is to establish district by district programmes which are run by district teams, which are answerable to the central National Rural Sanitation team. Means are being developed to provide loans to some financially weak sections of the Rural Communities to enable them to afford latrine construction.

PROBLEMS AREAS

Although considerable progress has been achieved in promoting latrine construction in the country, there still remain problems to be sorted out. In most of the areas of activities, only about 25% to 75% of the trained latrine builders are active. Hence, it would be of benefit to us if the participants of this conference could provide us with some new ideas of ensuring 100% participation of trained latrine builders, towards construction of more latrines, in order to achieve 90% coverage of latrines in Rural Lesotho, by the year 2,000.

BRIEFING NOTES:

RURAL SANITATION PILOT PROJECT AND NATIONAL RURAL SANITATION PROGRAMME IN THE KINGDOM OF LESOTHO

Background:

The conceptualization of Rural Sanitation Programme in Lesotho stems from assessments during the past decade of Lesotho's village water supply and rural health care programmes. Among other findings, these assessments indicated that improving a water supply alone has negligible impact on rural community health status. An integrative approach is now recommended which will provide concurrent and balanced improvements to water supplies, sanitation, and personal/community hygien in order to improve rural health conditions. The Rural Sanitation Pilot Project (RSP) was conceived as the first phase of a national rural sanitation programme which would adopt this integrative approach.

Implementation of the RSP began in October, 1983 with support from the United Nations Development Programme (UNDP), United Nations Children's Fund (UNICEF), and the United States Agency for International Development (USAID). Execution of the external assistance for the Project has been undertaken by the Technology Advisory Group of the World Bank (TAG). As a pilot project, the objectives of the RSP have been:-
To determine the form and inputs required for an integrative national rural sanitation programme.
To develop a national capacity to plan, implement and monitor/evaluate the national programme.
In the long term, to achieve a sustained improvement to rural health status.

The RSP has been implemented through two Ministries by the Government of Lesotho, the Ministry of Health (MOH) and the Ministry of Interior, Chieftainship Affairs, and Rural Development (MOI). MOH is the lead Ministry and is responsible for project administration, health education, promotion, non-technical training, monitoring and evaluation. These responsibilities are executed by the Environmental Health Section of MOH. MOI, through the Village Water Supply Section, is undertaking technical research and development and technical training. This inter-ministerial arrangement is expected to continue for the foreseeable future.

The RSP terminated at the end of 1986 and the National Rural Sanitation Programme (NRSP), adopting the strategy developed during the pilot phase, was launched by the Government of Lesotho concurrently.

Strategy:

The strategy for the NRSP, taking into consideration existing constraints on Government spending seeks to:
minimize the need for an expanded GOL establishment or physical infrastructure to support the programme;
maximize the active participation of the private sector and beneficiary groups in planning, management and implementation of the programme.
A decentralized approach has been adopted which uses the district as the focal point for programme implementation.

The Ventilated Improved Pit Latrine (VIP) has been selected as the technology of choice for the programme. The VIP is a simple, relatively low-cost improvement of a traditional pit latrine. Its main distinguishing features are a strong foundation, secure concrete slabs for flooring, seat and pit cover, and a screened ventilation pipe which extends at least ½ meter above the latrine. The vent pipe draws foul air out of the pit, keeping the latrine smelling fresh and preventing flies from entering the latrine or pit. In collaboration with the Urban Sanitation Improvement Team (USIT), the RSP developed a standard design and kit of components for Lesotho VIPs. Rural households are encouraged to build VIPs based on these kits using locally available materials wherever possible to keep costs low.

Behavioral change with regard to personal and community hygiene habits is considered to be perhaps the most important objective of the national programme with regard to health impact. Hence, a strong and comprehensive health education and social marketing package is envisaged for the Programme.

At the district level, District Sanitation Teams (DSTs) will be formed comprising One District Sanitation Coordinator (Senior Health Assistant) and two to four Health Assistants, all from EHS - MOH, and four Technical Assistants from VWSS - MOI. In close collaboration with other primary health care and village water supply activities, the DST will develop a plan of action t

increase effective demand for VIP latrines, ensure that skills for constructing VIPs are present in rural communities, and encourage improved personal and community hygiene habits. The team will conduct courses for local artisans, Village Health Workers and other interested individuals in VIP latrine construction. Successful trainees will then be expected to build latrines on a commercial basis in their home communities. A variety of training, community mobilization and promotional techniques will be used by the DST before, during and after these courses to increase demand for VIPs and to ensure their effective use and maintenance.

Rural households are expected to pay the full cost of VIP latrine construction. Hence, minimizing these costs is an important concern of National Programme planners and implementors. With regard to labor, an attempt is made to balance profitability with affordability through written agreements between trained builders and their communities which indicate ceiling prices to be charged for labor inputs. Households are encouraged to use for VIP construction materials which are available locally at little or no cost, such as stone or mud blocks, and to undertake some or all of the construction themselves, if they have sufficient skill.

In order to assist lower income groups who may have difficulty in affording a VIP, methods for providing loans are being developed. After testing and evaluation of their effectiveness and manageability, these credit schemes may be incorporated into district programmes.

At the national level a rural sanitation team will be maintained in order to assist with the establishment of DSTs and coordinate the implementation of district programmes. This national team will train DST staff, mobilize resources for district programmes. regularly monitor and evaluate national and district programme progress, develop and produce project support communications inputs for the DSTs, and ensure that all district programmes are implementing consistent and effective policies.

Achievements to Date:

During the pilot phase the RSP was active in six sites in Mohale's Hoek District. Over 700 VIPs have been built, and over 140 rural latrine builders trained during the three-year period. A plan of action for monitoring and evaluation of the National Programme has been developed and is now undergoing testing, as well as a strategy for health education and social marketing of the Programme.

During the final year of the pilot phase a district-wide rural sanitation programme was stated in Mohale's Hoek, and staff placed for the DST. Two additional district programmes are now being established in Leribe and Butha Buthe Districts with support from the Overseas Development Administration of the United Kingdom. Also, a detailed section on the National Rural Sanitation Programme has been included in the Draft Fourth Five Year Development Plan for Lesotho.

Targets and Plans for the Next Five Years and Beyond:

A target of 70,000 VIPs for rural households has been proposed for the fourth national development period. In order to achieve this target, district programmes will need to be initiated in all ten districts by 1990. As was stated above, three district programmes have already been established. Donor support for a fourth district, Mokhotlong, has also been assured. When fully under way, each district programme will require at least 200 active VIP latrine builders who will complete at least 40-50 VIPs per district each week.

In the longer term, it is expected that 90% of rural households will have VIP latrines by 1999. Achieving this coverage will require the construction of 275,000 VIPs through the district programmes. It is also expected that the latrine construction effort will occur concurrently with water supply improvement and positive behavioral changes with regard to personal and community hygiene.

To reach these targets an intensive and well coordinated effort will be required from Government personnel at both the district and national levels, as well as private sector individuals and organizations. Health education and social marketing will form a critical element of the programme in order to increase demand for improved sanitation, and to induce improved hygiene practices. A regularly implemented and well designed monitoring and evaluation component will be required which provides useful, sufficiently detailed and timely information on programme implementation and impact. This will allow for regular and rapid modification of programme design and implementation in order to enhance its effectiveness.

RURAL SANITATION IN MOZAMBIQUE - SEARCHING FOR THE CORRECT APPROACH

by Mike Muller and Paulo Oscar Monteiro

Background

In response to the need for an improved technical solution to the problem of low-cost sanitation in the periphery of Mozambican cities, the National Institute for Physical Planning initiated a programme to develop an appropriate technology. The result, a simple unreinforced concrete slab, has been demonstrated to be successful.

A National Programme has established production of slabs in Maputo and 5 other Mozambican cities. Production is organised on a community basis with small cooperatives producing locally. 30 000 slabs have been sold since the Programme began and current production is over 1000 slabs per month.

The Programme relies on a high degree of community participation both in the organisation of the workshops and in the promotion of the use of the latrines. Local currency running costs are met by the proceeds from the sale of the latrines. The most important measure of the success of the Programme is that demand for the improved latrine slab outstrips supply.

The Rural Dimension

The improved latrines programme in Mozambique at the moment functions exclusively in the peri-urban areas of six (shortly to be increased to 8) cities. So what are the perspectives for the rural areas ?

Sometimes, visitors can provide a useful point of reference. Thus, a donor agency consultant who recently visited Mozambique reported:-

> "There is no national department specifically charged with responsibility for sanitation in rural areas."

Were that to be true, it would be clear that some major institutional problems would have to be resolved before even venturing into the field. Fortunately it is not, as the same source acknowledged, albeit in a somewhat elliptical form:-

> "It is traditional that when a family builds their traditional hut, they also build some kind of latrine. As such, it should not be difficult to implement a programme of appropriate latrine construction," he wrote in his report.

It is true that there is a tradition of latrine building in Mozambique. As we show in the figures appended, in Mozambican villages, the majority of households have latrines. According to the WHO's data, Mozambique has twice as many latrines in the rural areas as the African average. The point is however that the tradition is of very recent origin, the result of intensive sanitation campaigns promoted by the Ministry of Health and by the whole local government and Party apparatus, immediately after independence. The consultant's confusion arose because the Ministry of Health's Environmental Health Unit promotes rather than constructs latrines.

Questions To Be Answered

Given that the Ministry of Health is promoting latrine construction using local resources, what role is there for a construction programme like ours ? We are reluctant to extend our activities to the rural areas before our potential contribution has been clarified. The questions as we see them are:-

- where there are no latrines is this because of failures in the promotional campaign or because of specific technical, social or economic problems ?
- where there are latrines, are they in fact used, by all or even any of the family ?
- is there a need for technical assistance from outside the community to enable latines to be built ?

Even if there is a technical need, we still need to establish the potential benefits of an externally based latrine construction programme. While there may be health benefits (though these depend more on the change of behaviour than on the latrine technology itself) there are few of the time-saving/production related benefits which help to justify rural water supply investments. It is also more difficult to mobilise people for whom improved sanitation is not as important as improved water supplies.

(In parenthesis we should note that one critical issue to be taken into account is the real nature of our rural communities. The depredations of the armed bandits have created great instability and it is necessary to distinguish between temporary settlements, effectively of refugees, and permanent, viable rural communities.)

Priorities

Against this background, what are our priorities ?

- we need to confirm through surveys that our impression of a relatively good coverage of latrines in the permanent rural settlements is in fact correct;
- at the same time we need to determine the reasons for failure to build latrines or to use those that exist;
- in the event that technical problems are either preventing latrine construction or discouraging usage there may be a case for a latrine construction programme although this should use locally available materials wherever possible.

What must be avoided is on the one hand an 'enforced' campaign which obliges people to build latrines and on the other, 'give away' programmes which provide one or other type of improved latrine effectively free of charge. Our impression is that neither compulsion nor handouts achieve the fundamental objective which is to change peoples' behaviour. It is that behavioural change rather than any technical improvements in latrine construction that must be our priority.

RURAL SANITATION IN MOZAMBIQUE - APPENDIX

1. AFRICA - SANITATION COVERAGE - RURAL POPULATION

	1980	1983
AFRICA	20%	18%

(Source: Progress in the Attainment of the Goals of the International Drinking Water Supply and Sanitation Decade - Report of the Secretary General, UN General Assembly Economic and Social Council, A/40/108, E/1985/49, 6th March 1985)

2. MOZAMBIQUE - RURAL LATRINE COVERAGE

(1980 Census)	(%)
NIASSA	62
CABO DELGADO	49
NAMPULA	
ZAMBESIA	48
TETE	45
MANICA	29
SOFALA	18
INHAMBANE	59
GAZA	45
MAPUTO	43
NATIONAL	43.4

3. LATRINE COVERAGE - CABO DELGADO PROVINCE

(33 Village Survey 1982/3)

54% Average

(Maximum - 90%, Minimum 6%)

DISCUSSION PAPER

TOWARDS TOTAL COMMUNITY PARTICIPATION IN RURAL WATER SUPPLY PROJECTS IN ZAMBIA

by Peter Chola

NATIONAL POLICY

The general water supply policy in Zambia ensures the provision of permanent supplies of water of acceptable quality and quantity for the benefit of the target communities. In this respect, the Local Administration Act (1980) and Water Act (1964) spell clearly the responsibilities, powers and obligations of the sector institutes while the latter deals with ownership, control and use of water. The main policy framework for planning, implementation, operation and maintenance of drinking water supply and sanitation facilities in the country is provided for in the Local Administration Act. This calls for community involvement in all stages of the water supply and sanitation projects.

PLANNING

1. Within district council boundaries, the council has the statutory duties of planning and providing safe water supply and sanitation using its funds and necessary technical manpower, where technical personnel is lacking the Department of Water Affairs may be requested to execute the council's jobs.

2. In rural areas, planning for water supply is done in consultation with the intended beneficiary community. The political and administrative institutions are very much involved in the early stages of project planning and village consultative meetings come later.

CONSTRUCTION, OPERATION AND MAINTENANCE

1. In large urban areas and townships, councils are responsible for the construction, operation and maintenance of water supplies. The communities they serve contribute towards these tasks through payment of water charges. The water tariff policy is such that the consumers are responsible for meeting all or part of the cost of the provision of water supply and sanitation services.

2. In rural areas most projects employ local people who are paid daily fixed wages during the construction stages of the projects. However, after the completion of the projects, say installation of handpumps at a new well, the villagers are left with the responsibilities of looking after their water supply. Under the World Bank and NORAD funded rural water supply projects currently under execution, the villagers form a water committee which mainly consists of women and headed by such local leaders as school teacher, headman, woman political leader or a village clinical officer. This committee's functions among other things is to collect money for minor repairs of their water supply, keep the well surrounding clean and organise transport for a messenger to report to the Department of Water Affairs, the donor's executing agent, in case a major breakdown of their water supply for repairs.

In the pilot piped water supply schemes in Kabwe Rural under study by IRC and St. Joseph Primary School in Ndola Rural monitored by Water Affairs Department, the water committees of these respective schemes are doing well in the operation and maintenance of their supplies. They collect water revenue, issue receipts and bank the money in commercial banks. A treasurer is appointed to look after such matters and he keeps good records. The money collected is used for payments of electricity and minor maintenance and repair charges.

REALISATION OF COMMUNITY PROJECTS IN ZAMBIA?

There has now come a general awareness among all Zambians that the days of "free services" are over. For example, the casual workers engaged in the World Bank Rural Water Supply Projects (Construction of Wells), volunteer to do maintenance works on the well after the well has been handed over to the village water committee. The same people are even hired by less fortunate villages in the area to construct wells for them if their village wasn't included in the World Bank Programme. With this new development it is hoped that future well construction projects will be initiated by the local people themselves and the Department of Water Affairs to come in later for technical and material assistance at the people's request. The materials the rural communities need are cement, pre-cast concrete liners, windlasses and handpumps.

To increase participation and community responsibility the project executing agents have to:

(i) educate people the need of project maintenance and operation - health aspects;

(ii) educate them to use local skills and materials;

(iii) be prepared to learn the people's way of life and not to antagonize their culture.

SELF-HELP RURAL GRAVITY PIPED WATER PROJECTS IN MALAWI

by Ministry of Works and Supplies, Malawi

1. INTRODUCTION

There are now 55 Rural Gravity Piped Water Projects in Malawi serving a Rural Population of nearly 1,200,000 people; and there are a total number of 8,100 village taps which people themselves have installed by laying 5,700 Km of piping. The total cost has been K6,444,200.00, that is an average of K805.00 per tap unit. Another Rural Gravity Piped Water Project (Mpira/Balaka Water Project) which will cover a population of 234,000 people has been started and is expected to be complete in four (4) year's time.

2. PLANNING

The planning of Rural Gravity Piped Water Projects is carried out by the Department of Water in the Ministry of Works and Supplies. The Community play a significant role in the planning by identifying streams/springs for possible gravity piped water projects in their areas. These requests are channelled through the area action groups to the District Development Committee. The District Development Committee (DDC) sends the applications for survey of possible water project to the Water Department. Some of the requests are presented to the Department by members of Parliament during Parliament proceedings. The Department also identifies Catchments for Potential Water Projects and in addition to the requests from the DDC's and members of Parliaments, the Department prepares national plans for Rural Water Supply Projects.

Preliminary designs are carried out before the donor agencies are identified. The design criteria are 36 lit/capita/day for the projected population; each tap is allocated to serve 120 people and maximum distance between taps being 1 Km.

3. FINANCING PROVISION

Most of the Rural Gravity Piped Water Projects are funded by Donor Agencies for purchase of commodities, motor vehicles for transportation of materials and operating costs during constructions. The Government and the Community contribute overhead costs and self-help labour respectively.

4. PROJECTS LEADERSHIP AND ORGANISATION OF WORK

The key to the success of Rural Gravity Piped Water Projects in Malawi is the involvement of the whole community and the setting up of an organisation which can handle the large amount of work which has to be done and to ensure that everyone does his share. On identification of funds, a public meeting is held to announce the project at which all the leaders are present: members of Parliament , Chiefs and Party Leaders. This meeting will ascertain that the people want the project and are willing to work for it. The meeting then appoints a project committee to organise the work.

The Committee has the authority of the Chiefs, all the Leaders and the people. It is therefore able to control the work which has to be done and is able to overcome any problems which may arise. It is important that these Committees are not appointed by the Government but that they derive their authority from the people, Chiefs and Leaders.

Under the main committee, in a large project, there will be a number of section committees which will be responsible for different sections of the pipelines. Finally, there will be a village tap committee in each village. This committee will have a number of women and will be responsible for the cleanliness of the tap surroundings and for the maintenance of the tap which includes replacement of the washer, replacement of bibcock when broken and repair of concrete apron when it cracks.

5. MAINTENANCE

The maintenance of the Rural Gravity Piped Water Projects has been developed from long experience since the first project was installed in 1969.

On commissioning of the newly constructed project, meetings are held to explain to the community their role in the maintenance of the project. This includes money contribution for the payment of a caretaker for the intake, nomination of repair teams for repairing broken pipes, cleaning

of storage tanks and clearing tank surroundings, reridging of pipelines every year and planting of special grass to mark the pipelines. The money which is contributed by the community is wholly controlled by the committee who either save it in the bank or save it with the area action group.

The Government sets aside a revolving fund for the purchase of taps (bibcocks) and sell to the community on request at tax free. The pipes for repairs are given free and normally these are the remainder after the construction of the project(3% to 10% provision for repairs is made in the initial estimate for purchase of pipes for each project).

After the completion of the construction of the project, the number of Government field staff (Monitoring Assistant) is assigned to monitor a section covering about 30,000 people with manageable distance to be covered by pushing bicycle.

The duties of the monitoring assistant include:-
(i) training repair teams how to mend the pipes;
(ii) get the records from the repair teams after they have repaired pipes;
(iii) monitor the functioning of all project committees;
(iv) monitor the functioning of the project and fill in forms which are then sent to the Engineers for action.

6. POINTS FOR DISCUSSION

It is now well accepted that Rural Gravity Piped Water Projects have become very successful in Malawi and this has been achieved mainly due to the involvement of the community in all stages of planning, construction and maintenance.

It is now felt that as the projects age, more funds will be required for repairing of intakes, replacement of steel pipes which get excessively corroded after long use and other rehabilitations necessary. With large expansions of these water projects, the Government may not always find money to cope with the maintenance or rehabilitation. The question is whether the community should contribute more than what they are already contributing. What system of contribution and control of funds should be developed without affecting the self-help spirit which is already very high.

RURAL WATER SUPPLY IN MOZAMBIQUE

by Luis Elias, PRONAR, Mozambique

1. Organisational framework:

The implementation of rural water supply programmes is, in Mozambique, a task of the Provincial Governments, the provincial Directorates for Construction and Water (DPCA).

Within the structure of the DPCA's a number of so called "Sanitary Workshops" have been or are being established. These parastatal organisations are in charge of shallow well construction, handpump installation and repair and assistance with operation and maintenance of small piped systems. The planning, control and financement of their work is a task of the DPCA itself. The state-owned drilling company Geomoc is in charge of borehole drilling. At central level in Mozambique the rural water supply programme is coordinated by the "National Rural Water Supply Programme Cabinet" (PRONAR), within the structure of the National Directorate for Water (DNA) and therefore the Ministry of Construction and Water (MCA). The Mozambican rural water supply is supported by about 15 foreign organisations providing technical assistance, equipment and material supply for about 30 projects.

2. Technologies applied:

For about 70-80% of the Mozambican rural population shallow wells may serve as a reliable water source. If maintenance and repair can be guaranteed, handpumps are installed; if not, a bucket, rope and pulley system is installed or no provisions are made.

If geohydrological conditions are not favourable for shallow well construction, boreholes are drilled and equipped with handpumps. Piped water schemes are maintained operationable or are constructed for district capitals and other important rural centers and where neither boreholes nor shallow wells provide a reliable water source.

Policy is to standardize on India Mark II (chain-link) handpumps for boreholes. They are locally manufactured. A suitable type of handpump for shallow wells, that can be locally manufactured, is still looked for. As a pilot project on a strong participation of the community in the planning, construction and maintenance phase was quite a success, it is therefore now extended to other provinces. Special attention is also payed to hygiene linked with water. This community participation and education component is implemented in close cooperation with other entities and organisations, like the Ministry of Health, the Mozambicans Women's Organisation, etc.

3. Some figures:

About 80-85% of Mozambican population, i.e. about 11-12 million, lives in the rural areas. Policy is to have one safe water source for each 500 consumers (100 families) within a distance of about 500 m. In certain cases 1000 m however has to be accepted.

From 1980 to 1986 about 1700 wells and boreholes were constructed, the number of people served increased from about 150,000 to about one million. In the same period the number of people served,as a percentage of the total rural population, increased from 5.7% tol2.9%.

THE PROJECT OF RURAL WATER SUPPLY IN THE PROVINCE CABO DELGADO/MOZAMBIQUE

The province Cabo Delgado is situated in the northeast of Mozambique. The province borders Tanzania to the north and the Indian Ocean to the east. The land area is 82,625 Km^2 and the estimated population in 1987 is 1.07 million inhabitants. 4.6% of them are living in urban areas and 95.4% in the country: 200,000 people of this rural population are living on the plateau of Mueda, which is supplied with a piped water system.

The project of rural water supply in Cabo Delgado started in 1981, with the objective to provide one safe water-source for 100 families (500 inhabitants). This programme was based on the construction of shallow wells with prefabricated concrete rings or boreholes (with drilling machine or hand-drilling equipment). At the beginning of the project, hand pumps were installed on the wells, but later, because of difficulties in operation and maintenance, an easier technology was used, i.e. the installation of a rope and bucket system. Meanwhile the process of finding a more appropriate handpump was going on. For depths of 10 m and more a solution seems to have been found with the handpump India Mark II, which since 1985 has also been produced in Mozambique.

Until the end of 1986 the project constructed 716 water sources in the province. The Swiss government financed, through the non-governmental organisation HELVETAS, foreign exchange costs, technical assistance, imported materials and equipment worth about 3 million US $ until the end of 1986. In the same period, the Mozambican government contributed 83.45 million of Meticais, about 2.1 million US $, for salaries and the purchasing of local materials. That means, that the average costs of a constructed and maintained water source were about 7122 US $, which benefits on average about 500 people.

In the year 1984 the project introduced a very important new component, the community participation and education programme. It had already been seen that many water sources were damaged or misused by the villagers, as they thought that the water would be bad, not being used to this type of water supply. Through this new programme of participation and decision making before and during the construction work, the villagers gained a new consciousness for a good operation and maintenance of the water source.

URBAN LINKAGE TO RURAL SANITATION DEVELOPMENT - DISCUSSION PAPER

by B.Brandberg, Sanitation Adviser

Background

The Water Department, Ministry of Works and Supplies together with Technical Advisory Group (TAG) of the World Bank is undertaking an Urban Low Cost Sanitation Demonstration Project (INT/81/047) aiming at demonstration of appropriate sanitation systems for planned and unplanned urban low cost housing areas.

The Housing Situation

The urban areas, which are served with low cost sanitation include planned and unplanned areas of both high and low density. Income and form of tenancy varies from place to place. The outer urban fringe areas are actually no different than rural areas.

Technology

Considering the wide spectrum of physical, legal, social and economic housing conditions prevailing in the concerned areas, a range of technical options for low cost sanitation have been developed, starting from a simple sanitation platform (San-Plat) up to upgradable ventilated septic latrines. The cost is from K3.00 up to some hundred kwacha depending on technical standard and number of users.

Sanitation Centres

As part of the demonstration activities a proposal for the delivery system is presently under development and field testing. The proposal is based on the existence of local sanitation centres (San Centres). Four such centres are so far in operation, one in each of Lilongwe, Blantyre, Mzuzu and Zomba.

The function of the San Centres is principally to provide sanitation services to the neighbouring population by the sale of prefabricated sanitation components (i.e. San-Plats and screened vent pipes) on a cost recovery basis. The San-Centre is also a place for training of project staff, local contractors and self help builders. Various types of demonstration latrines are being demonstrated at the centre.

Linkage to Rural Sanitation

In connection with the DANIDA funded Karonga Lakeshore Integrated Water Supply Project a delegation with participants from Ministry of Health, Ministry of Community Services and Ministry of Works and Supplies surveyed and analysed the situation of rural sanitation in the Karonga Lakeshore Area.

In connection with the GTZ funded project in Liwonde, 600 new or existing traditional latrines have been improved using San-Plats and another 400 are under way. Total 1,000 improved latrines in less than one year.

It was concluded that the prevailing situation in many aspects was similar to the situation in the peri urban areas, and that an integrated approach could be used to improve both peri urban and rural sanitation.

Three Steps for Improvement'

The principal objective of improving sanitary conditions is to safeguard hygienic conditions as a base for health improvements. Other aspects are user acceptability and improved sanitation economy. These objectives are principally to be met through:-

1. Introduction of well designed slabs
2. Introduction of vent pipes
3. Introduction of long lasting pits.

The San-Plat (Step 1)

The most cost effective way to improve hygienic conditions for new or existing latrines is to

install a San-Plat (price at San Centre K2.95). With no or small extra costs a San-Plat can easily be installed by any self help builder. The San-Plat will give:-

- Better hygienic conditions
- Reduction of smell
- Control of fly circulation
- Improved hygiene
- Child safety

The San-Plat is illustrated in the pamphlet "San-Plat" and presented more closely in the paper "Some Whys and Hows".

VIP Latrines (Step 2)

Ventilation of the latrine pit is today a well known way to eliminate bad odours and flies from the latrine. Large scale construction of ventilated improved latrines (VIP Latrine) implies, however, technical and economic implications, which may require relatively strong institutional support and probably also considerable subsidies, if the programme shall reach out to the majorityof the rural polulation.

Long Lasting Pits (Step 3)

One well known reason for not investing in a better latrine is the often limited expected life time. The latrine is generally seen as a temporary structure due to fill up, and be replaced at regular basis.

Introduction of vent pipes will exclude the need of putting ashes into the latrine pit, for smell and fly control, hence prolonging the life time of the pit. Large volume pits eventually lined with local building materials might therefore extend the expected life time of the pit up to over 30 years.

Such improvements will make investments in hygienic permanent building materials more attractive for the owner.

Implementation Strategy

Priority has so far been given to urban sanitation. The reason for this is principally that the danger of inappropriate sanitation generally is higher in areas where more people live and where the population density is higher.

Another reason is that development in urban centres do have spin off effects in rural areas. Most urban inhabitants have their "home village" and are more likely to transfer inventions from their urban environment to the rural areas than opposite. Consequently, relatively small investments in urban areas (the centre) could have great promotional impact in large rural areas (the periphery).

Peripheral San Centres

In connection with the Karonga Integrated Lakeshore Project, the establishment of peripheral San Centres has been discussed. A local San-Centre can be established in the township (Boma) of Karonga which could serve the "urban" population of the Boma, following the same principles as other San Centres, with sales to the public, demonstration, training etc. The Karonga Boma San Centres could be monitored from the Lunyangwa San Centre in Mzuzu and could also supervise more peripheral San Centres in i.e. Kapungu, Ngula, Chilumba etc.

Demonstration latrines

For the purpose of education and information to the public demonstration latrines can be built at public places like:-

- San Centres
- Schools and Educational Centres
- Health Posts and Clinics
- Churches
- Market places etc.

Promotion and Subsidies

Experience from successful rural sanitation programmes (i.e. in Zimbabwe) shows that promotion and incentives are necessary requirements to motivate the population in a programme aiming at large scale implementation and good coverage. This will require the involvement of institutions with strong executive capacity in the concerned areas and a committed involvement of one or more donor organisations.

Institutionalization

Considering the necessary executive power in the field, the involvement of the right institutions is essential for the success of the programme. The personal opinion of the Sanitation Adviser is that a multisectoral approach involving i.e. Office of the President and Cabinet, Ministry of Health, Ministry of Agriculture, Ministry of Local Government, Ministry of Works and Supplies and Ministry of Community Services could be necessary.

The role of each institution could vary from location to location depending on conditions and needs.

For the coordination of the programme a steering committee should be formed, with representatives from the involved institutions.

Training

As mentioned earlier training of project personnel can be executed through existing San Centres under the guidance and supervision of the Sanitation Adviser provided that funding, time and necessary clearances etc are available.

Special attention must be given to the motivation and training of extension workers and promoters.

Nation wide coverage

The principles outlined in the paper for peri urban areas and the Karonga Lakeshore area could with adaptations be used for other areas as well.

The objective is consequently to achieve nation wide coverage of improved sanitation.

NOTE: This discussion paper presents the opinion of the author, which does not necessarily reflect the official position of the Government of Malawi nor of the World Bank.

REMUNERATION FOR COMMUNITY WORKS

by D.R.G. Morris and R.B.M. Hunink
ILO Regional Office for Africa

1. Background

1.1 The ILO helps developing countries to generate employment and to improve living conditions in rural areas through the creation and the subsequent use and maintenance of productive, economic or social infrastructure by means of Special Public Works Programmes (SPWPs). Ideally, these are multi-sectoral aggregations of labour-intensive, community-based projects and thus may encompass all types of rural works: feeder roads, village infrastructure, water supply, sanitation, self-help housing, small-scale irrigation, soil conservation, land reclamation and even afforestation. For the purposes of this note, the works done fall into three categories.

1.2 Public works are those in which the workers do not necessarily benefit from the assets created and are remunerated in full for their work, e.g. the construction of an irrigation scheme by labourers who will not have any irrigated land. In such cases, remuneration (which may be up to 50 per cent in kind) should at least be equal to the opportunity cost or the market price of labour, whichever is the higher. Thus, if a public works project fails to attract labour, it is almost certainly because the wages are too low.

1.2.1 Individual/Household works are those in which people work essentially for their own benefit, e.g. building themselves houses or pit latrines. In such cases, technical assistance is usually necessary and material assistance may be justified in some circumstances but there should be no remuneration, i.e. self-help labour.

1.2.2 Community works are those in which the workers are members of a community which will benefit directly from the creation of communal assets, e.g. villagers providing unskilled labour and locally available materials for the construction of village schools, clinics or water supply schemes. In such cases, both technical and material assistance are usually necessary but remuneration (which may be 100 per cent in kind) can range from zero to full remuneration. Failure to determine the appropriate level and form of remuneration is a common source of problems for community works projects.

2. Purpose

The purpose of this discussion note is to highlight some of the key factors affecting remuneration for community works and to illustrate specific aspects with a case study from Uganda.

3. Key factors affecting remuneration for community works

3.1 People are motivated to work on community development projects in several ways, notably by
- their perception of the benefits accruing from the projects;
- social, religious or traditional obligations for mutual help;
- genuine community participation in the identification, planning and implementation of projects and in the use and maintenance of the assets created; and of course by
- remuneration, in cash or kind and, for many people, this may be the most important fact.

3.2 The main disincentives to working on community development projects are probably:
- the opportunity cost of the labour, especially for subsistence farmers who cannot afford to take unnecessary risks with their crops;
- an unfair distribution of work amongst members of the community;
- a highly individualistic, movement-oriented society; and
- the feeling that the government should provide the facilities and that community works are simply another way of exploiting the people.

3.3 From an essentially economic point of view, then, the perceived benefits (ideally the actual benefits) plus any remuneration should compensate participants for the opportunity cost of their labour and any risks they have taken with their livelihood. This proposition implies that:
- remuneration should vary from worker to worker (but this is unlikely to occur in practice); and that
- remuneration will probably be necessary whenever the perceived benefits are low and the opportunity cost of labour is high.

It also highlights the importance of:
- participants being fully informed of the actual benefits (and the contributions they will be required to make); and or
- programming community works to coincide with the agricultural slack season (when the opportunity cost of labour is low).

3.4 This proposition is modified, however, by socio-cultural factors which may encourage or discourage participation in community works. Social, religious and traditional obligations may foster community spirit and thus reduce the need for remuneration. It is even possible that a person who does not expect to benefit will participate in order to enhance his or her status in the community or simply to acquire merit. However, not all traditional mutual-help arrangements encourage the provision of free labour; many impose reciprocal obligations and serve to formalise the exchange of labour without money. In such cases, and those where community works are regarded as an unfair imposition, remuneration is likely to be required.

3.5 Thus, it is likely that community works will often involve some remuneration, the level of which should be determined from a socio-economic study of potential participants before work starts. This study should also determine the appropriate form of remuneration. Food for work is a common reward but it is not always the right answer:
- it can discourage agricultural production;
- it may fail to attract the desired workforce; and
- it may develop relief and social welfare features.

Cash or a combination of cash plus agricultural inputs and tools may be more appropriate. Community works should supplement agriculture not supplant it.

4. Case study for Uganda

4.1. Luwero District, some 60 Km north-west of Kampala, has been ravaged by successive waves of internal conflict. The infrastructure has been destroyed and the economy of this once productive and prosperous district has been crippled. In March 1986, the government invited the UNDP and the ILO to set up a SPWP to rehabilitate the infrastructure, initially in a pilot village, Kalege, and then throughout 63 hamlets of Semuto Sub-county. The pilot phase started in September 1986 and was completed at the end of February 1987. The expanded phase is now in progress.

4.2 The Village Resistance Committee (RCI) of Kalege was responsible for arranging labour for the community works. Workers were paid a wage higher than the government's minimum for four days/week but in return they were expected to contribute one day/week self-help labour, based on the traditional "burungi bwansi" system of mutual help.

4.3 In the initial phase of the pilot project the villagers, being mobilised by civil servants and cabinet ministers, were working once a week on a "burungi bwansi" basis (clearing feeder roads, digging murram and sand, planting trees along main road, etc.). However, in time the "burungi bwansi" activities collapsed and the direct interest of the villagers for the project decreased for a variety of reasons.

4.4 First, the villagers were probably not fully informed about the project's objectives. As a result, many people did not see themselves as beneficiaries and refused to work unless highly paid.

4.5 Secondly, there appeared to be a lack of mobilisers who, in close collaboration with the villagers, would clearly establish their priorities and motivate them for project activities such as road, school, cooperative store and other communal assets rehabilitation. In fact, only towards the end of the project's main activities the villagers have started working again on a self-help basis while technical and material inputs are provided by the project. These activities concern the rehabilitation of the school's pit latrine, headmaster's and teachers' houses as well as the catholic and protestant churches.

4.6 Thirdly, the village is situated in a very fertile area and agriculture has always played a predominant role in their economy. Thus, from the villagers' point of view, the short-term benefits of agricultural production by far seemed to outweigh the longer-term benefits of rehabilitating schools, clinics, etc.

4.7 In the case of Kalege, this was proved when, towards the end of the pilot phase, a tractor service assisting the peasants in opening up their fields was organised by the project. In return, peasants were willingly engaging themselves in project activities. This approach appeared to be very successful and is quite understandable from the fact that on the one hand the opportunity

cost of labour is high in this area and on the other hand working for project activities is not going to be at the expense of basic agricultural activities.

4.8 Finally, it may be that traditional socio-cultural factors play a very important role in the "burungi bwansi" system which had not been recognised in an earlier phase. For instance, the actual rehabilitation of a shallow well in Kalege was not initially supported by the villagers because they were of the opinion that clearing the well-site would drive off snakes and ghosts which could lead to the disappearance of the water in the well.

5. Issues for Discussion

5.1 Economic factors appeared to dominate the villagers' decisions but to what extent were these modified by socio-cultural factors?

5.2 What should the SPWP field staff and RCI members have done to encourage the villagers to participate voluntarily?

5.3 What level and form of remuneration would have been appropriate?

5.4 How should the SPWP staff approach the next phase of the project?

6. Acknowledgements

6.1 The authors gratefully acknowledge the assistance and advice they received from Dr. T. Crudele, ILO Chief Technical Adviser to the Crash Labour-intensive Employment Programme in Uganda.

6.2 The authors also wish to express their gratitude to the ILO for allowing them to prepare and present this discussion note. However, the contents and the opinions expressed are the responsibility of the authors alone.

THE USE OF AN IMPROVED HYDROCYCLONE TO PROTECT PUMPS

by Dr D A Mashauri, University of Dar es Salaam

Hydrocylones in particular and cyclones in general have been used in the field of separation for a long time. The separation can be that of solid from solids, liquid from liquids or solids from liquids. The common denominator in these processes is that classification of materials is carried out by centrifugal acceleration which has different effects on the particles to be removed depending on their specific weights.

Since most of the water supplies in the tropics are from surface waters (ie rivers, ponds and dams) it is inevitable that the waters contain a lot of suspended solids. The suspended matter content is seasonal and depends on the stage of the stream and erosion of the banks, bed and catchment area. The solids eventually end up at the pumping station where water must be raised to the consumption points. Many pretreatment methods have been tried - for example rouging filters, hydrocyclones and vortex settlers. This papers deals with the design, improvements and performance of hydrocyclones.

To date various designs of hydrocyclones have emerged to suit individual separation tanks. In this Note an improved hydrocyclone is presented as a means to protect pumps. The protection is achieved by the removal of suspended solids (using the hydrocyclone) prior to reaching the suction side of the pump. Results obtained in a laboratory scale model show improved removal of suspended solids which are responsible for the pitting of pumps and their accessories. It is hoped that this type of hydrocyclone can be used effectively to deter solids from being sucked by the pumps.

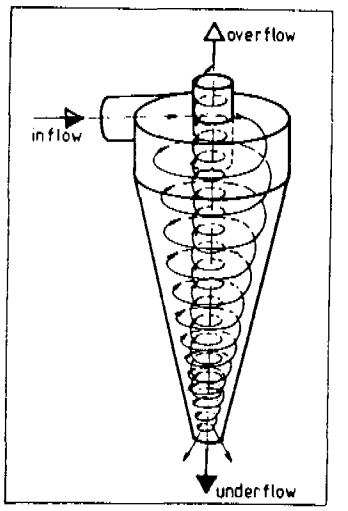
The task of providing a clean and dependable supply of water to the rural population of Tanzania lies squarely on the shoulders of the government. Since most of the population lives in the rural areas this declaration exerts considerable demands on the resources available. We want both safe water and cheap treatment, but it is not at all obvious that when we have achieved one we get the other. Surface water forms the biggest source of water for domestic use in Tanzania. However, its quality in terms of turbidity varies significantly especially during the rainy seasons.

A hydrocyclone has three main parts:

- the inflow at the top, where suspension is led tangentially into the cyclone;

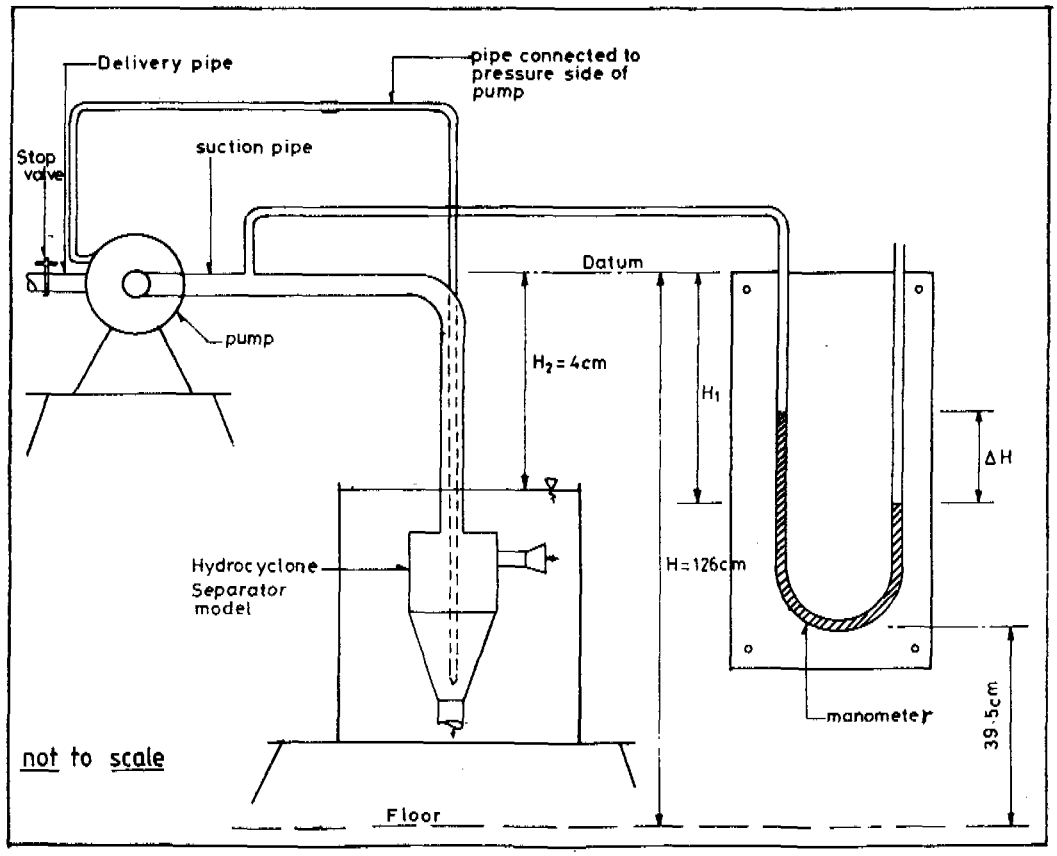
- the underflow at the bottom, where most of the solid particles (the separated fraction) and a small amount of water exit; and

- the overflow at the top, where the clarified water and a small fraction of the solids go through.



A modified hydrocyclone is introduced to remove the suspended solids often found in surface waters prior to reaching the pump or any other water raising machinery. The use of this hydrocyclone was tested in the hydraulics laboratories of the University of Dar es Salaam during the 1983/84 academic year. The results of the experiments show that this type of hydrocyclone can be used effectively in the removal of suspended solids.

In this research work the main improvement to the hydrocyclone was due to the provision of a connecting pipe from the delivery side of the pump to the hydrocyclone, as shown below. Note the size of the hydrocyclone relative to that of the pump.



This arrangement influenced the removal efficiency of the cyclone. The water "pushed" back into the hydrocyclone tended to increase the downward axial velocity of the solid particles. The particle removal is independent of gravitational forces.

The efficiency of the hydrocyclone was never below 60%. It is therefore hoped that the method will be utilized by others involved in the provision of water to rural areas, expecially where pumping is involved.

Discussion Paper

Livulezi Integrated Groundwater Project For Rural Water Supplies

by Ministry of Works and Supplies, Department of Water, Malawi

1. Introduction

The Upper Livulezi Valley was withdrawn from the Rural gravity piped water programme owing to increasing cultivation in the catchment of the surface water sources. The upper Livulezi groundwater project replaced it. The project was the first full scale testing of the new integrated approach. It integrated five components of the rural groundwater development programme viz:-

(a) The protection of exixting shallow wells
(b) The rehabilitation of existing boreholes
(c) The construction of new dug wells
(d) The construction of new low cost boreholes
(e) The establishment of a system for maintaining water points. This is largely community based.

The objectives of the project were to implement on a major scale an integrated system of providing dug-well protection and borehole rehabilitation together with the construction of new low cost boreholes and dug wells in the valley.

2. Location

The project area is located in Ntcheu District and occupies about 200 square kilometres North East of Ntcheu Boma. It is bounded by the foot slopes of Kirk Range in the West and the scarp zone of the Bilila fault in the East.

The valley is part of the Nsipe-Livulezi shelf which runs diagonally across Ntcheu-Balaka area.

3. Project Implementation

The project involved the local community right from the beginning. Water-point site selection was done by the rural communities themselves, preparation of access roads, moulding bricks for apron, washing slab construction, supply of sand crushed stone and labour for the civil works.

Each water point unit has got a committee, composed of women who look after the point surround carry out preventive maintenance and reporting any major breakdowns. These pump caretaker committees are trained by personnel from Water Department and Health.

The success of this programme depends on a suitable hand-pump. Presently, maintenance of AFRIDEV is carried out by the women themselves. MALDEV involves paricipation of Water Department personnel and local community.

Because of the World Bank/UNDP handpump project of which Livulezi is one of the testing grounds, it had not been possible to leave maintenance of handpumps wholly in the hands of the local community. This requires a standard handpump for the whole project area. The aim is to leave as much as possible in the hands of the local community.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

DISCUSSION GROUP REPORT

Hydrology, groundwater location and pollution

Chairman: S.M.N. Mainala
Rapporteur: E.Z. Laisi
Discussion paper: O.N.R Shela

The chairman informed the participants that there was need for all participants to contribute their own experiences.

A. HYDROLOGY

The author introduced his paper and noted that there is little attention given, in most cases, to water resources investigations before the development of water supply schemes when their reliability depends on careful study of the resource potential.

Comments from the forum included the following:

1. There is indeed need to thoroughly investigate the water resources potential of an ungauged catchment but time may be a limiting factor. There is need to visit the supply source area and establish whether it is perennial or not. Rural population in the vicinity should participate in the resource investigation by fully participating and establishing its reliablility.

2. The smaller the catchment area the more dangerous it is to estimate through first principles. The model must emphasize the influence of the catchment area. The smaller the catchment the lesser the baseflow even if the parent channel could be resourceful.

3. The model was only a direct estimation guideline by proportion yet as catchment areas need to have a coefficient in estimating runoff therefrom, due to soil types vegetal cover etc. there is equally a need to consider incorporating this aspect in the flow formula proposed.

4. Pumping for abstraction and other influences through the expanse of dambos can produce erractic results when using the model.

5. There was need to consider alternatives of water supply when the water supply scheme should fail in times of severe and contiuous drought as had hit parts of Eastern and Southern Africa.

6. Water Supply Engineers tend in most cases to work independently of Hydrologists and Hydrogeologists - this needs to be discouraged.

RECOMMENDATIONS

The following recommendations were passed:

1. Runoff models for an ungauged catchment need to consider and incorporate the influence of dominating catchment area and catchment type.

2. Mathematical models must not be seen to give a complete picture of water resources reliability in any one catchment.

3. As much as possible rural communities must be involved in the resource investigation studies and the resource investigator must visit site of concern before he can do a desk study in estimating resource reliability.

4. There is need for very close liaison between hydrologists, hydrogeologists and water suppl and resource investigation studies.

5. There must be close liaison between all relevant government and non governmental institutions in water supply projects so as to guarantee an adequate social, economic and

environmental atmosphere for the planned water project.

6. Pollution monitoring is a 'must' before and after the installation of the water supply scheme.

7. Political leaders at all levels must participate.

8. Social and cultural aspects need to be looked into in the planning stages of the project.

9. Regulations must be enforced to control pollution and overabstraction for a healthy environment.

10. Training must be extended to all beneficiaries of the water supply scheme.

11. Governments must give serious thought to supporting organizations responsible for data collection being useful input into successful water supply and other water related development projects.

8. GROUNDWATER AND POLLUTION

The chairman gave a brief outline of the groundwater activities in Malawi which he said included the:

(a) Dispersed Approach - a programme of activities providing quick response to where water is required urgently and

(b) Integrated Approach- a programme that has to follow well time-tabled operations to cover all work and completed by the design date in an area and includes

(i) rehabilitation of boreholes

(ii) rehabilitation of wells

(iii) maintenance of boreholes

(iv) maintenance of wells

(v) construction of new boreholes and wells

(vi) Establishment of community-based maintenance systems

Groundwater surveys in Malawi were not by drilling operations alone but by resistivity methods as well and provide useful data with existing information for appraising area groundwater resources. The problems faced by the groundwater department include the siting of boreholes where it may be found that the resource is abundant in an unpopulated area and away from inhabited localities. Thus it becomes more difficult to especially force village communities to move to newly constructed boreholes. Such problems even extend to those associated with cultural beliefs particularly when boreholes are located in areas close to cemeteries and yet safe to use.

The deriberations included the following additional comments:

1. Beneficiaries of rural water supply schemes particularly where boreholes are used, usually attach their usefulness to the taste of the water and as such sociologists must initially be engaged to gather information from local communities and reach an agreement with them as to where exactly they would prefer to have their water supply from. Community meetings should be encouraged to involve objectives of the meeting on the planned project for the local inhabitants will usually offer alternatives to new drilling sites.

2. Diseases had from unhygienic water points will prove useful in educating the local communities in using safe water supply sources and train them further to exercise maximum health precautions in using the new water supply alternative.

3. More information on groundwater resources must be gathered by hydrogeologists to reduce borehole siting problems.

4. Hydrogeologists must give high priority to maintenance of boreholes since if these pumps remained unusable for a longer-than-required period, users would return to their traditional water points.

5. Governments should ensure that all boreholes are registered and must include drilled holes by private contractors.

6. Where there was conflict between pit latrines and water supply points initial stages in the planning process must address this problem.

7. There must be adequate borehole designs where the top end of the hole has to be sealed to hold off inter flow from pollution sources. Further to this there is need to look at the type of the aquifer and determine its persimisivity.

8. Present rural water supply problems must form future water supply planning inputs and must therefore not be repeated.

RECOMMENDATIONS

The foregoing discussions ended in drawing up the following recommendations:

1. A carefully studied water sanitatation programme must complement all water rural and urban Water supply programmes and must in no way be divorced from each other. Water points for animals must be kept away from water supply points for humans. Monitoring of pollution for rural water supply schemes should involve continuous inspection.

2. Training or Health education must be one component fulfilled and carried out from the planning stages of the project to its final stages beyond.

3. Adequate and appropriate borehole designs including dugout wells must be considered in installing the system.

4. Prefeasibility studies in technical and social aspects of rural water supply schemes should be encouraged and should at the same time involve the rural communities.

5. There should always be exchange of information and exchange of visits and experiences in various problems and successes on rural water supply projects among governments in order to avoid repetition or recurrence of any of such undesirable problems in future.

6. The siting, construction and maintenance of rural water supplies should as much as possible include the full participation of the beneficiaries.

7. More research on potential pollution hazards and resource reliablility must form a large part of the project in its planning stages.

8. There should, within each country, be a coordinated water supply development and management programme and that local participation be a cornerstone in implementing a successful water supply project.

The above recommendations were all agreed upon and passed to plenary for consideration.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

DISCUSSION GROUP REPORT
Operation and maintenance of water supplies

Chairman: W.J. Lewis
Rapporteur: K.W. Lesoana

KEY ISSUES FOR RURAL WATER SUPPLIES

1. Organisational Structure (Community Participation)
2. Income Generation
3. Preventive Maintenance
4. Reporting
5. Training

1. Organizational Structure (Community Participation)

The group felt that any rural water supply scheme was doomed to failure where the community did not have a sense of ownership of that scheme. A community had to perceive the need for an improved water supply and see this as a priority.

The group realised that the village committee played a vital role and therefore the composition of a committee was an important factor. The committee had to be based on the national leaders of a community either from the party or from traditional committees. After completion of a project it was vital to maintain close contact with the committee to ensure their continued interest in the project.

2. INCOME GENERATION

In addition to the self-help component, the group were of the opinion that the community should contribute some cash each year to purchase simple spares for maintenance, the caretakers salary and, in some countries, diesel. Delegates from Lesotho reported that their policy was to get the community to contribute before the scheme started as a sign of commitment.

The group felt that management of the fund was often problematic and government could play an important role by administering the fund on behalf of the community.

The whole question of affordability to maintain a scheme was often not full appreciated and donors are often reluctant to invest in projects which government could not afford or a community could not maintain.

3. PREVENTIVE MAINTENANCE

The group stressed the importance of the repair committee being completely familiar with the whole distribution system. The construction phase should be used as a training period and also for the selection of people with an aptitude for this kind of work.

The division of responsibility had to be clear but the community should be encouraged and permitted to do as much as possible and government taking care of the major repairs or those beyond the skills of the repair committee.

Regular inspection of the system by the community was also felt to be a key issue. This had to be supplemented by periodic inspection by a government official. Again familiarity with the system was important for trouble shooting.

Provision of an adequate stock of spares was another key factor. It was recognised that these spares should be readily available. The group were of the opinion that the government should purchase the spares since they could buy duty free and then sell to the

community using a revolving fund.

4. REPORTING

The group were unanimous in their opinion that the chain of reporting should be as short as possible. The composition of an efficient reporting organisation was thought to be:

Tap Committee - Consumer
Repair Committee - Simple Repairs
Monitory Assistant - Government employee, more difficult repairs but with manpower provided by the community
District or Regional Supervisor - Government major repairs.

It was recognised that government involvement at district or regional level was the weak link in the chain either due to manpower, material or transport constraints. Failure by central government to act swiftly was an important cause of loss of credibility in the scheme.

It was suggested that the community should be allowed to mobilise their own resources where government could not respond to the community. The question which remained unanswered was how to give the community the necessary resources.

TRAINING

The group felt very strongly that training should be conducted from the bottom upwards. The construction phase was the most important with regard to training.

Training should consist of formal training, on the job training, and continuous training at a series of refresher courses. It was realised that training was a cost and this should be built into the project so that donors could assist.

Communication or interchange of experience with other groups was also thought to be important. Training at all levels was required, for instance it was recognised that professional engineers often lacked the necessary training in community participation skills. It was suggested that this type of training was best handled at local level.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

DISCUSSION GROUP REPORT
Agriculture and irrigation

Chairman: C.N. Roberts
Rapporteur: R.A. Lambert

The discussion began with comments on the aspects of irrigation and agriculture in several countries. Ms Siakantu gave some details on irrigation in Zambia. She informed us that government has just formed an irrigation branch. Mr Stoutjeskijk commented on the use of dambos and the problem of marketing.

Mr Mphande and Mr Mwakikunga told us that in the case of self-help irrigation in Malawi, the government waits for the farmers to initiate the scheme and then provides support in the form of advice or certain inputs. Government does not intervene in the case of kitchen gardens. The paper by Brown on the Zumulu self-help scheme illustrated these points.

Mr Mbugua from Kenya told us about the wide range of irrigation in his country. He mentioned traditional furrow irrigation on the slopes of Kilimanjaro, a run-off collection project, use of domestic waste water and the BURA irrigation scheme.

Mr LeMercier described rice irrigation in Zanzibar and the problems of growing high cost rice when good quality, cheap imported rice was available. Mr Taylor mentioned the wide range of irrigation on mainland Tanzania including some successful large-scale sugar plantations.

After these initial comments the discussion developed around a variety of themes which are summerised as follows:

- Women usually do most of the work in irrigation but have little power of decision. They may be free to grow crops for family nutrition but men control crops for cash.

- The problems of the Bura scheme in Kenya illustrated the problems of irrigation development where it is introduced as a new technology. There are fewer problems when traditional forms of irrigation are supported eg dambo cultivation. When possible the step-by-step approach should be used. Clearly this will not always be possible and the use of pilot projects should be considered.

- It was recognised that extension workers can be crucial and so require good training, motivation and encouragement. It is vital that they are trained to listen to farmers and appreciate their skills, not just to give them advice.

- Formulators of irrigation policy should recognise how farmers balance the minimisation of risk (eg by planting a variety of crops) against the maximisation of profit that may be possible with one high-value but high risk crop. Traditional farming systems irrigation may form only part of the system along with dry field cultivation.

- On the question of technology, the need for improved water-lifting devices was recognised. This should be considered in conjunction with improved water-use efficiency through mulching or sheding. Given the problems of scarce labour, improved water lifting technology must fit in with other labour demands such as those for weeding.

- Water supply planners need to recognise potential conflicts in demand. Examples are domestic water supplies being used for irrigation, fishermen blocking irrigation canals etc.

- Irrigation must be seen in the context of soil and water management. Farmers must be able to cope with removing excess water in one season and supplying water to satisfy a deficit a few months later.

- Water engineers in irrigation who know nothing about agriculture or marketing, or agriculturists with no knowledge of domestic water requirements can be a menace.

Finally the discussion made it clear that there are great differences between and within countries in relation to irrigation and agriculture. There is no single solution to the problem of irrigation development.

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DISCUSSION GROUP REPORT
Health and pollution aspects of sanitation

Chairman: M.E. Nyirongo
Rapporteur: A. Geake
Discussion paper: P.A. Colbert

The group initially discussed the differendt scales of health and pollution risks in rural areas where the population is scattered, and peri-urban areas where there can be much greater problems because of much higher density of settlement. There can be very different approaches to solving these problems depending on the institutional networks (or lack of them) available for communication and organisation.

Health Education

Health Education was seen as being vitally important to the success of any water or sanitation project in improving community health, as habits have to be changed. There is a need to persuade people to use latrines (especially children), to dispose of household wastes and sullage water safely, and to take care to avoid contamination of drinking water at the collection and use points. Only in such ways can the faecal-oral route of disease transmission be broken; the mere provision of a safe-water supply and a sanitation scheme cannot do this.

It became clear that health education programmes need to be sensitive to local cultures, so that they would be acceptable. There is a need for the training of parents, teachers and children alike to maximise the impact on the community. Education can be carried out in a variety of ways, and those methods involving the community themselves such as drama, singing and disscussion groups with pamphlets appeared to be more successful than formal lectures.

It was felt that health education should be encouraged in rural areas, even before sanitation and water supplies are improved, and that it sould be seen as an on-going process with periodic updating once projects have been completed.

Integrated Approach

It was felt that the integration of sanitation, water and health education programmes was desirable to minimise the pollution risks and increase the health benefits to the community. (It helps if engineers are trained in health issues, and health workers in technical issues). However, numerous case-studies were discussed where logistical difficulties arose in carrying this out, especially where there were many Government Departments involved, each with different priorities. There can also be tensions between donor agencies and Executing Governments in agreeing the extent of integration.

The main conclusion was that, although integration was desirable, the extent to which this is possible will depend on the type of project and the operational details.

Groundwater Pollution

The importance of groundwater for potable supplies in rural areas where there is often no other alternative was stressed, and therefore the pollution hazard from sanitation needs to be considered. The risk will depend on the hydrogeological conditions and the loading on the aquifer (obviously greater in per-urban areas with denser population). The need for careful siting of boreholes in relation to sanitation units was discussed. The soil and unsaturated zone act as an effective filter and groundwater pollution in wells is often due to poor sanitary completion with contamination direct from the surface rather than indirectly from on-site sanitation.

It was felt that a small amount of groundwater pollution, for example from nitrates, might be acceptable in-order to allow sanitation units to be located close to the houses, otherwise they may not be used. In high risk areas, it may be more appropriate to site boreholes out of the village, and in per-urban areas it may even be necessary to treat the water or import an alternative piped supply.

The greatest hazard to health is from pathogens, but since these die off with time, a more persistant problem may be from high nitrate concentrations both derived from on-site sanitation

and the increasing use of fertiliser.

Whilst the issue of groundwater quality was considered important, it was also felt that there were often greater risks to health from gross contamination of water after it was collected.

Research Needs and Recommendations

1. Health impact assessment studies need to develop suitable indicators to measure improvements eg Ascaris worm eggs.

2. Establishment of post-graduate monitoring and evaluation of water quality, with feed back for future projects.

3. More widely available guidance on groundwater pollution risks for practical use by sanitation engineers.

4. Health education to encourage use of sanitation units, and care of water needs to be improved.

5. The expected life time of pit latrines needs to be investigated.

6. Economists should appraise the investments in projects (espcially where foreign exchange is limited) as the benefits can broadly be assessed at the identification stage.

7. The optimal and acceptable levels of pollution need to be assessed.

8. A final recommendation is that the objective of helping improve the situation for rural people is not lost from sight, whilst the above investigations are carried out.

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DISCUSSION GROUP REPORT
Design and construction of latrines and implementation of sanitation programmes

Chairman: C.L. Chirwa
Rapporteur: J.K. Katerega
Discussion papers: (i) R.A. Bocarro and C. Williams
(ii) & (iii) L. Matjama
(iv) Muller and Monteiro

Discussion paper i) was introduced by Mr Bocarro who outlined the various technical aspects covered under the experiment for upgrading sanitation systems in Maseru - Lesotho using the Low Volume Flush Toilets (LVFT) being developed.

Some of the issues covered under this experiment include:

- installing a number of LVFT in Maseru and monitoring their performance,
- connecting the LVFT to conservancy tanks of reduced volume design to respond to the LVFT,
- encouraging residents of Maseru to start installing LVFT and Low Volume Septic Tanks for their house sanitation system,
- trying the connection of the Ventilated Improved Double Pit latrines (VIDT) to the low volume septic tank while emptying the kitchen sink waste water into modified long shallow trenches (10 m long x 1 m deep and 0.5 m wide).

Cost saving was mainly in:

- reduction of water used from over 10 gal per flush for a convenient flush toilet to 3 gal per flush for the LVFT.
- Also reduction in septic tank construction cost was reported from over £300 for the conventional to less than £225 for the low volume septic tank.
- The connection of the VIDP to the low volume septic tank also reduced the frequency and therefore the cost of emptying the VIDP.

Discussions:

In the discussions, delegates agreed that there was a need to offer upgrading sanitation possibilities and to take this into account when planning for low income residential areas. If not offered, the residents themselves will always find ways of upgrading their systems in an unplanned and unorganised manner which creates more sanitation problems later on.

- Examples of such cases were given by delegates from Lesotho and Malawi.
- The approach and problems of voluntary relocation of people to areas with already upgraded facilities were also discussed. At present, various levels of sanitation options operate side by side which is not conducive to upgrading an area to a small bore sewerage system for example in Lesotho, such ideas tend to be limited by land ownership and complex settlement patterns.
- The issue of reducing or eliminating completely the use of pipes to soakaways was discussed and found to be desirable as another means of reducing cost in the sanitation system.
- Also planting of grass over the long shallow trenches was proposed as a means of increasing their efficiency.

Discussion papers ii) and iii) were introduced one after the other by their respective authors and then discussed together.

The author of paper ii) from Lesotho outlined the main objectives of the overall National Rural Sanitation Programme and that of the pilot phase of the Rural Sanitation Project in Lesotho.

The main objective of the pilot phase was to design, develop and demonstrate a low-cost sanitation system using simple latrines suitable to the rural conditions and at the same time affordable and acceptable by the local people from the social-economic and cultural point of view and which is easy to maintain with minimum environmental pollution.

He outlined the implementation process of the pilot phase including:

- the design of the VIP latrine,
- construction of demonstration latrines in public places and at some local leaders (chiefs),

- training of local builders how to construct the latrines,
- health education and promotion of the use of the VIP latrines by the rural communities,
- monitoring and evaluation of the use and performance of the latrines etc,
- the institutional arrangement which included the ministry of health and that of inferior and the local chiefs for implementing this pilot phase.

He pointed out that a number of the rural families could not afford the cost of building the VIP latrine and therefore the idea of extending loans to these families to build the latrines was being considered.

The author for paper iii) outlined work in urban areas of Mozambique where VIP latrines are being sold to the rich first and later to the poor families.

The introduction of the VIP latrines to the rural areas of Mozambique was regarded as inappropriate due to a number of constraints. Current surveys indicate that less than 20% of the rural families have any kind of latrine. VIP latrines are not the priority of the rural people in Mozambique and the problem of the high cost and transportation of materials in the rural areas would make them fail if introduced.

Issues discussed relating to the two papers included:

- design standards and affordablility of the VIP latrines by the rural people,
- maximum local people's participation in the VIP latrine programme including the local leaders and chiefs,
- health and sanitation education and promotion to be part of the VIP latrine programme to compliment each other,
- implementation strategy to include institutional framework with maximum community participation to ensure continuity when public inputs are phased out of the programme.

In design standards, it was stressed that minimum standards should be aimed at with maximum use of the available local materials and human resources. Therefore, VIP latrine designs should be both easy to construct and affordable by the rural people.

On paricipation by the local people, the use of locally based administrative structures for project implementation was stressed. This would ensure continuity and success of such projects in rural areas.

The importance of combining health and sanitation educational and promotional programmes was also supported as these two aspects compliment each other.

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DISCUSSION GROUP REPORT

Community participation in water supply programmes - A

Chairman: L.A. Msukwa
Discussion papers: (i) P. Chola
(ii) Ministry of Works and supplies, Malawi

INTRODUCTION

The group started the discussion by asking the question "Why is community participation essential." It was felt that community participation promotes the sense of ownership of the project and, therefore, will easily take the responsibility of its maintenance. Generally, it was felt that where governments have planned and implemented projects for the people, management and maintenance of the system have failed.

ROLE OF GOVERNMENT AND PARTICIPATION

The group felt that there is a lot that the government can do in promoting community participation. Although the people can identify the problems, they often lack technical skills and expertise in implementing the projects. In that case, the government must provide the necessary technical backup. One of the roles that the government could play is to sensitize the community to identify their own needs and assist them in organizing themselves to meet the identified needs. The government should also be responsible in training the communities in order to impart the necessary skills for maintenance of the projects. Provision of adequate funds to supplement community resources was one of the aspects the group felt that the government does not undertake. Care should also be taken that government does not impose leadership on communities. Government should not see community participation as a threat to its own power but as an essential element for sustained development.

SOCIO-CULTURAL FACTORS IN COMMUNITY PARTICIPATION

In order for community participation to be successful, those responsible for programmes should take time to understand the social structures within the community and any cultural aspects that may hinder or promote community involvement. Even within the same country, development organisations should not assume that something that works in one community will equally be successful in another.

CHOICE OF TECHNOLOGY AND THE ROLE OF COMMUNITY IN DIFFERENT WATER PROGRAMMES

The type of programme to be implemented for example, a borehole, gravity-fed piped water or mechanized system will to a certain degree dictate the choice of technology to be used which in turn will influence the level of participation to be expected. It has been said that in Malawi the hydrological siting of the borehole and its drilling are both high technical activities which can only be undertaken by professionals. Therefore, the involvement of the community in this programme has almost been nil, even though there is provision for the community to provide an apron and drain around the borehole. In contrast, it has been observed that in piped water schemes there is a great degree of community involvement due to the fact that the technology is simple enough for the community to understand and maintain.

In order to sustain community motivation, the people must be assured that the technology works. It may, therefore, be important to start a project on a small scale so as to bring about results in as short time period as possible. It is also important that in the planning stage adequate provision should be made to ensure that spare parts for the maintenance of the scheme will always be available.

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DISCUSSION GROUP REPORT
Community participation in water supply programmes - B

Chairman: P. Hotchkiss
Rapporteur: V.N. Dlangamandla
Discussion papers: (i) P. Chola
(ii) Ministry of works and supplies, Malawi

We all know that Community Participation is an old practice in African Culture - it is nothing else but working together as a group to acheive expected benefits. It is important, therefore, in any development programme.

We are discussing it because we are aware of its natural death. People have been exploited for too long; now they do not trust anyone who asks them to work for nothing. Socio-economic and cultural values have changed - people need money to survive. Consequently, Community Participation is nearly a thing of the past.

Countries differ in their approaches to Community Participation. For example in Malawi the method involves:

- agreement between people and government
- selection of local committees
- digging of trenches
- training of repair teams
- monitoring assistance etc

The discussions showed that this society has very few problems on Community Participation as National Policies emphasise it and, hence, people are aware of its necessity.

It was noted that the proportion of the community affected is most important in implementation of certain programmes, hence the Government of Malawi would rather encourage programmes that benefit a large group than those benefiting only a few. In addition, participants had observed that provision of structures, without the involvement of the community in the initial stages does not guarantee that they will be used.

Problems of Community Participation

In Malawi, DDC members are chosen from the existing committees making implementation easy, whereas in other countries various problems occurred.

1. Communication breakdown outsiders, who implement programmes, and the communities.

2. Negotiating at national level and making unfulfilled promises promotes distrust in communities

3. Priorities tend to be given according to noise and not to needs, especially where politicians are concerned.

4. Time is necessary for changes in attitudes towards new developments, hence, persuasion and counselling of communities should be taken seriously.

Case Study - Ugandan Project

Problems encounted by experts included the following:-

- activities were left unfinished
- people were not fully informed
- there was a lack of mobilisers
- agriculture was the main priority in the eyes of the community, as they benefited from it (food and cash)
- socio-cultural influences were not understood

The group thought that such a society needs more patience to allow for effects of the civil war. Linkage of projects was recommended - eg the harvest has to be transported to market therefore

they need to construct roads.

"Is Community Participation really free labour where experts exploit certain sections of communities to get the job done?"

Discussion on this question suggested that it is not free labour as communities are asked to participate in projects that will benefit them. For example, -

- those who work in town can contribute money or food or hire labour from elsewhere to do their share of the work

- the price is decided by the community, calculated according to days or hours of absence

- the use of this money will be the choice of the community and not the project people (though they may advise)

The problem of what to do about villagers who do not participate was considered; eg are they allowed water from the project's stand pipe? It was concluded that Community Participation needs several approaches to convince people of the needs and benefits. Meetings alone can be ineffective. For example, the Community Development officers should find out the 'language' necessary to ensure people change their attitudes - this may involve moral, rational, emotional and sometimes religious approaches: legal requirements, as in Malawi ie non-voluntary participation may not work everywhere but needs to be looked into.

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DISCUSSION GROUP REPORT

Hand pumps - selection, operation and maintenance

Chairman: R.D Kafundu
Rapporteur: J.S. Sutton
Discussion papers: (i) L. Elias
(ii) J.M. Yarsiah and O.B. Kulah

The two discussion papers outlined the organisation, present staturs and future programmes or rural water supply in Mozambique (Cabo Delgado Province) and Liberia. In both countries while overall policy and feasibility are treated at national level, implementation is more the responsibility of provincial level organisations while maintenance is further devolved to district and perhaps village levels. General problems of coordination also arise from a diversity of funding agencies and sometimes from a promotion of donor country interests or short term involvement of the funding agencies.

In the specific area of handpump selection it was agreed that while national or regional level standardisation was an ideal it was not a practically attainable one and in pump selection due attention had to be paid to a number of points, both physical and human. The main points noted were:-

1 Depth to groundwater (height of water lift required)
2 Water quality (aggressivity, tendency to precipitation)
3 Well construction and type of well.
4 Availability of spares.
5 Level of local manufacture feasible.
6 Level of maintenance sustainable.
7 Ability to local community to support the installation.
8 Anticipated level of usage.

With respect to maintenance discussion concentrated around the level of training and servicing that could be sustained and the forms of reward that should be offered to local maintenance staff and payment that might be expected from the local community. It was agreed that due regard must be given to the local political system and the ability of communities to pay. Payment for maintenance services can in part be linked to staturs but must remain within the means of the local community and it must perhaps be accepted that some level of institutional support particularly for major repairs will be required throughout the forseeable future. Additionally the dangers of the local community attempting repairs beyond their abilities were noted.

In conclusion the need for sharing experiences both within countries and regions was emphasised and the desirability of exchange of experiences and ideas on a level less formal than occassional international conferences was stressed.

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DISCUSSION GROUP REPORT
Roads and communications

Chairman: G.J Chisi
Rapporteur: J.R. Plumb
Discussion paper: D.W. Jennings (tapes/slides)

Mr Jennings' tape/slide presentation was a report on the construction by one of the labourers recruited to work a labour unit. The presentation included among the development benefits perceived:

(a) the workmans pride in what he had achieved;
(b) and the availability of access to the community by government officials.

The balance of participants in the discussions was heavily weighted towards experience in Malawi and Lesotho. The general conclusion reached by the Discussion Group were that:-

1. Labour Intensive Road Construction methods are an appropriate form of construction for village feeder roads and rural access roads. Financial cost advantages in using labour intensive methods are not alwys apparent compared to using plant intensive methods. However, significant rural development benefits do exist for example maintenance of the costs expended on a project withing the community. For labour intensive methods to be used successfully there has to be surplus or excess of labour available for work on the project. Comparison was made in discussion with Uganda where availabilty of labour from normal agricultural activities was much less than in Lesotho.

2. Task Work systems were considered to be a desirable means of controlling and managing the productivity of labour intensive work. Both Lesotho and Malawi have established appropriate work capacities for given task in their road works.

3. The general view of the discussion group was that integrated rural development should be an achievable objective. In this context the road is an improtant and significant component usually because of its high capital cost. The group considered that greater coordination should take place and was indeed imperative for the successful implementation of integrated projects. This coordination has to be led by the most senior level in government by them setting the general policy for intergration of rural development and coordination. The group attached great importance to the need for regular meetings to take place at district level. The meetings should be attended by all the senior officers responsible for implementing the different disciplinary components of a project.

4. The final plea was made by participants in this group was in recognition of the need for coordination and exchange of information. The group considered the best means for doing this was through more frequent seminars and meetings.

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DISCUSSION GROUP REPORT

Operation and maintenance of sanitation scheme and stormwater drainage

Chairman: E.K. Mwawa
Rapporteur: R.W.A. Franceys
Duscussion paper: B. Brandberg

The discussion started with a description of the Malawi urban sanitation programme which has attempted to meet the particular needs of the low income urban people. The Sanitation Centres are seen as a key element in the delivery of improved latrines. So far there have been 200,000 recorded visitors to the various sanitation centres with 500 sanitation plates or slabs sold. It was felt that there must be components of the sanitation system for sale at the demonstration point as otherwise people's raised expectations would be thwarted.

There was some discussion between the Lesotho and Malawi delegates as to the size of squat holes and preferences for sitting or squatting. It was reported that an indiviuals squatting position depended on the degree of flexibility of their achilles tendon, but as for as each individual this remained constant people soon learn where to position themselves on the foot rests.

The implementation of sanitation programmes in rural areas was then discussed. This brought out a difference of opinion as to whether we should be planning organised programmes with subsidies and credits and field staff or whether rural work could be seen as a natural extension of the urban work with very simple Sanitation Centre demonstration units. The role of Village Health Committees and the use of Ministry of Health Inspectors as facilitators was also explained.

The consensus reached was that we must be prognostic - realising that there are things the people can afford and that they can dhoose themselves according to their own affordablility and desires. The role of the sanitation expert must be to demonstrate technologies which people understand and which require a minimum of maintenance. Sanitation must be adequate to local situations, cultural acceptability is vital. We should improve existing facilities not impose new ideas. We have to go as equals not as lecturing experts.

With regard to the technical side of operation and maintenance, it was recognised that where digging a pit costs only K5 and land is not a constraint then redigging every twenty to thirty years is preferable. However, where there are particular gound conditions such as in Lesotho where expensive lined pits having a life of around five years then desludging must be the answer.

The group finally considered the need for adequate drainage. Stormwater was not seen to be a significant problem from the health point of view but sullage water required extra care. The use of appropriate soakaway pits on sites and services schemes in Malawi was strongly endorsed by the group.

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DISCUSSION GROUP REPORT
Integrated rural development including building and housing

Chairman: M.S. Polela
Rapporteur: G. Kamwenja
Discussion paper: D.R.G. Morris and R.B.M. Hunink

1. The Present State of Implementing Rural Projects

The participants noted with concern that most rural development projects in developing countries are not carried out in a coordinated fashion due to the following reasons:

(a) Sectorial Interests

- There is a tendency by individual ministries/
- departments to think that they can carryout their
- projects in isolation of other related projects
- e.g. water supply without consideration for
- sanitation.

(b) Lack of linkages of community needs as being e.g. too many project officers in one area at the same time each emphasing their own projects, rather than a single unified project.

(c) Wastage of Scarce Resources

e.g. Different Ministries providing similar facilities within the same area, without consultation with other Ministries.

2. Integrated Approach to Rural Development

In order to improve on the present trend of running the rural development projects, the following approaches are recommended:

(a) Establishment of a national Institution/Ministry to coordinate all Rural Development Projects from the various Ministries. Such an institution/Ministry would be expected to:-

(i) Establish aoverall Rural Development Policy.
(ii) Establishment of national development priority areas.
(iii) Coordinate all inputs from donor agencies.
(iv) Coordinate Management and Training programmes relevant to Rural Development.

(b) Because of the importance of local participation in the rural development programmes, it is recommended that Development countries at District or village level be formed/ strengthened, with powers to take charge of the development activities in their areas such as:

(i) Decision on priority Project.
(ii) Decision in the allocations of funds.
(iii) Maintenance of projects after completion.

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DISCUSSION GROUP REPORT
Human resources development

Chairman: E.G. Snape
Rapporteur: P. Colbert

The development of the human resource was seen as a vital part of general development and some examples of good practice were considred in some detail. The question of incentives for development was considered. Obviously some kind of remuneration - whether in cash or in kind - was deemed necessary during training and subsequent to the training but it should be part of an overall package. Career advancement was also seen as a powerful motivating agent and a proper career structure with people able to progress all the way through a career to the top was seen as something to aim for. The need to avoid disincentives, such as when new, keen staff are attached to demotivated older staff, was also recognised.

Development of this resource needed to be part of the general development of the village, community. profession or whatever if it was to be effective. Examples where the community had considerable say in who was trained and when seemed to be more successful than isolated schemes. It also has advantages in that the content of the training is more likely to be immediately relevant and therefore more easily understood. Such a system, however, must be part of an ongoing process if it is to keep pace with the introduction of new technology. A point was made that so often some technologies were castigated as inappropriate when in fact it was the management and other necessary skills which had not been provided - when they could quite easily have been included in the commissioning package.

With any development the staff who lead must themselves have adequate and appropriate training. This was seen as a key requirement with particular reference to the need of trainers of trainers establishing the flexibility in tutors so that they are able to respond to the students or trainers that they are actually dealing with - which may be quite different from the design group. It may even be necessary to redesign the job until the staff have gained more experience and confidence.

Three levels of essential training were identified in the successful programmes. A basic training session, which may in fact be quite short, was seen as an essential first step. This should be followed by a period of 'on-the-job' training attached to appropriate qualified staff before assuming the role for which the training had been designed. Finally there should be an element of continued training during the remainder of the trainee's career. This should cover new introductions of technology and should also be seen as a mechanism by which field experience could be fed back into the training programme.

Finally the need to make the training appropriate at all levels was strongly expressed and this was seen as meaning difficult decisions would be necessary when funds were very limited.

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DISCUSSION GROUP REPORT

Water treatment and distribution

Chairman: L.G. Hutton
Rapporteur: R.J. Young

The group considered options available for the treatment of waters with high levels of turbidity particularly those with large seasonal variations in flow and quality. The discussion centred on horizontal-flow roughing filters (HRF). Dr Mashauri commented on the effectiveness of such systems in Tanzania. Results appear very encouraging and possibilities for development work definitely exist. It was suggested that IRCWD, Switzerland would be interested in suitable field evaluation sites and delegates with sites in mind should contact IRCWD. High levels of performance are possible with a wide range of media and are not significantly grading dependent. Innovation in hydraulic design to facilitate cearing is an area suitable for investigation.

Iron removal was discussed. It was considered extremely important that the nature of the problem be defined, wither in terms of iron concentrations in the raw water or as a contamination problem from iron containing components in the abstraction and distribution system. Several delegates reported success in iron treatment using cascade aeration. Mr Lupiya requested information on the treatment of iron in borehole water.

The discussion relating to chlorine disinfection (particularly by batch process) centred on operator responsibility, motivation and training. The group was strongly of the opinion that this process with obvious overlap in other operator dependent phases of treatment was critically affected by operator efficiency.

It was concluded that it is essential to adequately inform, motivate and train operators. However it was not considered obvious or easy to achieve this training. Attention should be given to language, culture and technical factors in establishing a training structure, which should include a clearly defined localisation plan. Mr Saeseli indicated the existance of a caretaker manual from Lesotho which might act as a model for the design of training schemes. (Details available from Mr Saeseli).

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DISCUSSION GROUP REPORT

Financing and management of rural development

Chairman: J.I. Mandanda
Rapporteur: P. Barker

The concept of the Appropriate Approach in the formulation of development programmes was discussed. Adoption of the Appropriate Approach requires engineers to face squarely the moral, social and political context in which investment programmes are activated. Only when these issues are taken into account could a project be considered properly defined. Discussion centred on the implications of this concept for:

(i) The consultant engineer who has traditionally seen his role more narrowly defined in technical and financial terms.

(ii) The commercial responsibilities of consultancy firms balanced against their social responsibilities recognising their need to survive in a competitive environment.

(iii) Finally, an account of the role and contribution of the South African Development Bank in infrastructure provision was recounted. Details were given of their attempts to define programmes in terms of the peoples needs.

The group's second line of discussion involved the personal national experiences of delegates in the area of rural water supply. Specifically, we addressed the issues of:

(i) Who should be responsible for framing the terms of reference of National Water Plans and lower level projects?

(ii) The respective responsibilities of donors, recipient governments, consultants and the recipient communities. In this connection the idea of sustainability of investment, locally and nationally, was emphasised.

Our group recommended a clearer definition of these responsibilities so that terms of reference might avoid confusion and ambiguity. An important aspect of theis issue is that responsibility and the source of finance for on-going of maintenance should be delineated.

The final area of discussion focussed on the desirability, parcticability and purpose of charges for water supplies. The group found a consensus on the following points:

(i) Charges should be designed to enable the local community to carry out routine maintenance. Exceptional, major maintenance should remain the responsibility of the government.

(ii) Charges should encourage the economic use of water whilst not reducing consumption below basic needs levels.

(iii) Charges should be at levels bearable by the community taking account of low income levels. Phased charges rising as the benefits and income generation of improved water supplies were realised received attention.

(iv) Changes had a role in fostering local pride in facilities and discouraged vandalism.

(v) The group recognised the need for education informing the people of the benefits of potable water. This would encourage a greater willingness to pay and would discourage resort to polluted supplies.

(vi) Agreement was reached that the ultimate aim was village or local self-reliance.

Finally, the group considered that village people should be made awater that traditional, polluted sources were not costless. The price they paid was in fatigue from carrying water, lost output because of time spent in carrying water, lost income opportunities in promoting village crafts and industry and not least, the cost of poor health and too frequently premature death.

13th WEDC Conference

Rural development in Africa
Malawi: 1987

DISCUSSION GROUP REPORT
Low-cost technology other than latrines and hand pumps

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Discussion paper: P.A. Mashauri

Discussion of the paper suggested that although the cost appeared relatively small and, once installed, the hydrocyclone, was maintenance free, water for domestic consumption would still need treatment. In addition further research and field testing was necessary to determine in-performance running and maintenance costs. It was, therefore, not easy to conclude that this particular technology was suitable for rural areas.