WHO
International Reference Centre
for
Community Water Supply

Bureau of Resource Assessment and Land Use Planning
and
Economic Research Bureau
of the University College, Dar es Salaam

BRALUP Research Paper 11

RURAL WATER SUPPLY
IN EAST AFRICA

Proceedings of the
Workshop on Rural Water Supply
held at the
University College, Dar es Salaam
17 - 19 December, 1969

Edited by Dennis Warner
May, 1970

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This report contains the proceedings of the Workshop on Rural Water Supply, which was held at the University College of Dar es Salaam, Tanzania, on the 17th through 19th December, 1969. Included herein are the summaries of the meetings, as well as all of the papers which were prepared for the Workshop.

The objectives of the Workshop were:

(1) to acquaint the participants with the various existing programmes of research and implementation on rural water supplies in East Africa;

(2) to identify common problems faced by the participants;

(3) to compare ideas and experiences dealing with these problems; and

(4) to set out the major issues for deliberation at the 1970 East African Conference on Rural Water Supply.

A total of 43 participants representing 30 different organisations took part in the Workshop. Included in this list were representatives from the Governments of Tanzania and Kenya, all three member colleges of the University of East Africa located in Dar es Salaam, Nairobi, and Kampala, agencies of the East African Community, the United Nations, religious organisations, and commercial firms. The Workshop was sponsored jointly by the Economic Research Bureau and the Bureau of Resource Assessment and Land Use Planning of the University College of Dar es Salaam. Financial assistance provided by the Ford Foundation helped to defray most of the local expenses of holding the meeting.

As indicated by the fourth of the objectives above, this Workshop was considered to be an essential preliminary to the East African Conference on Rural Water Supply scheduled to be held in late 1970. That this objective, as well as the other three objectives, was achieved is amply demonstrated by the proceedings presented in this report. Of particular significance are the fourteen recommendations related to future water supply policy and implementation in East Africa. These recommendations are the result of the combined efforts of the Workshop participants, whose professional backgrounds and practical knowledge cover a wide range of rural water supply related activities. This was the first time that a meeting of experts from such widely differing disciplines had gathered to discuss the problems of rural water supply in East Africa. Because of the great importance of this subject to the future development of East Africa, this report has been produced in the hope that it will contribute to the welfare of the people living there.

Note: All monetary values referred to in this report are given in East African shillings or Kenyan pounds, whereby EA Shs 20 = 1 K£ = US $2.80 = shillings 23/3d Sterling.

Wednesday, 17th December, 1969

10:00 - 10:15 am

Introduction: Dr. I. N. Kimambo, Acting Principal, University College; Dar es Salaam, Tanzania.

Opening Address: Mr. F. K. Lwegarulila, Director, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Dar es Salaam, Tanzania.

10:15 am - 12:15 pm

Topic: Field Research in Rural Water Supply

Chairman: Mr. Ian Livingstone, Director, Economic Research Bureau, University College; Dar es Salaam, Tanzania.

Panelists: Mr. Dennis Warner, Economic Research Bureau, University College; Dar es Salaam, Tanzania.

Mr. John McKay, Bureau of Resource Assessment and Land Use Planning, University College; Dar es Salaam, Tanzania.

Mr. Dariusz Stanislawski, Field Investigations and Research Unit, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Morogoro, Tanzania.

Questions for Discussion:

1. What type of rural water supply research is needed for East Africa?

2. To what degree should social, economic, and technical factors contribute to research on rural water supplies?

12:30 Lunch

2:00 - 3:30 pm

Topic: The Improvement of Health as a Function of Rural Water Supply

Chairman: Dr. Vincent van Amelsvoort, East African Insitute for Medical Research; Mwanza, Tanzania.

Panelists: Dr. Graham White, East African Institute of Malaria and Vector-Borne Diseases; Amani, Tanga, Tanzania.

Dr. Joachim Kreysler, Medical Director, Max Planck Nutrition Research Unit; Bumbuli, Soni, Tanzania.

Mr. P. J. Madati, Principal Chemist, Ministry of Health and Social Welfare; Dar es Salaam, Tanzania.

Dr. Fergus McCullough, WHO/Tanzania Bilharziasis Pilot Control and Training Project; Mwanza, Tanzania.

Questions for Discussion:

1. Is it possible to determine changes in public health as a result of an improved rural water supply?

2. Does East Africa need a special set of water quality standards for judging the suitability of its rural water supplies?

Topic: The Technical Aspects of Providing Better Water Supply

Chairman: Mr. Duane Eriksmoen, Production Division, Ministry of Agriculture, Food and Co-operatives; Dar es Salaam, Tanzania.

Panelists: Mr. Paul Barker, Kenya Farmers' Association (Co-op) Ltd; Nakuru, Kenya.

Mr. Derek Broadhurst, J. S. Davis & Co. Ltd.; Dar es Salaam, Tanzania.

Rev. George Cotter, M. M., Buhangija Mission; Shinyanga, Tanzania.

Questions for Discussion:

1. What types of technical innovations would best promote rural water supply development in East Africa?

2. What types of technical manpower are most needed for rural water supply development in East Africa?

Thursday, 18th December, 1969

8:30 - 10:15 am

Topic: The Task of Implementation

Chairman: Mr. M. A. Viitasaari, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Dar es Salaam, Tanzania.

Panelists: Mr. B. Z. Diamant, World Health Organisation; Nairobi, Kenya.

Marion, Lady Chesham, M.P., Executive Director, Community Development Trust Fund; Dar es Salaam, Tanzania.

Mr. H. A. Mbelwa, Kibaha Health Centre, Nordic Tanganyika Project; Kibaha, Tanzania.

Questions for Discussion:

1. What role should non-Governmental organisations play in promoting the development of rural water supplies?

2. Should local contributions of labour, materials, and money be a part of small water project development?

10:30 am - 12:15 pm

Topic: Water Supplies as a Stimulus to Community Development

Chairman: Mr. Seth Rookwell, Matunwa Farmers' Co-operative Society; Kisii, Kenya.

Panelists: Rev. Michael Duffy, M. M., Buhangija Mission; Shinyanga, Tanzania.

Mr. Franz van de Laak, Ndoleleji Water Development Scheme; Shinyanga, Tanzania.

Mr. G. L. Cunningham, Ujamaa Village Division, Ministry of Regional Administration and Rural Development; Dar es Salaam, Tanzania.

Questions for Discussion:

1. Does the provision of an improved water supply act as a catalyst for further development of a village community?

2. Should non-Governmental organisations or private individuals attempt to promote community development projects?

12:30 Lunch

2:00 until return: Visit to Miembasaba Village, which is a Water Development and Irrigation Division project, conducted by a staff member of the Division, and to Temboni Village, a Kibaha Health Centre project, conducted by Mr. H. A. Mbelwa, Health Officer, Kibaha.

8:00 pm Dinner in Council Chambers

Friday, 19th December, 1969.

8:30 - 10:15 am

Topic: Planning for Rural Water Supply

Chairman: Mr. Ian D. Carruthers, Insitute for Development Studies, University College; Nairobi, Kenya.

Panelists: Mr. Andries Klasse-Bos, Economic Planning Division, Ministry of Agriculture; Nairobi, Kenya.

Mr. Pravinchandra J. Shah, Water Development Division, Ministry of Agriculture; Nairobi, Kenya.

Mr. F. B. Mbaga, Ministry of Economic Affairs and Development Planning; Dar es Salaam, Tanzania.

Mr. Bo Barting, Water Development and Irrigation Division, Ministry of Agriculture, Food, and Co-operatives; Dar es Salaam, Tanzania.

Questions for Discussion:

1. Should expenditures on rural water supplies by looked upon as a social service or an economic investment?

2. What are the long-term goals for rural water supply in both Tanzania and Kenya?

10:30 am - 12:15 pm

Topic: Conclusions and Recommendations

Chairman: Mr. Ian D. Carruthers, Institute for Development Studies, University College; Nairobi, Kenya.

12:30 Lunch

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WATER DEVELOPMENT AND IRRIGATION DIVISION, MINISTRY OF AGRICULTURE, FOOD AND COOPERATIVES, DAR ES SALAAM, TANZANIA

Mr. Chairman, Ladies and Gentlemen. I am delighted to have been given the honour of opening today the Workshop on Rural Water Supply, which is is a forerunner of the Rural Water Supply Conference to be held in later 1970. Due to shortage of time it has not been possible to have as many papers for this workshop as many of us would have liked, but having gone through the papers submitted for discussion, I am fully convinced that useful discussion on Rural Water Supply will come out of this Workshop which will set a tempo for the 1970 Rural Water Supply Conference.

I wonder, Mr. Chairman, how many of us here have had the opportunity of living in those areas affected by acute shortage of water. Such experience gained by living under those conditions will help to enlighten some of us who may be approaching the subject from a detached point of view.

It is true that from time to time a town like Dar es Salaam does experience shortage of water. This may be in the form of a reduction in pressure in the distribution main or restriction on the extravagant use of water in such a way that watering of gardens or washing of cars become temporarily suspended, thus causing some inconvenience. On the other hand shortage of water in the rural areas carries a totally different picture. Here, shortage of water does not mean a simple inconvenience to the person in the rural area, but it is a case of real hardship which may involve a day's work in fetching a debe of water. In the limiting case it is the question of availability or non-availability of water. These simple facts have to be kept in mind when dealing with rural water supply. It may be a staggering revelation for some of us here to know that within this country the price of water fluctuates very wildly from place to place and, curiously enough, it is the man in the rural areas who has suffered most.

For the sake of illustration of the above statement, let us compare the price of any commodity, say cement, and that of water. In Dar es Salaam for this matter a ton of cement will cost Shs. 170, while in remote areas like Mbeya or Bukoba it is roughly Shs 340 or just double the Dar es Salaam price. What about water? There are some areas in Tanzania where, due to acute shortage of water, the price for water is as high as Shs. 1/- per debe or Shs 250 per 1,000 gallons. This means that the cost of water at such a place is just over 40 times the cost of water in Dar es Salaam where the normal charge is Shs. 6/00 per 1,000 gallons. This clearly shows how costly water can be.

Within certain limits the demand for water is highly inelastic. As the Government is committed to rural development, it has to tackle the entire range of rural water supply, comprising various shades of gradations between the supply of water for social conveniences and the supply of water as a necessary commodity to sustain human life and other activities. The principle underlying rural development efforts is to improve conditions in the rural areas so that the conditions in these areas do not differ much from those in the urban areas. When there is a big gap between conditions in the concerned is not any better off in town by moving from rural hardship into urban misery. This is a complex problem for any Government to tackle. A supply of clean potable water to the rural areas is one of the factors needed to improve conditions in the rural areas, thus reducing the social inequalities existing between rural and urban living conditions.

An interesting question to address to ourselves is how soon can all rural areas in Tanzania be supplied with water. If funds were unlimited, a crash programme could be embarked upon with a view of completing the job possibly within ten years. But Tanzania, like other developing countries, has scarce financial resources and there are heavy commitments on these scarce resources. Under such conditions every project to be financed should justify itself in terms of its relative urgency and importance to the entire economy in competition with all other projects having alternative claim to these scarce financial resources. With respect to rural water supply, how do we compare the competing claims on these resources of drilling a borehole in a rural area as against erecting a steel mill in an industrial area? This question is not easy. I would rather pose the problem to the distinguished participants in this Workshop to provide the answer. However, there is a small point to take note of. When we are dealing with water as a basic social necessity, a weighting factor to be known as a Social Necessity Correction factor should be introduced to bring the evaluation of benefits accruing from such a water supply project to a common datum with benefits derived from other projects having alternative claims to these scarce financial resources. This process of quantifying the social benefits has a far reaching importance in enabling us to determine the feasibility of a project heavily laden with social benefits, a category to which most of the rural water supply projects belong. The financing of such projects requires special consideration particularly when they are financed from the process of a loan, in which case the interest and repayment period should be different from those projects whose execution depend on purely economic justification.

Lastly, we should mention that as Tanzania is embarking upon an expanded rural water supply programme in the Second Five-Year Plan the cost is of paramount importance. The cost has to be kept to the minimum as far as possible. To achieve this, the project to be executed will be based on the most economic and technically sound designs, coupled with efficient execution of the projects in the field. I am glad to report that we have begun to take stock of our design procedures and our construction methods in order to reduce costs to the minimum, taking into consideration the local operating conditions.

Mr. Chairman, I declare this Workshop open and wish you all fruitful deliberations.

I FIELD RESEARCH IN RURAL WATER SUPPLY

Outline of Session

Chairman: Mr. Ian Livingstone, Director, Economic Research Bureau, University College; Dar es Salaam, Tanzania.

Panelists: Mr. Dennis Warner, Economic Research Bureau, University College; Dar es Salaam, Tanzania.

Paper: "A Summary of the Tanzania Rural Water Supply Impact Study"

Mr. John McKay, Bureau of Resource Assessment and Land Use Planning, University College; Dar es Salaam, Tanzania.

Paper: "Rural Water Development in NorthEast Nzega"

Mr. Dariusz J. Stanislawski, Field Investigations and Research Unit, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Morogoro, Tanzania.

Paper: "Various Aspects of the Water Economics Development Field Investigations and Research Programme in Tanzania"

Questions for Discussion:

1. What type of rural water supply research is needed for East Africa?

2. To what degree should social, economic, technical, and health factors contribute to research on rural water supplies?

Additional Papers:

J. Hrbek, East African Meteorological Department; Dar es Salaam, Tanzania:

"Short Description of East African Meteorological Department Programme of Development of Network of Precipitation Stations"

T. Hankins, Interdisciplinary Rural Research Project, University College of Dar es Salaam; Shinyanga, Tanzania:

"Farm Water Supplies in Sukumaland"

Mr. Dennis Warner, Economic Research Bureau, University College; Dar es Salaam, Tanzania.

In order to improve the decision-making and planning techniques for rural water supplies, a field research investigation is being conducted by the Economic Research Bureau. The purposes of this investigation are threefold: (1) to provide Regional Development Committees with criteria for selecting proposed water projects in the order of implementation; (2) to provide the Water Development and Irrigation Division of the Ministry of Agriculture, Food and Co-operatives with recommendations concerning domestic water point locations and per capita water use, and (3) to provide the Ministry of Economic Affairs and Development Planning with recommendations for future programmes of rural water supply development. An essential part of the investigation is the determination of the benefits that arise from improved water supplies. Thirty hypotheses concerning potential benefits are being tested as part of before and after situations in an attempt to assess the impact of water projects. Instead of the usual anthropological approach of an intensive study of a few villages, the investigation consists of an extensive study of 26 villages distributed over ten districts in order to obtain an overall picture of Tanzanian conditions.

Mr. John McKay, Bureau of Resource Assessment and Land Use Planning, University College; Dar es Salaam, Tanzania.

Northeast Nzega has been undergoing considerable developmental changes over the past ten years. The main water supply elements of this development to date have been the Bulenya Hills Dam and pipeline which serve an area of about sixty square miles. At present, the much larger Mwamapuli Dam is under construction and, along with its associated pipeline network, eventually will serve an area of about 600 square miles. The Bureau of Resource Assessment and Land Use Planning is studying the entire project area in order to provide planning information for the optimal location of the future pipelines. Because the Bulenya Hills and Mwamapuli projects will involve an anticipated total expenditure of Shs. 33,000,000 research into a wide range of geographical, social and economic factors is required to maximise the benefits of this investment. Consequently, current field investigations include studies of topography, soils, population and cattle densities, village settlements, co-operative organisations, water use, water point locations, and public health.

Mr. Dariusz J. Stanislawski, Field Investigations and Research Unit, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Morogoro, Tanzania.

There are two major problems affecting rural water supply development in Tanzania. One problem is the gap between pure research and the practical implementation of research findings. The other problem is the need for greater cooperation and coordination among the several organisations dealing with rural water supplies in Tanzania. Because of these problems, the Field Investigations and Research Unit has been established within the Division of Water Development and Irrigation of the Ministry of Agriculture, Food and Co-operatives for the purpose of providing factual reports of professional level field investigations carried out under up-country site conditions. The programme of this Unit includes: (1) investigations of new structures and equipment for major water supply projects; (2) investigations of new structures and equipment for minor, self-help water supply and irrigation projects, and (3) investigations into the planning and design of new schemes.

future water consumption for new project areas when no supply exists at present. In reply, it was pointed out that, if there is a cluster of people living in the area, an assumption as to their water use can be made. Water Development and Irrigation Division (WD&ID) in Tanzania uses a design figure of ten gallons per capita per day for communal piped supplies while the Water Development Division (WDD) in Kenya uses an average figure of five gallons per capita per day for most piped schemes. In several Morogoro villages, the Field Investigations and Research Unit of WD&ID currently is measuring domestic consumption through the use of meters and observers of domestic points. The average daily consumption has been varying around five gallons per capita. However, if the area is uninhabited, the final demand is difficult to estimate. Water supply alone is not the only factor causing population in an area to increase. In Northeast Nzega the building of the East-West Road had a great effect on the increase of settlement, even before piped water supplies were made available. It was suggested that the extensive experience accumulated by the international organisations be studied. The World Health Organisation, for example, has found that ten years after providing a piped water supply water consumption often has doubled and village population has increased by about 25 per cent.

Another issue arose over the relationship between water rates and total consumption. Experience in Kenya has shown not only that consumption is inversely related to the cost of water but that people are basically opposed to the idea of a permanent charge for water. This problem is illustrated by the fact that people frequently will refuse to pay a year round rate of five cents a debe* for water but instead will draw their supplies in one season from rain water pools and in another season will pay up to one shilling a debe for water brought by a vendor. Apparently many people prefer the option of either paying a high rate for water delivered to their house or carrying their own free water over long distances. This option allows for fluctuations in available household money. With a water rate, however, the cost of water remains constant and permanent.

The third issue was a question as to what selection criteria could be used to measure local attitudes. Of the thirty potential benefits listed in the impact study of the Economic Research Bureau, a total of 17 of them included "attitudes of villagers" as possible constraints affecting the resulting benefit. Mr. Warner of the Economic Research Bureau replied that the measurement of attitudes proved to be more difficult than originally expected at the beginning of the investigation. In the course of the field work, villagers had been asked a series of questions designed to gauge their attitudes towards the various potential benefits. Preliminary results from these questions for a few villages have not been particularly revealing, however, because the villagers tend to give the institutionally correct answers, indicating overwhelming acceptance within the studied villages of technology, modernisation and national goals. Such uniformity in their answers causes comparisons between villages to be extremely difficult. In order to better obtain these comparisons, the determination of attitudes currently consists of observations of the actions of villagers in related activities as well as their verbal responses to questions. It is hoped that a scoring system can be devised to reflect approximate differences between villages. On this same issue, Mr. McKay of the Bureau of Resource Assessment and Land Use Planning remarked that the determination of attitudes was not included in the Northeast Nzega Study because of the anticipated measurement difficulties.

* A debe is a 4-gallon tin that originally held kerosene.

improve cattle production or dairying. Furthermore, so little is known about the resulting benefits of large projects that additional economic research into such schemes is urgently required. On the technical factors, the Workshop participants were most concerned with research leading to simpler and less sophisticated techniques of project development. Technical recommendations included a re-evaluation of minimum design standards, an assessment of intermediate systems utilising human labour or animal power, and further study of the utilisation of rainfall. Despite the disagreements over health benefits, it was widely agreed that additional research into the possible public health benefits of water was needed to resolve the issue.

II. THE IMPROVEMENT OF HEALTH AS A FUNCTION OF RURAL WATER SUPPLY

Outline of Session

Chairman: Dr. Vincent van Amelsvoort, East African Institute for Medical Research; Mwanza, Tanzania.

Panelists: Dr. Graham B. White, East African Institute of Malaria and Vector Borner Diseases; Amani, Tanga, Tanzania.

Paper: "Insects of Medical and Veterinary Importance That Are Associated with Water and Some Aspects of Water Management Relevant to Their Control"

Dr. Joachim Kreysler, Max Planck Nutrition Research Unit; Bumbuli, Soni, Tanzania.

Paper: "Total Coli Counts: A Method to Determine Biological Contamination of Rural Water Supplies: The Ismani Example"

Mr. P. J. Madati, Principal Chemist, Ministry of Health and Social Welfare; Dar es Salaam, Tanzania.

Paper: "Water Quality Standards in Tanzania"

Dr. Fergus McCullough, WHO/Tanzania Bilharziasis Pilot Control and Training Project; Mwanza, Tanzania.

Paper: "Water Resources and Bilharziasis Transmission in the Msungwi Area, Mwanza District, North-West Tanzania"

Questions for Discussion:

1. Is it possible to determine changes in public health as a result of an improved rural water supply?
2. Does East Africa need a special set of water quality standards for judging the suitability of its rural water supplies?

Additional Papers:

Vincent van Amelsvoort, East African Institute for Medical Research Mwanza, Tanzania:

"Teaching of Better Water Supplies to Medical Auxiliaries"

Alan Fenwick, Tropical Pesticides Research Institute; Arusha, Tanzania:

"The Use of Molluscicides to Control Bilharzia on an Irrigated Sugar Estate and the Evaluation of Control Using Diagnostic Methods on the Local Population"

M. A. O. Kipuyo, Regional Medical Officer, Ministry of Health and Social Welfare; Arusha, Tanzania.

"Mass Treatment of Urinary Schistosomiasis with Ambilhar Among the Wambugwe of Hanang District, Northern Tanzania: A Preliminary Report"

Summaries of Presentations by Panel Members

Dr. Graham White, East African Institute of Malaria and Vector-Borne Diseases; Amani, Tanga, Tanzania.

There is a need for greater attention to be drawn to the widespread importance of insects that are associated with water as vectors (i.e carriers) of diseases of humans and of domestic animals. Those disease-bearing insects which are directly associated with water in East Africa include the biting midges, blackflies, horseflies, mosquitoes, and tsetse flies. Biting midges (Ceratopogonidae) breed in damp soil around the margins of marshes, water courses, and sea shores and are responsible for transmitting a filarial worm responsible for human blood disease over wide parts of East Africa. Blackflies (Simulidae), on the other hand, always breed in running water and are capable of transmitting the disease "onchocerciases," which often leads to blindness in man. The horseflies (Tabanidae), which breed in mud or wet sand, are the least dangerous of the group, although they are capable of transmitting the diseases of anthrax, tularemia, and trypanosomiasis. Mosquitoes (Culcidae) are the most important insects medically because of their existence near almost all sources of water and because of their ability to transmit malaria and elephantiasis. The last group, tsetse flies (Glossinidae), does not require damp areas for breeding but does inhabit heavy vegetation near bodies of water and is capable of transmitting sleeping sickness. When planning water development projects, engineers and administrators can minimise insect breeding by steeply sloping the banks of all bodies of water, clearing away vegetation from banks and shallows, and periodic flushing of ditches and small streams.

Dr. Joachim Kreysler, Max Planck Nutrition Research Unit; Bumbuli, Soni, Tanzania.

During November, 1969, coli-form counts were made of fecal pollution in the water provided by the Ismani pipeline in Iringa Region. This pipeline is 44 miles long and serves a present population of 20,000 to 30,000 people over a 200 square mile area. Water samples taken from 19 different locations along the pipeline showed moderate to high rates of coli contamination. The least contamination occurred in water taken directly from the communal taps, while high contamination was found at the pipeline intake, at the washout valves, and in the tap water stored in the households in domestic containers. Because the local population has an unwarranted belief in the purity of tap water, an effort should be made to convince people that piped water does not necessarily mean clean water. Greater public health education and filtration of the water before it enters the pipeline will be necessary if the danger of a large scale epidemic is to be avoided. In this manner an improved water supply will improve public health. In general, it is recommended that simple biological assessment of the water supply be made in each existing and proposed project to see if purification is required.

Mr. P. J. Madati, Principal Chemist, Ministry of Health and Social Welfare; Dar es Salaam, Tanzania.

Water quality standards to which Tanzania subscribes are essentially those set out by the World Health Organisation in 1958. A further lowering of these standards may be hazardous and should not be done for the principal purpose of saving money. If it is felt necessary to lower the standards, it should be done only if there is substantial proof of the harmlessness of doing so. At present, the quality of most waters in Tanzania is judged from a chemical analysis standpoint. Far more important is the bacteriological analysis, and routine testing of all waters should be primarily by bacteriological means and only secondarily by chemical means. Regional Health Officers throughout Tanzania should be equipped with portable bacteriological testing kits for use in the field. Furthermore, a small mini-laboratory should be established in every Regional Hospital for carrying out the more urgent chemical analyses of water intended for development projects.

A bilharziasis pilot control project, sponsored by the Government of Tanzania and the World Health Organisation, is being carried out in two representative and contrasting pilot areas in Mwanza District, northwest Tanzania. In brief, the aims of the project are to determine the feasibility of bilharziasis control within the context of Tanzanian resources and to train staff in the conduct of appropriate control and investigation procedures. The project is being carried out in three phases. During the first phase baseline data on the parasitological (prevalence and intensity of infection), biological (snail host), social, and environmental aspects are being collected and plans for control operations will be finalised. During the second phase the implementation of the control measures, envisaged as being most suitable during the first phase, will be carried out. During the third and final phase the evaluation of the effectiveness and cost of the control operations will be undertaken. To date, most effort has been concentrated in the Misungwi pilot area where the problems of implementing a realistic control programme would appear to be more complex than in the Mwanza urban pilot area. The progress of the project is described in detail in quarterly reports and in the annual reports of the East African Institute for Medical Research (1967/68, and 1969 in press).

In Tanzania, there is evidence that the distribution and intensity of bilharziasis is increasing, and this indisputable trend provides the main justification for expending funds to support research and operational control measures designed to prevent or reduce the incidence of infection. As water conservation schemes, especially major irrigation developments, invariably bring about markedly increased transmission of bilharziasis, it is imperative that there should be from the outset close and continuous cooperative action between water supply authorities and public health officials at both central and regional levels.

In general, urban bilharziasis is preventable at a lower per capita cost than is rural bilharziasis. It is considered that Mwanza town has the funds, staff, and facilities to implement a feasible control programme, providing that full support from both technical and administrative sources can be continuously assured. A study of the diverse factors influencing transmission in Mwanza urban area has recently been made and proposals for the implementation of a practical control programme are now being detailed.

Discussion of Questions

Question 1. Does East Africa need a special set of water quality standards for judging the suitability of its rural water supplies?

It was the general concensus of the participants that the question of water quality has been ignored in most rural water supply schemes in East Africa to date. As a result, the major concern of this session was the basic issue of how to actually incorporate some water quality considerations into future planning efforts. Standards for judging the quality of rural water supplies were considered to be important, but it was not felt necessary to establish separate sets of standards for rural and urban areas. Several individuals stated that the present method of chemical analysis of water quality does not serve any useful purpose, partly because it fails to assess the more important bacteriological state of the water and partly because Government does not have the resources to change the chemical condition of water at the present time. It would be much better to test for the bacteriological quality of water. One of the most promising ways of doing this is with portable field kits sold by the Millipore Corporation. In the near future the Ministry of Health in Kenya will be provided with field laboratories which will be served by Land Rovers specially equipped for collecting and transporting water samples for bacteriological analysis.

In several instances, there was support for reduced standards of rural water quality so that as many people as possible could be supplied with water. The Workshop participants did not come to a clear concensus on the issue of water quality versus water quantity, but it was pointed out that on major water supply projects supplying water from a single untreated source, such as the Ismani pipeline, the hazards of water-borne diseases are much more serious than on small projects. Therefore, water quality considerations should be especially important on large projects.

Most discussion centred upon the technical aspects of water quality and project design. The participants agreed that minimum design standards to protect against public health hazards should be incorporated into project designs. No specific design standards were outlined, although it was suggested that guidelines might be obtained from the World Health Organisation drinking water standards. A variety of factors need to be considered for such design standards, including the differing conditions of water quality and quantity between areas as well as the view of the local people as to the nature of good quality water. There was widespread agreement that close cooperation should take place between engineers and public health officials in the planning and design of water projects. Such cooperation can result in protective measures to reduce the public health hazards of water projects, such as automatic siphons to eliminate the breeding of blackflies in dam spillways and drainage aprons around communal water taps to prevent the formation of muddy foci for hookworm infection and the breeding of mosquitoes. The major deterrent to the treatment of rural water supplies is the cost. There is a great need for further information and research on treatment systems that are cheap, durable, and capable of being maintained by village personnel. Proper maintenance is a key factor, and the poor record of maintenance on past projects must be considered in any future design standards. Lastly, the participants emphasized that health education in the community, as well as the development of water quality standards and new treatment systems, must be an essential part of any attempt to improve the quality of rural water supplies.

Question 2: Is it possible to determine changes in public health as a result of an improved rural water supply?

Some participants argued that there has been no conclusive proof that an improved water supply has positive effect upon public health. Others argued that such proof does exist, citing the general case of Europe over the past one hundred years and the more specific case of the Zaina water scheme in Nyeri District, Kenya. In most projects it is implicitly accepted that a better water supply improves public health. The difficulty lies in proving such a statement. It was pointed out that the cost of a proper evaluation of the public health effects of a water supply would be about ten times the costs of initially building the project. A careful evaluation should include both public health and economic data collected on a before and after basis. Incidences of intestinal diseases were suggested as the best indices for a medical assessment. Because of the high costs of evaluation, one participant argued that only one out of a hundred projects need be randomly selected for such as assessment of the public health effects. Another participant added the warning that an improvement of the water supply alone was not sufficient to bring about an improvement in public health and that a programme of health education of the people was a necessary factor for such a result.

III THE TECHNICAL ASPECTS OF PROVIDING BETTER WATER SUPPLY

Outline of Session

Chairman: Mr. Duane Eriksmoen, Production Division, Ministry of Agriculture Food and Co-operatives; Dar es Salaam, Tanzania.

Panelists: Mr. Paul Barker, Kenya Farmers' Association (Co-op) Ltd.; Nakuru, Kenya.

Paper: "Butyl Rubber Sheeting in Water Conservation and Storage"

Mr. Derek Broadhurst, J. S. Davis & Co. Ltd.; Dar es Salaam, Tanzania.

Rev. George Cotter, M. M., Buhangija Mission; Shinyanga, Tanzania.

Paper: "The Shinyanga Lift Pump"

Questions for Discussion:

1. What types of technical innovations would best promote rural water supply development in East Africa?

2. What types of technical manpower are most needed for rural water supply development in East Africa?

Additional Papers:

R. W. Dawson, Tanzania Agricultural Machinery Testing Unit, Ministry of Agriculture, Food and Co-operatives; Arusha, Tanzania:

"Inertia Hand Pump"

Dennis Warner, Economic Research Bureau, University College; Dar es Salaam, Tanzania:

"Polythene Pipe Chart for Rural Water Supply"

M. A. Crawford, Regional Water Engineer, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Moshi, Tanzania:

"A Preliminary Field Study of the Standard Domestic Point and Long Cattle Trough in Kilimanjaro Region, Tanzania"

Summaries of Presentations by Panel Members

Mr. Paul Barker, Kenya Farmers' Association (Co-operative) Ltd; Nakuru, Kenya.

Butyl rubber sheeting is an inexpensive and durable material which is readily adaptable to various types of water storage schemes. Although only recently available in East Africa, butyl sheeting has been used in the United States for over twenty years. The material is tough, flexible, elastic, impermeable to liquids and gases, and resistant to temperature changes, fertilisers, soil acids, sunlight and the effect of aging. In East Africa sheets of 0.030-inch thickness and varying dimensions up to 100 feet by 120 feet are available. The main water related uses of butyl sheeting are as (1) liners in excavated ground reservoirs, (2) liners for metal weld mesh storage tanks of 5,000 to 20,000 gallon capacities, (3) seepage barriers in earth dams, and (4) water storage bags of 250 to 3,500 gallon capacities. To date, butyl sheeting has been used in the construction of a number of water supply reservoirs and storage tanks in Kenya.

Mr. Derek Broadhurst, J. S. Davis & Co. Ltd.; Dar es Salaam, Tanzania.

Much of the present development of rural water supplies in East Africa involves equipment, such as pumps and engines, that are relatively complicated, expensive, and beyond the economic grasp of most small villages. The main technical need for these small communities is a range of water supply equipment that is easy to install and maintain, inexpensive and suitable for small projects. Much present expense could be saved if this equipment could be made locally. It is hoped that the discussions at this Workshop will point out the types of equipment most relevant for such installations.

Rev. George Cotter, M. M., Buhangija Mission; Shinyanga, Tanzania.

The Shinyanga Lift Pump is a simple and inexpensive hand pump constructed from locally purchased materials and designed to tap the high ground water table in western Shinyanga Region. Installed in areas where the ground water table is less than 20 feet from the surface, the pumps can be used by a small child to fill a three gallon bucket in 30 seconds. Most pumps are fixed over dug wells, usually averaging four to ten feet in depth, which are lined with tapered cement blocks that fit together without mortar. The pump body is made from plastic tubing and galvanised steel pipe. Valves are fabricated out of plastic rings, a rubber patch from an inner tube, and a stainless steel ball. The only maintenance required is to change the rubber plunger flap twice a year. Over forty of these pumps have been installed in the Sukumaland area on a self-help locally purchased, locally maintained basis. The total material cost to a village for a five foot deep well, well cover, and pump is about Shs. 130. Although the pump and its associated well helps to protect water sources from outside contamination, the most difficult part of the well programme is to convince people of the need to drink clean water. A major objective of the programme is to open people to change so that other innovations may be more readily adopted. To date, however, there has been little visible carry over in the villages where wells and pumps have been installed.

Discussion of Questions

Question 1. What types of technical innovations would best promote rural water supply development in East Africa?

Discussion of this question showed that a wide range of technical innovations have been successfully employed in various parts of East Africa. The promotion of rural water supply development, therefore, appeared to be areas rather than to search for new, untried innovations.

Basically, rural water supplies can be classified into two categories - individual household supplies and community supplies. For household supplies, it was suggested that roof rainwater catchments and simple handpumps on the order of the Shinyanga Lift Pump provide the best systems. For community supplies, maintenance must be the key consideration, and for this reason the preferred systems include gravity piped schemes for pump-free operation and hydraulic ram installations for schemes requiring pumping.

Some technical innovations simply involve a choice of technique. It was pointed out that charcos, which are small 1,000,000 gallon capacity reservoirs, could be built in the ravines of rainy season streams at a cost of Shs. 40,000 each. By constructing several along the same ravine, a series of charcos could provide the same amount of effective storage for far less cost than an earth dam which usually averages about Shs. 300,000. In Kenya, the Water Development Division (WDD) has developed numerous rock rainwater catchments by building low walls around the rock outcrops found in many parts of the country. Furthermore, in Machakos District, WDD successfully developed an underground reservoir by building a subsurface dam in a dry riverbed. During the rainy season the riverbed behind the dam becomes saturated and remains so throughout the following dry season. Additional discussion focused on the use of butyl sheeting in ground tanks, on the possibility of locally fabricating water tanks from corrugated steel sheets, on methods of evaporation control, and on the utilisation of windmills. Although WHO in Kenya has obtained poor results from windmills, the recent experience of the Ndoleleji Water Development Scheme (NWDS) in Shinynaga has been very promising. The NWDS windmills start automatically in a wind of 5 - 6 miles per hour (mph), require a minimum wind velocity of 3 - 4 mph, and reach the maximum pumping output of 700 gallons per hour in a wind of 16 mph. Wind conditions in the Shinyanga area are favourable for windmill operation throughout the year, and the maintenance needs of these windmills are easily met by locally trained personnel. Unfortunately, Government has not yet shown any interest in promoting windmill power in the area.

A number of participants felt that administrative problems were more critical than technical problems. For example, in Tabora District, self-help, hand dug wells have been financed by the District Council at a total cost of Shs. 700, while the same type of well built under WD&ID auspices costs Shs. 3,000. Another administrative problem occurs in the maintenance of community water supply schemes. The World Health Organisation in Kenya has found that the maintenance of new schemes by central authorities tends to destroy the villagers' sense of responsibility towards these schemes. Furthermore, not all villagers are convinced of the worth of the schemes or the need to pay for them, with the result that it is very difficult to collect water rates sufficient to repay the local share of the capital and maintenance costs. WHO has successfully dealt with this problem by allowing an adjustment period of two to three years before amortisation payments begin. During this period, the villagers are required only to pay for routine operating costs. They are protected from extraordinary maintenance expenses by a private insurance scheme to which WHO project villages subscribe. A third administrative problem was described as the lack of an organisation in Tanzania at least, capable of effectively promoting technical innovations. There exist research organisations, such as the Tanzania Agricultural Machinery Testing Unit in Arusha and the WD&ID Field Investigations and Research Unit in Morogoro, but there is no machinery by which the findings of the organisations can be translated into actual technical equipment which can be manufactured locally, sold by commercial firms, and utilised by both private and government agencies.

water supply development in East Africa.

Two main types of technical manpower are especially needed in East Africa: professional engineers and project supervisors. Uganda, in particular, is suffering a critical shortage of water engineers. At present only five of twenty engineering posts are filled - four of them by expatriates. Throughout East Africa expatriates hold the overwhelming majority of professional engineering posts, with the consequent effect that East Africans are not fully involved in the planning and design of their own development projects. Another undesirable effect of expatriate staffing is that accumulated field experience tends to leave East Africa at the expiration of overseas contracts. Qualified local staffing of professional posts is the only way to retain experienced personnel in the various technical departments. A review of salary inducements and educational opportunities should be made to encourage East Africans to enter the engineering professions.

The second type of technical manpower required is the skilled project foreman capable of supervising the construction of water supply projects. For example, WDD in Kenya pays Works Inspectors Shs 14,000 per year and in return requires five years of construction experience on water mains and storage tanks, some knowledge of chemical treatment, and the ability to work under difficult conditions. Part of this manpower shortage could be satisfied if there were sufficient in-service training courses for upgrading field personnel as well as the lower grade technical assistants. Frequently, a promising individual languished in a low, unproductive post because he neither has the paper qualifications for advancement nor the opportunity to obtain them through further training.

Along with project supervisors, there is a great need for qualified personnel to operate and repair rural water supply schemes. The universal lack of proper maintenance of projects was the most commonly repeated problem among the Workshop participants. All projects require some maintenance and the more complicated the scheme, the more care that will be needed for its continued operation. One recommendation was that WD&ID should give the rudiments of pump and water supply maintenance to one or two people in each village having a water project. In Kenya, WDD is organising district maintenance teams which include a works inspector, a pipe fitter, and a foreman for the purpose of advising on maintenance problems within their respective district. Somewhat similar was the suggestion that Government set up local teams for the construction of hand dug wells and the hand drilling of shallow Banka boreholes. It also was pointed out that community development and agricultural extension personnel usually are unable to give competent advice on village water supply projects. Therefore, it might be worthwhile to consider posting water extension agents in the rural area until such time as the community development personnel are better trained.

Outline of Session

Chairman: Mr. M. A. Viitasaari, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Dar es Salaam, Tanzania.

Panelists: Mr. B. Z. Diamant, World Health Organisation; Nairobi, Kenya.

Paper: "The Development of the WHO/UNICEF Assisted Rural Water Supply Programme in Kenya"

Marion, Lady Chesham, M. P., Executive Director, Community Development Trust Fund; Dar es Salaam, Tanzania.

Paper: "Community Development Trust Fund of Tanzania Village Water Wells Programme"

Mr. H. A. Mbelwa, Kibaha Health Centre; Nordic Tanganyika Project; Kibaha, Tanzania.

Paper: "Water Supplies of Kibaha Villages of Coast Region Tanzania"

Questions for Discussion:

1. What role should non-Government organisations play in promoting the development of rural water supplies?

2. Should local contributions of labour, materials, and money be a part of small water project development?

Mr. D. Z. Diamant, World Health Organisation; Nairobi, Kenya.

Over ninety percent of the population of East Africa lives in rural areas and only ten percent of this total has piped water supplies. In Kenya, a recent assessment showed that the construction of new piped water schemes has been insufficient to cope with the natural population growth of 350,000 per year. As a result, the Kenyan programme of assisted rural water supply sponsored since 1960 by the World Health Organisation (WHO) and the United Nations Children's Emergency Fund (UNICEF) has been reorganised to achieve an annual target of 100 to 110 new rural water supply schemes. This programme has been established mainly to promote community health, although it is expected that the major impact of the programme is the demonstration effect of the benefits of piped water. Local contributions from County Councils, the Ministry of Health, and from local villagers now amount to about 75 percent of the total cost of the schemes. Of the remainder, WHO provides professional personnel and UNICEF supplies a portion of the materials. Total project costs, including UNICEF materials average Shs. 40,000 per scheme. Standardised procedures have been established whereby all project investigations, designs, and costings are carried out by Government Health Inspectors in the field. Administrative costs are kept to a minimum through the use of fixed criteria for the selection of materials and equipment for generalised types of projects. Additional aspects of the programme include (1) the technical training of health inspectors, (2) installation of water treatment facilities, (3) an insurance programme to cover major maintenance expenses, and (4) initial deferral of water charges during the early years of project operation. The experience of the WHO/UNICEF programme, which has assisted over 450 schemes serving 500,000 people to date, can be easily transferred outside of Kenya, and the WHO staff is ready to assist in implementing similar programmes in any other country.

Marion, Lady Chesham, M.P., Executive Director, Community Development Trust Fund of Tanzania; Dar es Salaam, Tanzania.

Any attempt to bring about rural development in Tanzania should be in accordance with the national policy of self-reliance. People must become involved in projects so that they feel the project is theirs. This is the approach of the Community Development Trust Fund in promoting simple, hand dug wells with hand pumps. The objectives of the programme are to relieve village women from some of the drudgery of water carrying and to improve public health by providing a clean supply of water. Most materials are supplied by the Fund, while supervision and self-help labour are the responsibility of the local community. Since 1962, the Fund has helped in the installation of 745 water wells throughout Tanzania. The average amount of assistance provided by the Fund for these wells varied between Shs. 1,000 and Shs. 1,600. Because of the great need in the rural areas, there is considerable room for additional water supply assistance by other organisations. To coordinate the water supply activities of these organisations, such as Water Development and Irrigation Division, the Community Development Trust Fund, and international agencies, there should be a clearing house to which lists of proposed village water projects could be sent by the different organisations. The clearing house would act as an information centre to report whether any other organisation has already constructed a project in those villages or intends to do so in the near future.

In late 1966 the Kibaha Health Centre set up a programme of small village water supplies for the immediate area around the Centre. The objectives of this programme were to provide as many villages as possible with a protected water supply in order to reduce the incidence of bilharzia, diarrhoea, and dysentery and to provide practical training for the health extension personnel trained at the Centre. Two types of protected water wells are constructed under the programme: hand dug wells utilising concrete well rings and hand bored wells utilising concrete culvert pipes. Each well is supplied with a cover and a hand pump. Materials and construction supervision are provided by the Kibaha Health Centre with the assistance of the Rural Development Officer, and the villagers provide the necessary self-help labour. Excluding labour costs, dug wells average between Shs. 800 and Shs. 900 each and bored wells average about Shs. 230. A total of 48 wells have been completed since 1966, while another ten are currently under construction. Although local enthusiasm for self-help well digging occasionally drops after a few days, most labour difficulties are avoided by insuring that all local party, government, and village officials, as well as the villagers themselves, are firmly behind the project before final approval is given.

Discussion of Questions:

Question 1. What role should non-Governmental organisations play in promoting the development of rural water supplies?

In general, it was agreed that non-Governmental organisations are playing a vital role in the development of rural water supplies in East Africa. The water needs in the rural areas are so great that Government alone is unable to bear the full burden and there is little to fear of activities overlapping or of excessive competition between organisations. Nevertheless, the idea of a clearing house to assist in the coordination of projects found widespread acceptance among the Workshop participants. There was some disagreement over the nature of the clearing house. A few individuals wanted it to have executive powers over the activities of the different organisations, although most participants believed that the clearing house should be limited only to providing information upon request. A master plan for the development of the water supplies of the entire country would assist in the activities of the clearing house. Recommendations as to the best location for a Tanzanian clearing house included WD&ID or the Ministry of Economic Affairs and Development Planning (DEVPLAN) as the most likely sponsoring organisations, with the Bureau of Resource Assessment and Land Use Planning of the University College of Dar es Salaam as an alternative choice.

Many participants felt the Government design standards often are too high and reflect a carry-over from the colonial times. One of the major advantages possessed by the non-Governmental organisations is their freedom from unrealistic standards coupled with their willingness to assist less sophisticated, low cost schemes in order to produce immediate results. Because such activities complement the work of Government agencies, the non-Governmental organisations should receive greater encouragement and materials assistance from Government.

Replies to this question were clearly divided between the non-Government and Government organisations: the former strongly defending local contributions and the latter generally opposed. Those in favour of local contributions argued that this was the best method to involve the people in a project and to give them a sense of responsibility towards it. A basic principal is that the outside organisation should provide only those materials which the people themselves are unable to supply. The WHO/UNICEF programme in Kenya supplies only valves, meters, weldmesh, and piping, while local people supply sand, cement, local transport, fittings, and labour. In varying degrees this is the general pattern for the non-Governmental organisations. In Shinyanga, the Ndoleleji Water Development Scheme requires from each household not only self-help labour but also the cash proceeds from an extra acre of cotton planted specifically for that purpose. Cost savings resulting from the use of self-help labour was the second major argument used by the proponents of local contributions. An example was given of a village water project in the Usambara Mountains whose overall estimated cost of Shs. 42,000 was reduced to Shs. 9,500 through the use of self-help labour. Furthermore, one participant claimed that the quality of self-help labour is superior to that of paid labour because paid labourers put in only the minimum required effort whereas self-help labourers maximise their effort in order to finish the job quickly.

By contrast, WD&ID in Tanzania has rejected the employment of self-help labour because of the problem of lack of control over the workers and the difficulty of preparing firm planning schedules for materials, equipment, and personnel. On most water supply projects, WD&ID provides all materials, transport, labour, supervision, and maintenance and no local contribution is required or solicited. There has been some utilisation of self-help labour on small schemes, but generally these projects either are financed by the local Regional Development Fund or are constructed in this manner at the discretion of the Regional Water Engineer. Where self-help projects have succeeded, the initiative for the scheme came from inside the village rather than outside. Paradoxically, self-help labour has not been extensively employed to build water projects in Ujamaa villages as WD&ID is primarily responsible for such projects. The experience of WDD in Kenya has been similar to that of WD&ID in Tanzania. Self-help labour has been found to be unsatisfactory over long periods of time. As a result, WDD is considering employing only paid labour on future projects. The difficulty of coordinating local contributions in Kenya is especially noticeable on non-Government projects involving several different sources of materials, supervisory personnel, and labour. Often these projects encounter long delays and high costs over the term of the scheme. At present, Kenya is experimenting with an Inter-Ministerial Committee on Rural Water Supplies in an attempt to coordinate local contributions to both Government and non-Government projects.

A few suggestions for new approaches to local contributions included the possibility of employing prison labour on nearby schemes and the use of army vehicles to transport pipes. Another suggestion was that Government should employ paid labour, but at the same time require cash contributions from the villagers, thus achieving the effect of self-help labour without the usual problem of lack of control over the workers. A final recommendation was that there was a need for Government to establish a rural water supply planning unit which would look into these various issues.

Outline of Session

Chairman: Mr. Seth Rockwell, Matunwa Farmers' Co-operative Society; Kisii, Kenya.

Panelists: Rev. Michael Duffy, M. M., Buhangija Mission; Shinyanga, Tanzania.

Mr. Frans van de Laak, Ndoleleji Water Development Scheme; Shinyanga, Tanzania.

Paper: "The Ndoleleji Water Development Scheme"

Mr. G. L. Cunningham, Ujamaa Village Division, Ministry of Regional Administration and Rural Development; Dar es Salaam, Tanzania.

Questions for Discussion:

1. Does the provision of an improved water supply act as a catalyst for further development of a village community?

2. Should non-Governmental organisations or private individuals attempt to promote community development projects?

Additional Paper:

Anthony O. Ellman, Ujamaa Village Division, Ministry of Regional Administration and Rural Development; Dar es Salaam, Tanzania:

"Rural Water Supplies and the Ujamaa Village Programme"

Rev. Michael Duffy, M. M. Buhangija Mission; Shinyanga, Tanzania.

Community Development means the people's awareness of their identity as a community. It does not mean inputs of money or capital into the community, but instead greater group self-awareness. In Sukumaland, people do not normally identify with a village community but rather with an area in which they have blood relations. The relations are the strong link binding their loyalties and interests. There is also a difference in developmental effect depending upon whether a small or large water project is built and whether it is a new supply or simply an improved supply. The Wasukuma communities tend to be dispersed over large areas, and the local supplies are usually traditional water holes serving either individual households or small groups of households. When the programme for installing the Shinyanga Lift Pump began, it was hoped that this small technical innovation would lead to other social and agricultural changes. This has not yet happened, probably because of the lack of feeling of community and the dispersed nature of the households. Therefore, in Sukumaland at least, water supply alone is not a sufficient stimulus to bring about community development.

Mr. Franz van de Laak, Ndoleleji Water Development Scheme; Ndoleleji, Shinyanga, Tanzania.

The basic aim of the Ndoleleji Water Development Scheme is to bring people together so that they can come in contact with modern methods of cultivation and benefit from participation in communal activities. Because the area in eastern Shinyanga District has excellent potential for cotton production but suffers from a shortage of year round domestic water sources, the development of water supplies was chosen as an initial means of achieving self-reliant, cooperative action on the part of the people. It is hoped that cooperative effort in building a community water supply, in turn, will encourage people to attempt additional cooperative activities in agriculture and eventually lead to the formation of Ujamaa villages. For a given project, the villagers select a local Water Committee responsible for organising the required self-help labour and collecting local funds to pay for materials purchases. The scarcity of known ground water sources and the ample wind resources of the area favour the use of windmills as a means of pumping water to villages from wells sunk in dry river beds. Technical advice and assistance in constructing the windmill is provided by the Scheme. To offset the material costs of approximately Shs. 20,000 for a windmill project, the project members each cultivate one extra acre of cotton in a common field. The harvest proceeds from this cotton crop are used for project expenses, with any remaining funds returned to the members.

Mr. G. L. Cunningham, Ujamaa Village Division, Ministry of Regional Administration and Rural Development; Dar es Salaam, Tanzania.

In theory, Ujamaa villages are supposed to develop slowly. This principle evidently has not been applied to the formation of new villages, because over the past eighteen months over 500 new Ujamaa villages have been created. These villages range in size from five or six families to more than 2000, although the average is somewhere around 50 to 70 families. The common feature of all of these villages is their need for social services, such as schools, dispensaries, and water supplies. It is true that it is easier to supply social services to nucleated communities than to the dispersed pattern of settlement found in most parts of Tanzania; however, the politicians have been organising Ujamaa villages faster than the executive agencies can provide them with these essential services. At the present time Government-financed water commonly is being used as a lure to draw people into Ujamaa villages, most of which are Ujamaa in name only. The Central Government builds the water method of providing water supplies does not have much connection with Ujamaa or self-help. Because Government is now giving priority to Ujamaa village water supplies, it might be said that the people living there are becoming a privileged group, but without any guarantee that these communities will ever really become genuine Ujamaa villages. They represent only a small sample of the national population, with the result that there is a distorted allocation of resources occurring.

If a new Ujamaa village is to be successful, it must create new political and social structures. Unfortunately, not much is known about this yet. Ujamaa villages provide an excellent opportunity to mobilise people for self-help efforts and to experiment with new forms of intermediate technology, such as hand pumps, hydraulic ram pumps, ox ploughs, and windmills. They are, for the most part, free of close Central Government or Party control. As a result, non-Governmental agencies can make significant contributions of a technological and agricultural nature to these villages. In the end, however, true Ujamaa development depends upon strong political education and the development of an indigenous leadership. Such leadership is probably Tanzania's scarcest resource. At the moment one might say Tanzania is attempting to achieve Ujamaa by providing water systems but ultimate success or failure of the programme will really depend upon the type of leadership that is developed, not the quality of the water provided.

Discussion of Presentations

On the issue of the availability of leadership, a question was raised as to the nature of present efforts to train leaders for Ujamaa development. In reply, Mr. Cunningham stated that high level discussions on the issue were taking place that very day and that over the past year TANU had conducted a series of two week Ujamaa seminars through the country. Because to date only high level Party and Government leaders were attending these seminars, he was doubtful as to their results. It was his opinion that the seminars should be directed at the people who actually live in Ujamaa villages, especially their leadership elements, rather than those who administer policies from District or Regional centres. Mr. van de Laak explained that at Ndoleleji there is an attempt to have meetings among small groups of three or four ten-house cells for the purpose of explaining how to obtain a community water supply. It is his hope that these meetings will help individuals to take the initiative in organising community support for the schemes.

Discussion of Questions

Question 1. Does the provision of an improved water supply act as a catalyst for further development of a village community?

This question proved difficult to answer because environmental conditions and the consequent developmental needs of people vary greatly over East Africa. Most participants seemed to agree that an improved water supply, by itself, does not provide sufficient catalytic action to insure subsequent development but must be part of a larger programme of coordinated inputs for a rural community. These inputs could be as diverse as dispensaries, cattle markets, roads, and even agricultural extension agents. No clear answer was found as to whether water should be considered as an economic, social, or political input. General agreement was reached only on the need to plan the proper mix of inputs and to use scarce resources optimally. The varying needs of different areas were illustrated by a comparison of the priority of development inputs required in the Ndoleleji area of eastern Shinyanga Region in Tanzania [illegible] western Shinyanga region. In the dry [illegible] area, where the primary need is for water supply, experience has shown that farmers are more open to the introduction of improved agricultural methods when the problem of water has been solved. On the other hand, in the water-rich Salawe area, water supply is not a critical issue among the farmers. The historical pattern of development in this area begins with the formation of a cotton buying society and continues with the construction of ginneries, the provision of transport, and eventually the development of a cash economy. For both types of areas, however, the impact of water appears to be greater in projects providing new supplies, such as the transport of water by pipeline to formerly dry areas, than in projects simply improving old supplies, such as a covered well protecting a former water hole. The conclusions drawn from this discussion were (1) that water supply may not be the most needed input for subsequent development in some areas, (2) that indiscriminate implementation of water projects conceivably could result in no further development at all, and (3) that water supply, to be considered a pre-condition for development, must be a factor upon which social and economic changes are dependent. On this last issue, it was claimed that Government technical agencies are not capable of evaluating the social and economic aspects of rural water supplies and, therefore, require guidelines to assist them in the planning process.

Some controversy arose over Government activities in establishing new villages, some of which have been founded in locations without adequate sources of water. It was suggested that the Tanzanian Government set up an organisation responsible for the siting of Ujamaa villages in order to prevent their formation in areas lacking water and suitable agricultural soils, as has occasionally happened. In mitigation of the present Ujamaa policy, it was pointed out that the siting of new villages in areas without water with the consequent result of high cost water supply projects will continue to occur if water supply is looked upon only as a social service. If water supply is to be allocated on the basis of economic criteria, then the development potential of the village site should be considered. The problem facing the Tanzanian Government is that decisions to implement water supply projects are based on social criteria in some cases and on economic grounds in others. In Kenya, where two-thirds of the land is arid or semi-arid, and only the remaining one-third is productive, community water supplies are looked upon essentially in terms of the economic contribution they can make to the country. Further discussion on this issue resulted in the general view that Government should direct its policy of villagisation so as to encourage people to move out of the dry areas and into the better-watered locations having available open land. The participants agreed that the solution to this problem was complicated by the fact that water supply is a very emotional and political issue. However, it was added that the success of rural development efforts in Tanzania depended upon the efficient use of resources, and unless economics was considered in the formation of rural development policies, these efforts would fail.

Question 2. Should non-Governmental organisations or private individuals attempt to promote community development projects?

For the most part, this question was answered in the affirmative during the discussion of implementation in the previous session. A note of caution was added to this answer because of the strong ideological basis that often underlies methods of community development in East Africa. The programmes of non-Government organisations must be consonent with the goals and general development philosophy of the country. If this is so, then no official difficulties are likely to hinder the work of such organisations. In Tanzania, it was pointed out that the Regional Commissioner is the chief interpreter of Government policy in the field. Therefore, the voluntary agencies usually find it in their interests to obtain the official approval and full cooperation of the Regional Commissioner for any new programmes of community development. These agencies must be a bit more careful in their approach to the politically sensitive Ujamaa villages, but in general non-Government programmes for rural water supply are welcomed everywhere.

There was widespread agreement among the participants that the non-Governmental organisations deserved greater support by Government. At the minimum level, local Government and party officials could give verbal assistance to the activities of voluntary agencies by informing people at meetings and in schools of the Government's support of the work of these agencies. The people could be encouraged to take part in the various development projects sponsored by these organisations in the vicinity. In some areas greater coordination is needed between the Regional and local officials and the voluntary agency officials to insure that conflicts over issues of local leadership do not arise to hinder effective cooperation in the field. Many participants felt that Government should do even more than simply provide verbal and moral support for non-Governmental organisations. Government should take advantage of the fact that the activities of non-Governmental organisations often achieve results at far less cost than comparable Government efforts. Programmes that have proved worthwhile should be eligible for financial subventions, if this was felt necessary for the continued operation or expansion of these organisations. In short, the voluntary agencies are especially suited to initiate new projects and programmes. If these programmes prove successful, it is the consequent role of Government either to take over these programmes or to decide upon the proper level of support for the organisations sponsoring them.

VI PLANNING FOR RURAL WATER SUPPLY

Outline of Session

Chairman: Mr. Ian D. Carruthers, Institute for Development Studies, University College; Nairobi, Kenya.

Panelists: Mr. Andries Klasse-Bos, Economic Planning Division, Ministry of Agriculture; Nairobi, Kenya.

Paper: "Rural Water Supply in Kenya: Its Role in Development"

Mr. Pravinchandra C. Shah, Water Development Division, Ministry of Agriculture; Nairobi, Kenya.

Paper: "Rural Water Supply in Kenya"

Mr. F. D. Mbaga, Ministry of Economic Affairs and Development Planning; Dar es Salaam, Tanzania.

Mr. Bo Barting, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Dar es Salaam, Tanzania.

Questions for Discussion:

1. Should expenditures on rural water supplies be looked upon as a social service or an economic investment?

2. What are the long-term goals for rural water supply in both Tanzania and Kenya?

Additional Papers:

Ian D. Carruthers, Institute for Development Studies, University College; Nairobi, Kenya.

"Data Requirements for Programme and Project Appraisal"

Summaries of Presentations by Panel Members

Mr. Andries Klasse-Bos, Economic Planning Division, Ministry of Agriculture; Nairobi, Kenya.

Until recently, planning for rural water supply development in Kenya was mainly the responsibility of County Councils. No consistent criteria for project planning was used. The wealthier districts built more projects than the poorer ones because they were able to provide the local contribution required to make them eligible for matching Government grants. In any case, the overall provision of water supplies in the country was not only unbalanced but also lagged far behind other development activities. Early in 1969 the Inter-Ministerial Committee on Rural Water Supplies was set up to formulate a consistent policy for an enlarged rural water programme. The following important policy matters have already been decided by the Government:

(1) Rural water supply development will be phased over a thirty year period. In the first twenty years, all parts of the country will be provided with basic communal supplies, while in the final ten years, these schemes will be up-graded to provide individual house connections.

(2) Water rates to cover the capital and operating costs will be assessed for all schemes, but a flexible policy of assessment will allow for variations in local conditions. The rates will be based on the expected social and economic benefits for each scheme rather than the costs. During the first two years of each project, rates will be low in order to encourage use of the scheme and investments in additional development inputs.

(3) Methods of rate collection will be decided upon by the local people at each scheme along specific guidelines set up by Government.

(4) Government will re-evaluate its present policy of providing matching grants to County Councils and instead attempt to formulate a more beneficial allocation of national water projects.

(5) Well-defined criteria for the selection of proposed schemes should be used to assist water project implementation. At present, those criteria do not exist.

In general, the Kenyan emphasis is upon the quantity of water rather than the quality. This is because the construction and maintenance cost of treatment facilities are too high at present to justify their inclusion in schemes. Economics cannot be ignored in planning water supplies, especially since the Government regards water as the key factor in promoting the progress of people in the arid and semi-arid areas. The Second Five Year Development Plan proposes that investment in rural water supplies should increase from Shs. 10 million in 1969 to Shs. 38 million in 1974. One of the major problems facing Government is the widespread attitude that water is free. This is wrong, for socialism should not mean free water. To supply free water would mean that small privileged groups would be supported by the taxpayers.

Mr. Pravinchandra J. Shah, Water Development Division, Ministry of Agriculture; Nairobi, Kenya.

As described earlier by Mr. Klasse-Bos, County Councils in the past were mainly responsible for rural water supply development in Kenya, but recently Government has instituted an enlarged water programme to accelerate this process. The present two year programme of the Water Development Division in the Ministry of Agriculture includes 82 different schemes having a total estimated cost of Shs. 22.6 million. These schemes should be considered as pilot projects because varying types of organisational procedures, designs, methods of construction, techniques of operation and maintenance, and methods of water charges and rate collection will be attempted.

Several critical and unsolved problems were identified during the formulation of the two year programme. Firstly, the difficulty of raising finance from internal sources is a key constraint on the expansion of a water programme. It is relatively easy to obtain finance from external sources to pay for capital construction costs. Recurrent operating and maintenance costs, however, must be raised internally. Experience in Kenya shows that County Councils are much more interested in giving financial priority to roads, schools, and health than to the necessary maintenance of water projects. It would be very useful if research were conducted into the capacity of WDD to absorb finance and to determine the bottlenecks to the further expansion of the rural water supply programme. The second major problem is the lack of an engineering staff composed of Kenyan citizens. It is unfortunate that many expatriates from pre-independence times are still in the same posts and still using ideas and designs brought from Europe. Often expatriates are promoted more rapidly than Kenyan citizens of equal experience. In the last five years, at least five Kenyan citizen engineers have left WDD because salaries were two to three times higher on the private market. At present, there is an established roster of 25 engineering posts, but in the future the department will need the services of fifty engineers. In addition to engineers, there is also a great need for more inspectors and foremen to construct and operate water schemes.

Mr. F. D. Mbaga, Ministry of Economic Affairs and Development Planning; Dar es Salaam, Tanzania.

During the period of the First Five Year Plan, 1964-69, the Tanzanian Government provided water to about 60,000 people per year in the rural areas. This number will be substantially increased during the Second Five Year Plan, which allocates a total of Shs. 406 million for rural water supplies. Of this total, Shs. 325 million are earmarked for water supply development, Shs. 28 million for the expansion of facilities, and Shs. 10 million for surveys and investigations. The Ministry of Economic Affairs and Development Planning (Devplan) is now operating on a twenty year planning horizon. Actual water supply planning is carried out on a year to year basis by the local Regional Development Committee, but only rough project selection criteria are available for planning purposes at this time. The main financial criterion is that project capital costs must not exceed Shs. 200 per person served. Priority for project implementation goes to Ujamaa villages, areas of acute water shortage, and areas of population concentrations.

Many rural areas of Tanzania are handicapped by poverty, ignorance and disease. The problem can be alleviated by coordinating the proper complementary investments to water supply. Unfortunately, it is difficult to justify investments in water, and for this reason economics alone cannot provide a solution to major policy questions on rural water supplies. More information on all issues of this problem is needed and Devplan currently is looking into the areas of project selection criteria, the employment of complementary investments, and the promotion of small projects. Devplan also has begun a hydrological research programme for the purpose of identifying the available sources of water, especially groundwater. Furthermore, Devplan, with the assistance of SIDA (Swedish International Development Authority), is carrying out investigations into the use of self-help labour, future organisation of water development activities in Tanzania, and the future staffing of WD&ID.

Mr. Bo Barting, Water Development and Irrigation Division, Ministry of Agriculture, Food and Co-operatives; Dar es Salaam, Tanzania.

For the purposes of rural water supply in Tanzania the Water Development and Irrigation Division of the Ministry of Agriculture, Food and Cooperatives is primarily an executing agency rather than a planning agency. WD&ID has the authority and capability only to carry out micro-planning for efficient project implementation and site development. As an example of the amount of work accomplished by WD&ID in recent years, the Division constructed about one thousand rural water supply projects involving costs of Shs. 123 million during the period 1949 - 1969. A total of Shs. 60 million, or almost half, was expended during the last five years. For the year 1968-69, the expenditure was Shs. 13 million. The Division has the overall objective of providing an appropriate water supply to all rural people over the next forty years. More than eleven million people live in the rural areas, and only one million of them have adequate water supplies. At a maximum allowable capital cost of Shs. 200 per person, the remaining ten million people could be provided water supply in the planned forty years only if an average annual expenditure of Shs. 50 million were made. This would total Shs. 250 million over each five year period. WD&ID is unable to attain these expenditure totals at present, but it is increasing the current year expenditure from Shs. 17 million to a total of Shs. 30 million next year. Because of the discrepancy between required expenditures and available resources, the most effective activity for WD&ID at the present time is to improve its planning procedures in order to reduce the cost of supplying water to rural areas.

Discussion of Presentation

A question was raised as to what was being done by WD&ID to solve the manpower shortage in Tanzania. Mr. Barting replied that no specific additional training courses were being planned, although the cheapest way for the Division to increase its output of water projects would be through the improvement of planning procedures and the hiring of more engineers and middle grade technical staff. The Chairman, Mr. Carruthers, added that perhaps it was worthwhile to encourage interest in the technical professions by giving more educational bursaries for technical studies and by having WD&ID officials give talks on the technical fields in the secondary schools. Another question, directed at the Water Development Division in Kenya, inquired into the plans of Government to use the private sector in rural water supply construction. In reply, Mr. Shah of WDD stated that the use of private contractors in Kenya increased costs of projects by 25 percent over that of Government. It was less expensive for Government to hire more expatriate engineers than to give contracts to private firms.

Discussion of Questions

Question 1. Should expenditures on rural water supplies be looked upon as a social service or an economic investment?

Opinions on this question were as divergent as any other single issue in the Workshop. Individual viewpoints varied widely between the opposite poles of pure social service and pure economic investment, while organisational tendencies were characterised by the WD&ID-Tanzania view that water supply is basically a social service having some economic ramifications and the WDD-Kenya view that water supply is basically an economic investment having some social considerations. Those participants who favoured the social service viewpoint based their argument, firstly, on the essential role of water in human life and, secondly, on the contention that water supply does not affect the economic activities of the people. It was claimed that the supply of drinking water has no effect upon agricultural productivity, although rainfall, which is a different matter altogether, does.

Furthermore, the attempts to produce economic benefits by releasing part of the local labour engaged in water carrying was fruitless because of the large reservoir of unemployed labour available in rural area. One participant went so far as to propose that economists be excluded from the planning of some social services.

Participants favouring the economic view argued that because rural water supplies involved large allocations of scarce resources they must be considered from an economic standpoint. It was pointed out that the recently enlarged programme of rural water supply expenditures in Tanzania during the Second Five Year Plan amounted to almost fifteen percent of the development budget over that period. Because large amounts of scarce resources are committed and will continue to be committed to rural water supplies, it was necessary to have continual assessment, not only of the cost effectiveness of resource allocation among the various water projects but also of the national welfare resulting from the respective resource allocations between water supply and the other development sectors, such as health, education, and transport. It was claimed that water supply is not different than rural electric supply, which usually is justified on the basis of improved health and increased productivity. Finally, one participant argued that planning is a creative process, but too often planners do the obvious, such as supplying water to a dry area, without considering possible alternatives. Economic evaluations often can help to determine better solutions, to the ultimate benefit of both the local people and the nation as a whole.

Somewhat related to the above was the discussion of the issue of whether to supply water free or to charge a water rate. Rural water supplies in Tanzania are provided to the local users free of any requirement to repay capital or recurrent costs, whereas in Kenya annual water charges to cover both capital and recurrent costs generally accompany the provision of rural water. At present, no change is anticipated in the Tanzanian policy, although Devplan may look into this issue in the future. Most participants from Kenya favoured the idea of water rates in order to make schemes self-sustaining, at least in terms of recurrent costs with somewhat less support for including repayment of capital costs. The Tanzanian participants for the most part preferred to leave the issue of water rates alone and instead concentrated on the desirability of obtaining local contributions during the construction of projects. One Tanzanian participant, however, did concede that water rates were valid, but only if the resulting income was significant.

Question 2. What are the long term goals for rural water supply in both Tanzania and Kenya?

Actual programme goals for the Government water development organisations in Tanzania and Kenya were outlined in the presentations opening this session. In brief, Tanzania intends to provide appropriate water supplies to all rural people within forty years, while Kenya aims at providing communal supplies to all rural areas in the next twenty years and individual household supplies over the following ten years. A more limited two-stage set of water supply goals was suggested by one participant. For the first stage, a country should provide piped, communal water to a total number of people at least equal to the annual increase of population. To accomplish this, the country must have an up-to-date assessment of the number of people receiving piped supplies. The second stage should be to increase these supplies to at least 25 percent of the population over a ten year period. Another participant added the cautionary note that the selection of such goals, which have fixed percentages of people to be supplied with water, is based upon implicit premises as to the benefits that will result. Yet, these benefits have not been clearly defined, and what is needed first of all is additional information into the actual benefits of rural water supplies.

A second recommendation for future goals dealt with Government policy on middle level manpower resources. It was argued that present salary scales discriminate against the individual working in a technical engineering post. For example, a middle grade technical assistant earning Shs. 500 per month with WD&ID receives only half the salary of a comparably qualified agricultural advisor in the same ministry. This differential exists despite the fact that the technical assistant may be working under arduous field conditions and be responsible for the construction of a water project involving hundreds of thousands of shillings. The solution to this problem is partly a question of salary and partly a question of status. There is need for a review of salary scales and national education policy so as to improve the status of technical assistants and other similar personnel.

Final conclusions resulting from the Workshop discussions were summarised by the participants in the final session, which was chaired by Mr. Ian D. Carruthers, of the Institute for Development Studies, University College, Nairobi, Kenya. The results were prepared as a list of fourteen specific recommendations relating to present and future rural water supply development in East Africa. These recommendations were directed mainly at the planning and implementating agencies of the East African Governments because of their predominance in this field. However, many of the recommendations are equally applicable to the voluntary and non-Governmental organisations involved in water supply development as well as to the international organisations which have water programmes in East Africa.

The fourteen final recommendations should not be seen as a reflection of unanimous agreement among the Workshop participants. On several of the recommendations there was heated debate over the necessity, and even validity, of the statements. In addition, some participants disagreed with what they felt were the general trends of the recommendations and would have preferred somewhat different emphases. It is neither unusual nor unexpected that these differences of opinion would arise among a group of individuals having such differing professional disciplines and technical backgrounds. Indeed, if no differences of opinion had arisen at the Workshop, one would have been justified in expecting the problems of rural water supply to have been solved long ago. Each of the final recommendations, however, does represent the general concensus of the participants taken as a group. Because of this concensus, the following recommendations are presented as the final conclusions of the Workshop and are directed towards all organisations involved in the development of rural water supplies in East Africa.

Final Recommendations

I Field Research

1. All programmes of both research and planning require accurate baseline information which does not seem to be adequate at present. There is a need, therefore, for detailed inventories of water resources, water supply facilities, and local conditions and needs over all of East Africa.

2. It frequently is claimed that the provision of water supplies to a rural community releases labour for more productive activities. Further research is needed to determine the actual benefits that arise from greater labour availability as a result of a reduction of time spent carrying water.

II Public Health

1. There have been instances of rural water supply projects adversely affecting public health. Therefore, medical expertise should be integrated into the planning and design of rural water supplies from the outset in order to avoid unintended side effects upon the health of the community.

2. Because of some uncertainty as to the relationship between water supply and public health, research should be carried out to determine the public health benefits that do result from an improved water supply.

3. In addition to chemical analyses, routine bacteriological analyses should be an automatic part of water quality testing. Plans should be made to expand bacteriological testing facilities to include the eventual analyses of all rural water supplies.

III Technical Aspects

1. There is a great need for reappraisals of the technical aspects of rural water supply projects, especially current design standards and construction techniques. These reappraisals should take account of changes in available resources and prevailing social conditions.

2. In the short term the immediate need is for in-service training programmes to train and up-grade capable field personnel such as mechanics, surveyors, and project foremen. To meet long term needs greater staffing of professional engineering positions by East Africans should be promoted by encouraging students to undertake technical courses of study at both the technical college and university levels.

IV Implementation

1. Non-governmental organisations have proved efficient in certain types of water supply projects and deserve government encouragement and support, including financial assistance, where appropriate.

2. There are conflicting claims as to the efficacy of self-help labour; generally the consensus is that it is efficient on small schemes but less so on large schemes. Research should be conducted into the applicability of self-help labour to rural water supply implementation in East Africa.

3. One organisation in each country should be responsible for keeping an inventory of all current and future water supply projects and should act as an information clearing house for all organisations involved with these projects.

V Community Development

1. Evidence suggests that investment in water supply alone is insufficient to guarantee development and, therefore, an improved water supply by itself may not be capable of acting as a catalyst for further development of a village community. Further research on the relationships between water supply and other complementary investments and their effect upon subsequent community development is required.

VI Planning

1. In view of the recent increase in anticipated expenditures on rural water supplies there is an urgent need to review both the rules of thumb applied to project selection and the utilisation of alternative institutions to speed up decision-making. This review should be used in setting up short term plans, and, because of the uncertainti as to the resulting social and economic benefits, additional researc investigations into project selection criteria should be conducted to assist in the formulation of long term plans.

2. Local contributions by the beneficiaries of a water supply are highly desirable. Whether this contribution should be in cash, materials, or labour, and whether it should cover capital and/or operation and maintenance costs is subject to national policies and local conditions. Because of the changing needs for local contributions, however, a continuing reappraisal of such policies is necessary.

VII East African Rural Water Supply Conference in 1970.

1. Because of the importance of rural water supplies for the development of East Africa and because of the many unresolved questions raised at this Workshop, another larger conference should be held on the subject of rural water supplies in 1970.

PART TWO

PAPERS

The duplicating process used for this paper produces some pages which are heavily inked. For easier reading the following pages have been left blank:

50, 52, 54, 84, 110, 128, 130, 132,

140, and 142.

Beneficial Changes

General form of the hypotheses: The provision of an improved water supply to a rural area results in (... benefit listed bel

Benefit	Factor To Be Measured or Investigated	Some Details of Measurement or Investigation	Some Possible Const Affecting Benefit
Health			
1. Increased consumption of water.	Total daily domestic water consumption.	at household at natural water source at domestic point	distance to water facilities manpower
2. Higher quality of water.	Chemical and bacteriological quality of water.	old water source new water sources	system design source
	Domestic treatment of water.	boiling, filtering, etc.	available time education
3. Greater frequency of bathing.	Frequency of bathing.	adults children at household at other location	distance to water available time bathing facilities
4. Construction of better quality houses.	Quality of house.	type of construction age of house season when repairs made	time available materials available manpower
5. Improved medical care.	Daily water consumption by village.	water using activities of dispensary	distance to water manpower
6. Reduced incidence of diarrhea.	Records of diarrhea treatment at village dispensary.	dispensary records statements of villagers	diagnostic capabili medicine available education
Productivity			
7. Greater efforts on former productive activities.	Usage of time savings.	total time saved statement of villagers farming, housebuilding, etc.	equipment available attitude of villager manpower

Benefit	Factors To Be Measured or Investigated	Some Details of Measurement or Investigation	Some Possible Co Affecting Benefit
8. Efforts on new productive activities	Usage of time savings	statements of villagers brickmaking, self-help, etc.	equipment availab attitude of villa manpower
9. Improved livestock condition	Quality of livestock	herd sizes market weights veterinary reports	grazing areas disease control
10. Increased economic returns from livestock	Monetary returns	market sales	transport disease control attitude of villa
11. Expansion of commercial activity	Extent of commercial activity	number of dukas bus service co-operative activities	transport population
12. Expansion of water-using industries	Level of industrial development	brickmaking, coffee pulperies beer brewing, etc.	distance to water materials availab transport
13. Increased village Gross Domestic Product	Official financial records	tax rolls co-operative records	climate markets transport
Education			
14. Acquisition of new skills	Level of skills	job-training for water projects subsequent use of skills	size of project attitude of vill
15. Improved adult education	Participation in education activities	adult literacy community development lectures	government activ attitude of villa time available to villagers
16. Increased school enrollment and attendance	School enrollment and attendance	school records	time available t distance to scho

			villagers
16. Increased school enroll-ment and attendance	School enrollment and attendance	school records	time available t distance to schoc attitude of villa

Benefit	Factors To be Measured or Investigated	Some Details of Measurement or Investigation	Some Possible Constrai Affecting Benefit
Self Reliance			
17. More reliable water supply	Performance of water supply	seasonality maintenance records opinions of villagers	design materials climate
18. Greater local involvement in evelopment projects	Participation in development projects	types of projects frequency of participation size of projects	attitude of villag transport availabl time available to v
19. Greater local awareness of benefits of co-operative efforts	Knowledge of benefits	statements of villagers	attitude of village education
20. Increased use of local labour, supervision and materials	History of water project	labourers, supervisors, materials official project records statements of villagers	design attitude of village
21. Increased home ownership by heads of families	Ownership of homes	number of house number of families population per house	distance to water land available attitude of village
Modernisation			
22. Greater acceptance of technology as a means of improving life	Attitudes towards technology	attitudes of villagers	attitudes of villag past experiences education
23. Greater sense of nationalism	Attitudes and actions towards nation	opinions of villagers response to govt. plans participation in national organisations	education government official attitudes of villag past experience
24. Increased rate of development in the village	Level of economic and social achievement	time sequencing of past proj. time sequencing of posting of government officials to village	time available to v government official attitudes of villag

Benefit	Factors To be Measured or Investigated	Some Deatils of Measurement or Investigation	Some Possible Constr Affecting Benefit
Ujamaa Socialism			
25. Greater commitment to co-operative activities	Acceptance of and action in co-operative activities	opinions of villagers self-help projects co-operative activities	attitudes of village education
26. Greater sense of socialistic ownership of water supply	Attitudes towards ownership of water supply	attitudes of villagers	attitudes of village education
27. Increased population clustering of the area	Population density in village area	population housing units areal extent of village	traditions of villag attitudes of village transport available land available
Equality			
28. Greater accessibility to water	Accessibility to water	distance to water time required to get water population	distance to water land available design
29. Reduced disparities of effort in obtaining water	Time devoted to water carrying	total time per household total household water consumption manpower available	manpower transport design
Democracy			
30. Greater democratic participation in decision making	Participation in decision making	activities of Village Development Committee activities of Co-operatives statements of villagers.	time available to vi past experiences attitudes of village

Field Studies

Information for this investigation is collected from a variety of sources: village field studies, Government files, and interviews with various officials ranging from the village to the national level. The field studies occupy the greatest amount of time. Villages are selected on the basis of several criteria which include their present and future water supply, their population, their representativeness to the water supply situation of the country, and their accessibility by bus transport for the student enumerators who collect the data. In general a selected village is investigated by three or four University College students who spend about one week on site. Approximately 15% to 30% of the heads of household in the village are chosen at random and then interviewed as to their water consumption patterns and other activities relating to one or the other of the 30 potential benefits. The questions in these household interviews are asked in an open-ended manner, with the student checking off the villager's reply on a precoded answer list. All questions are asked in Swahili for uniformity of presentation. Additional information is obtained from locally-based officials, such as the Bwana Shamba, Headteacher of the primary school, branch co-operative society chairman, etc, from commercial shops and from actual observations and measurements of water consumption and water carrying distances. Return visits are made to villages whose water supply situation has changed as a result of a new water project.

Classification of Villages by Type of Water Supply

Villages are classified according to five basic types of water supply situations:

Type 1: Villages without an improved water supply and with no expectation of obtaining one in the near future.

Type 2: Villages without an improved water supply, but expecting (or hoping) to obtain one sometime in the future (undetermined).

Type 3: Villages without an improved water supply at the present time, but are expecting to complete a water project in the very near future. (This is a "before" case.)

Type 4: Villages with an improved water supply that has just been provided in the recent past. (This is an "after" case.)

Type 5: Villages with an improved water supply that has been functioning for a year or more.

A total of 26 villages located in ten different districts of Tanzania are included in the investigation. An attempt has been made to select clusters of villages having similar economic, ethnic, and social characteristics but dissimilar water supply characteristics. Thus, an ideal cluster consists of three closely grouped villages, one of which has a type 1 water supply; the second has type 5, and the third has a type 3 supply which changes to a type 4 during the period of study. Investigations of the third villages at the time of its type 3 supply and later at the time of its type 4 supply serve to determine the changes that occurred in the village over that time interval. The other two villages are used for control purposes. Table 1 includes all the villages with their respective water supply types at the time of the initial investigation.

Table 1. Types of Village Water Supplies at the Time of Initial Investigations.

District		Village	Type of Water Supply
Pare	(Kw)	Kwakoa	3
	(Ny)	Nyata	2
	(Ng)	Ngulu	2
Kilimanjaro	(Md)	Mdawi	3
	(Ms)	Msaranga	3
	(PN)	Pumwani-Nanga	1
	(Mb)	Mbuyuni	5
Morogoro	(Ml)	Mlali	3
	(Kip)	Kipera	2
	(Pa)	Pangawe	3
	(Mik)	Mikese	5
Handeni	(Kz)	Kwedizinga	2
	(Kit)	Kitumbi	3
Rufiji	(Kib)	Kibiti	5
	(Bu)	Bungu	3
Dodoma	(Mat)	Matumbulu	1
	(Mw)	Mwitikira	5
	(Mv)	Mvumi	3
Singida	(Man)	Mangida	3
	(Sa)	Sagara	3
	(It)	Itaja	3
Shinyanga	(Sal)	Salawe	5
Manyoni	(Kil)	Kilimatinde	3
Kisarawe	(Mg)	Msegani	1
	(Vik)	Vikawe	1
	(Kis)	Kisambo	1

Return visits are being made to a number of the villages. It is intended that all villages having a type 3 water supply project will be re-investigated upon completion of their water supply projects. To date, data is available for return visits to nine of the villages, as listed in Table 2.

Table 2. Types of Village Water Supplies at the Time of Second Investigations.

Districts	Villages	Type of Water Supply
Pare	Kwakoa	4
	Nyata	2
Kilimanjaro	Ngulu	2
	Mdawi	4
	Msaranga	4
Morogoro	Mlali	4
	Kipera	2
	Pangawe	4
Rufiji	Bungu	4

Field Observations and Measurements

Preliminary water use summaries for the initial investigations are given in Table 3, while that for the return visits are tabulated in Table 4.[1] A word of caution is attached to the use of these data, which are based upon the verbal responses of villagers. Because of the subjective nature of these quantitative replies, inaccuracies and inconsistencies are common. For example, villagers in Kipera during the initial investigation in May, 1969, reported that their sources of water averaged a distance of 0.65 miles from their home, but these same villagers in September reported that the distance averaged only 0.16 miles. In both instances the villagers drew their water from th same locations on the same source, the Mlali River.

Major efforts are presently being made to obtain actual observations and measurements of such quantifiable data as distance, time, and total quantities of water consumed in the village. A few such measurements, although again preliminary, are available, as shown in Table 5. On the basis of this information, the actual distance between the Kipera households and their sources of water averages 0.43 miles. The water-carrying times listed in Table 5 are based upon an assumed walking speed of 2.5 miles per hour over the distance measured to the water source. It is expected that further analysis and additional data will modify the results presented in Table 3 to 5.

Before and After Comparisons of Areas of Water Influence.

As a graphic illustration of one effect of an improved water supply upon a village, Figures 1 through 4 show the influence of available water sources upon water carrying distances in the Pare District villages of Kwakoa, Nyata, and Ngulu and the Morogoro District village of Pangawe. Figures 1 and 2 reflect a before and after situation, respectively of a new water project in the Pare villages, while Figures 3 and 4 present the same type of information for the Morogoro village. In the case of the Pare villages, the distances to traditional sources of water are so great that the construction of a pipeline to Kwakoa village significantly affected the water carrying patterns of a portion of the households of both Nyata and Ngulu villages, even though these households are situated up to 1¼ miles from the Kwakoa pipeline. The drawings of both the Pare and Morogoro villages clearly show the changes in water supply influence areas that result from the introduction of domestic water points into communities that previously used traditional sources of supply.

Analyses and Conclusions

Subsequent analyses will attempt to show the effect of the above projects upon the people's daily activities, aspirations, and attitudes. Such analyses have already begun and will continue through the first months of 1970. With the exception of a few unfinished village investigations, most of the data collecting from the field has been completed. Data processing and correlations of factors within and between villages will be partially carried out by the use of a computer. The final report, containing recommendations for Regional Development Committees, WD&ID, and DEVPLAN, will be completed by mid-1970.

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[1]Additional data pertaining to water-related activities and attitudes of the people was presented in an earlier report. See, Dennis Warner, "Rural Water Supply and Development: A Comparison of Nine Villages in Tanzania," E.R.B. Paper 69.17, University College, Dar es Salaam

Table 3. Water Use Data From First Investigation Interviews

	Pare			Kilimanjaro				Morogoro				Handeni		Rufiji		Dodoma			Singida			Shinyanga	Manyoni	Kisara	
	Kw	Ny	Ng	Md	Ms	PN	Mb	Ml	Kip	Pa	Mik	Kz	Kit	Kib	Bu	Mat	Mw	Mv	Man	Sa	It	Sal	Kil	Mg	Vik
Population																									
Total Households in Village	72	45	106	90	37	50	74	172	96	94	177	110	122	193	164	290	140	128	119	123	200	44	35	244	87
No. of Households Interviewed	21	9	25	16	8	9	18	33	29	34	40	25	29	45	36	37	31	29	25	17	24	15	22	29	16
Population per Household	7.2	6.4	7.4	5.6	8.5	7.1	5.6	4.7	4.3	4.6	5.2	5.4	6.0	4.9	4.2	7.3	6.0	5.8	5.5	7.6	6.2	5.5	5.4	4.1	4.2
Total Village Population	518	288	785	504	314	355	414	808	413	432	920	594	732	945	689	2118	840	742	655	935	1240	242	189	1001	365
Daily Water Use at the House																									
Debes per Household	1.9	2.5	2.5	3.4	4.8	5.0	3.5	4.0	3.8	3.3	4.4	3.2	3.0	4.7	4.8	2.8	3.0	4.1	2.4	4.5	3.6	4.5	7.9	4.3	2.8
Gallons per Capita	1.1	1.6	1.4	2.4	2.3	2.8	2.5	3.4	3.5	2.9	3.4	2.4	2.9	3.8	4.6	1.5	2.0	2.8	1.7	2.4	2.3	3.3	5.8	4.2	2.[illegible]
Distance to Water Source																									
One-Way Distance (miles)	2.6	3.1	1.1	.63	1.5	1.4	.55	.63	.65	.46	.27	.78	.43	.36	.70	2.1	.45	.61	2.2	1.2	2.4	.14	.25	.19	1.0[illegible]
One-Way Distance (feet)	13700	16400	5800	3330	7900	7400	2800	3330	3430	2430	1430	4120	2110	1900	3690	11100	2380	3220	11600	6300	12700	740	1300	1000	540[illegible]
Walking Time and Trips																									
One-Way Walking Time (min.)	115	127	44	20	42	36	26	26	21	15	11	42	25	13	22	53	14	11	86	32	39	5.7	9.1	12	34
No. of Adult Trips per Day	1.9	2.6	2.2	2.3	3.6	3.1	2.7	3.5	4.1	3.4	4.0	2.4	2.7	3.8	3.6	2.6	2.9	2.7	2.0	3.0	3.7	3.4	0.7	3.3	2.[illegible]
Daily Adult Walking Time																									
Total Time per Household (min.)	437	661	195	93	304	239	146	182	173	103	90	200	134	100	156	276	82	61	343	192	289	39	13	79	17[illegible]
Total Time per Household (hr.)	7.3	11	3.2	1.6	5.1	4.0	2.4	3.0	2.9	1.7	1.5	3.3	2.2	1.7	2.6	4.6	1.4	1.0	5.7	3.2	4.8	0.6	0.2	1.3	3.0

Table 4. Water Use Data From Second Investigation Interviews

	Pare			Kilimanjaro		Morogoro			Rufiji
	Kw	Ny	Ng	Md	Ms	Ml	Kip	Pa	Bu
<u>Population</u>									
Total Households in Village	73	44	106	94	40	172	96	94	164
No. of Household Interviewed	18	12	21	14	12	34	29	34	31
Population per Household	6.2	4.9	7.0	6.6	6.4	4.3	4.4	4.5	4.2
Total Village Population	452	216	742	620	256	740	422	423	689
<u>Daily Water Use at the House</u>									
Debes per Household	3.3	3.1	2.7	4.9	4.2	4.3	4.3	4.4	5.2
Gallons per Capita	2.1	2.5	1.5	3.2	2.6	4.0	3.9	3.9	5.0
<u>Distance to Water Source</u>									
One-Way Distance - (miles)	0.11	1.9	0.51	0.14	0.58	0.05	0.16	0.03	0.21
One-Way Distance - (feet)	580	11000	2690	740	3060	260	850	160	1100
<u>Walking Time and Trips</u>									
One-Way Walking Time (min.)	5.6	59.7	15.7	5.6	18.8	3.1	9.2	2.0	7.3
No. of Adult Trips per day	3.1	2.9	2.9	3.5	3.1	4.3	3.1	4.1	4.2
<u>Daily Adult Walking Time</u>									
Total Time per Household (min.)	34.7	346	91.0	39.2	117	26.7	67.0	16.4	30.7
Total Time per Household (hr.)	0.6	5.8	1.5	0.7	2.0	0.4	1.1	0.3	0.5

Table 5. Measured Distances and Times to Water Sources

	PARE			MOROGORO		
	Kwakoa	Nyata	Ngulu	Mlali	Kipera	Pangawe
First Investigation						
One-Way Distance (mi.)	2.3	1.9	0.8			
One-Way Distance (ft.)	12100	9900	4200			
One-Way Time (min.)	55.0	45.0	19.1			
Second Investigation						
One-Way Distance (mi.)	0.16	1.2	0.59	0.12	0.43	0.08
One-Way Distance (ft.)	870	6100	3100	650	2283	407
One-Way Time (min.)	4.0	27.7	14.1	3.0	12.9	1.3

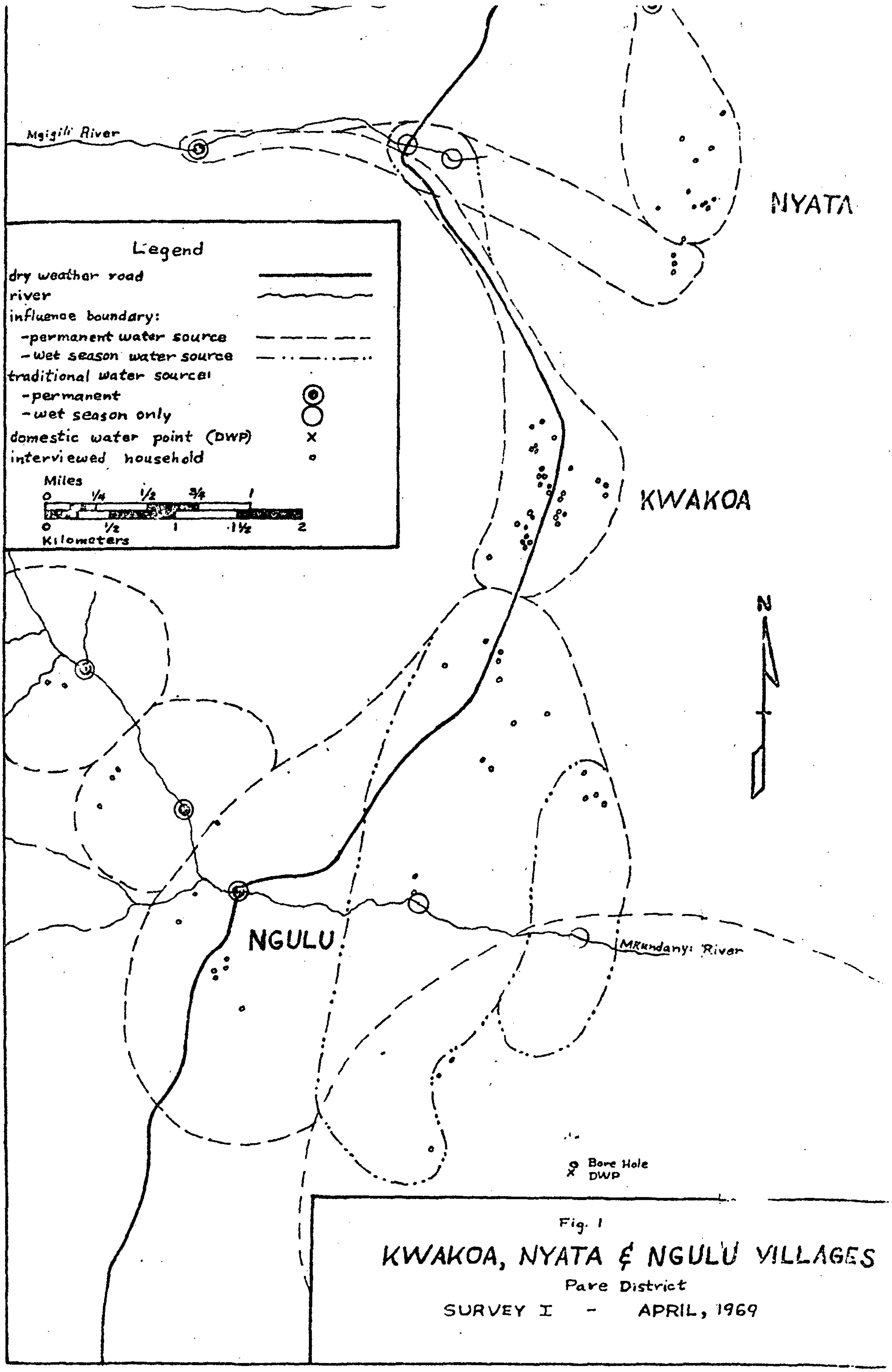


Fig. 1

KWAKOA, NYATA & NGULU VILLAGES

Pare District

SURVEY I - APRIL, 1969

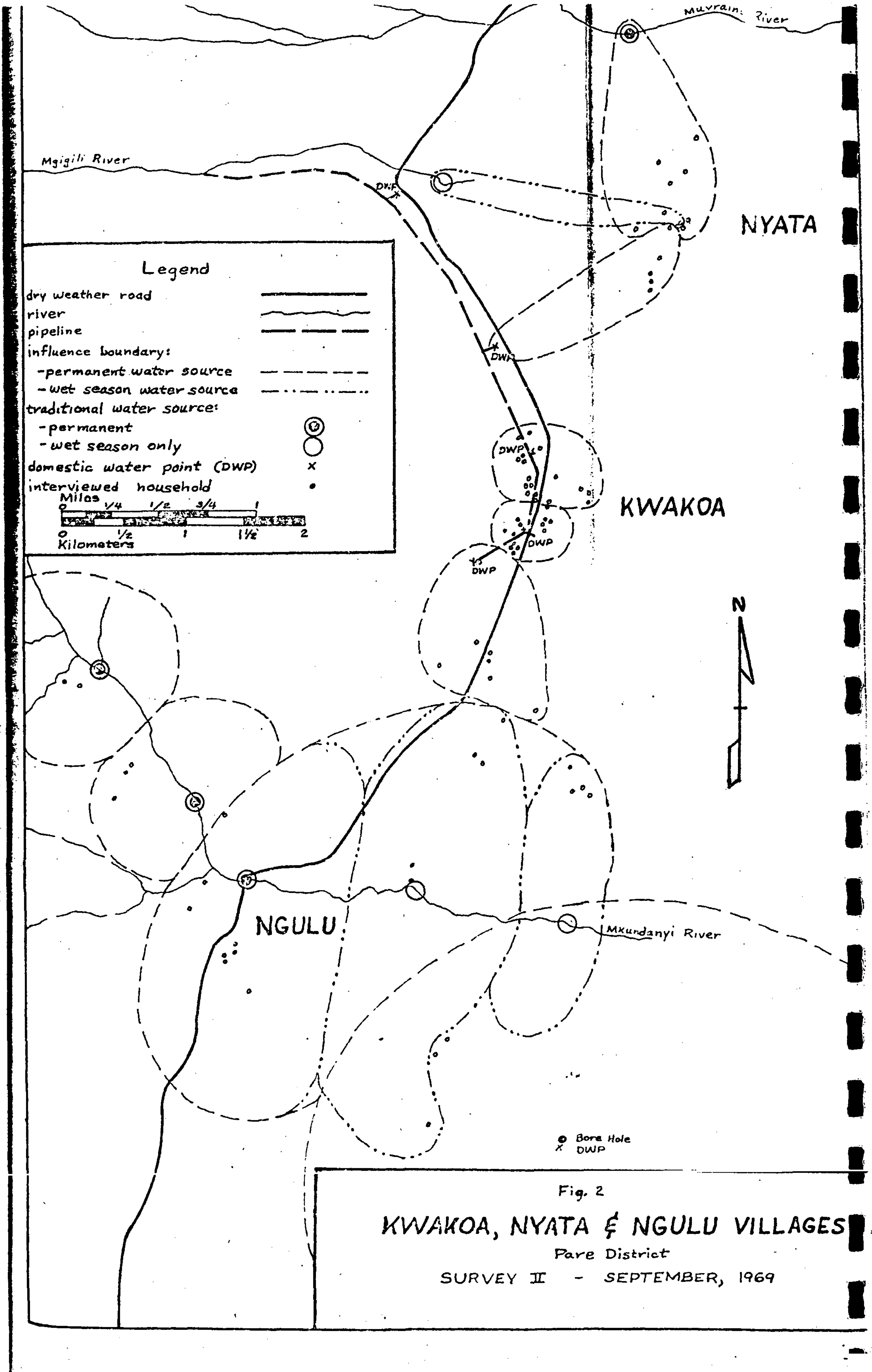


Fig. 2

KWAKOA, NYATA & NGULU VILLAGES

Pare District

SURVEY II - SEPTEMBER, 1969

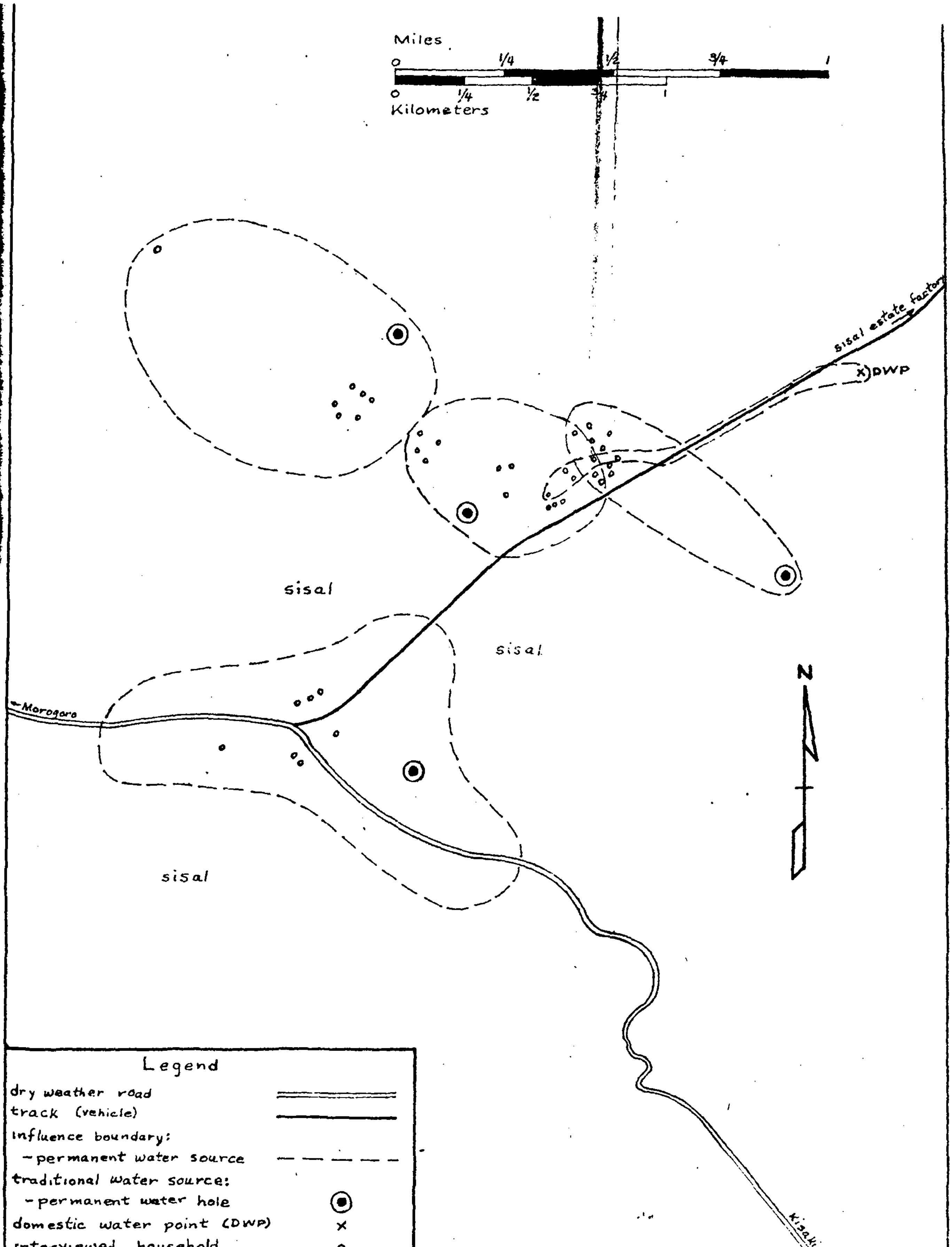


Fig. 3

PANGAWE VILLAGE

Morogoro District

SURVEY I — MAY, 1969

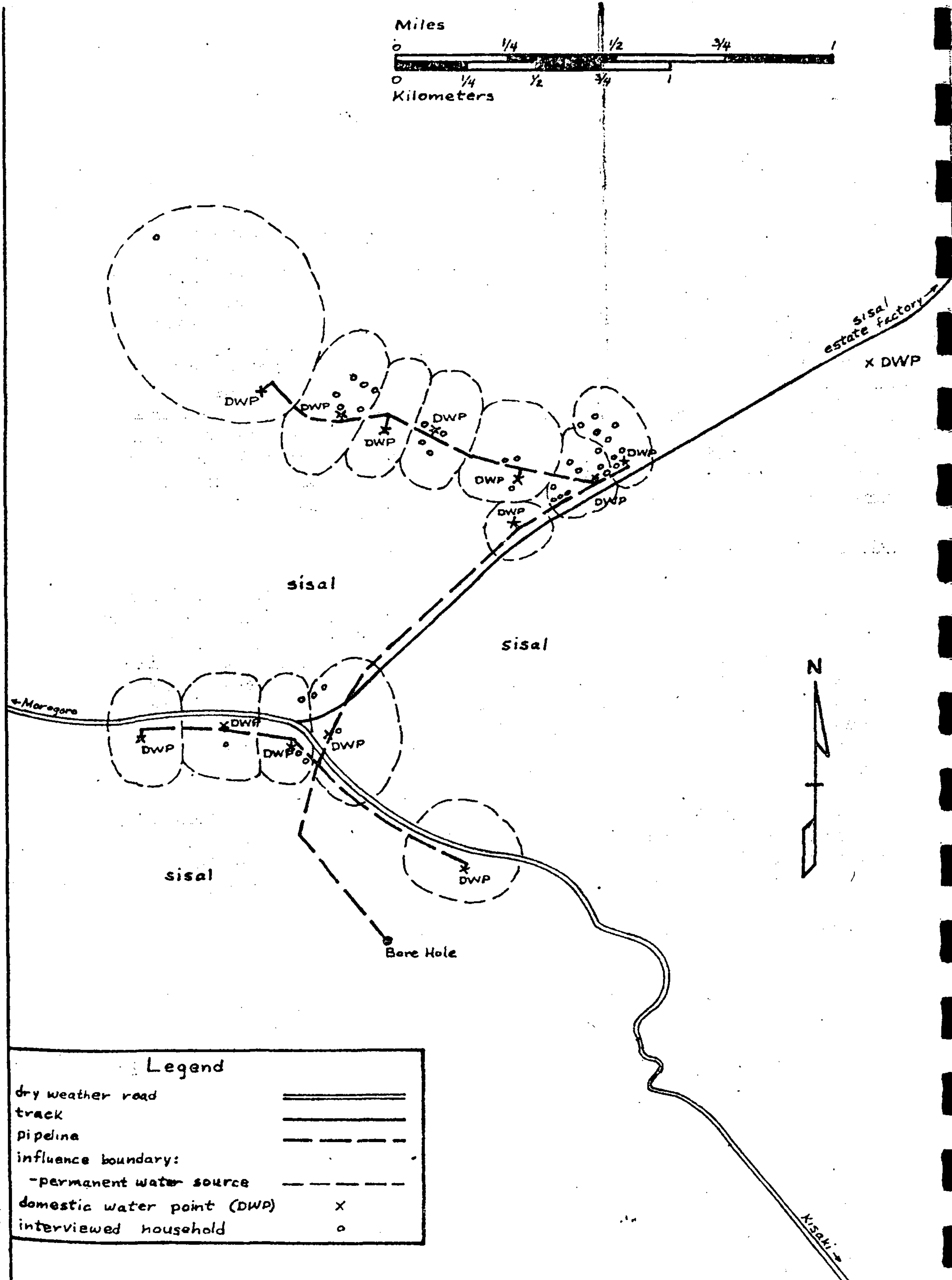


Fig. 4

PANGAWE VILLAGE

Morogoro District

SURVEY II - OCTOBER, 1969

Rural Water Development in ~~East~~ North East Nzega

by L. Berry and J. McKay

Introduction

North-east Nzega has been a relatively empty area until the last 15 years. However, since then there has been a steady inflex of people into the area mainly from the north (Sukuma) but also from the west and east. This movement may be part of the general spread outwards of the Sukuma farmers but it appears to have been assisted here by the presence of good cotton growing ibushi soils and since 1960 by the possibility of improved facilities in the area. The first facility was communication - the east-west road now crosses the area and has greatly improved links with Nzega and Singida. The second facility to be discussed in more detailed in this paper was the provision of drinking water in what hitherto had been a waterless zone in the dry season. In total the investment in rural water supply for an area of about 660 square miles (Map 1) has been a major undertaking which will not be complete for several years yet. Some of the problems and achievements of this exercise are discussed here, mainly those related to the rural water supply.

Plans for Rural Water Investment

Local authorities and Water Development and Irrigation Division (WD&ID) were quick to recognise the need and possibilities of the area and various systems of water control have been discussed for over 15 years. There are two dam sites in the surrounding hills, the smaller of which, the Bulenya Hills site (Map 1), has already been exploited by a earthfill dam built in 1959-60 and which stored 2,320 acre-feet of water. Later in 1963 - 1967 a pipeline 16 miles long was constructed to provide drinking water to the growing population and to a large number of stock at the maximum rate of 144,000 gallons per day.

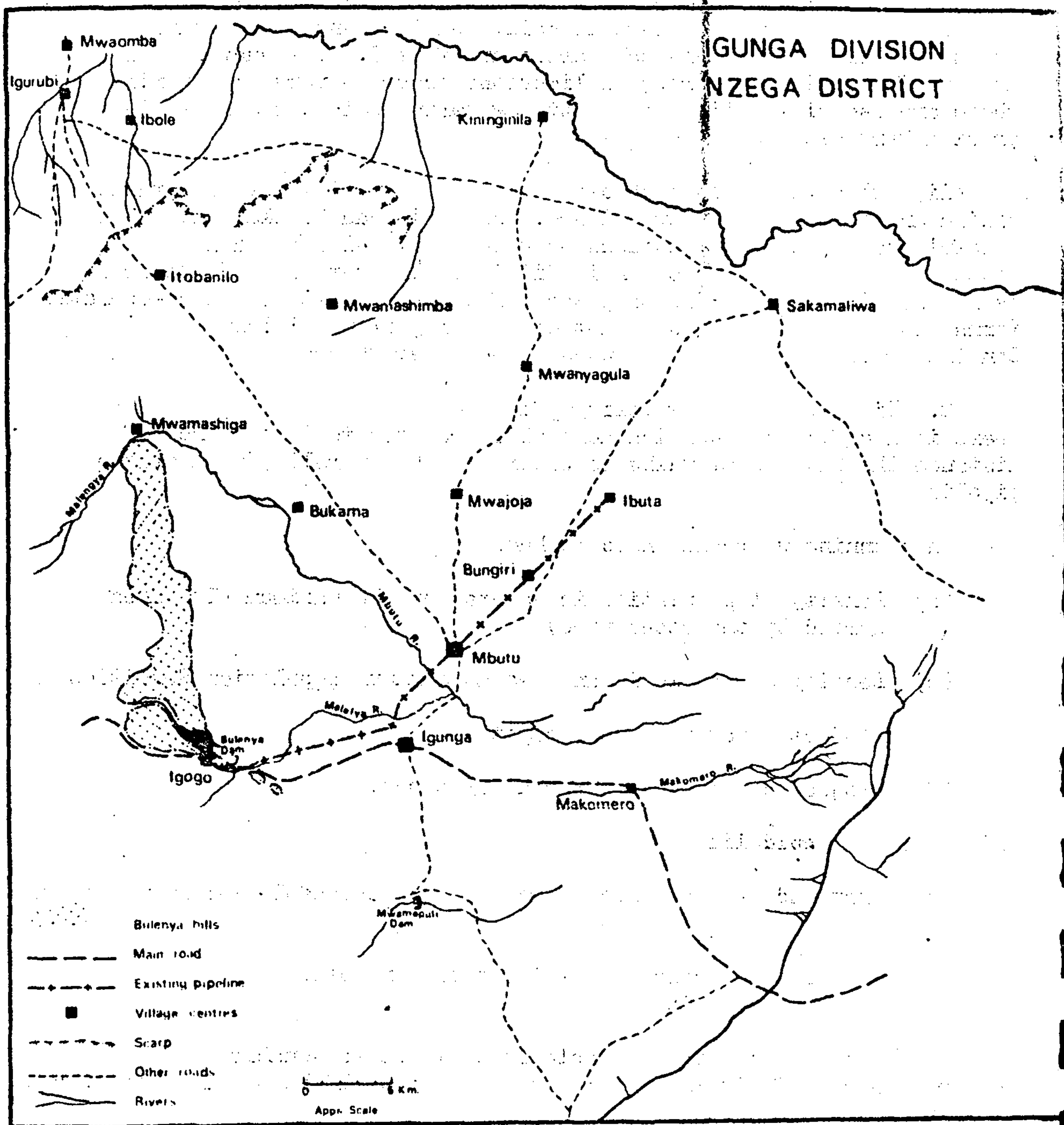
A Bureau of Resource Assessment and Land Use Planning (BRALUP) study of the benefits of the pipeline concluded "in the recent impressive growth of population in north-east Nzega the Bulenya Hills pipeline has played an important role by providing a permanent water supply to an area of such seasonal aridity but other factors notably the construction of the East-West road, have been equally important." (Research Report No. 5. BRALUP).

However at present an extension of the water supply system is planned. By the constuction of another dam at Mwamapuli a much wider pipeline system is contemplated which will eventually serve an area of about 600 square miles. Our present concern is to maximise the opportunities presented by this major investment and to attempt to learn from the experience of the Bulenya Hills pipe.

The Bureau has carried out a survey of the area. Much of it has still to be analysed and presented to Government before it can be fully discussed but the study of the water problems can be summarised as follows:

1. The area is poorly mapped and at first sight appears to be rather featureless except for a sharp minor scarp which bounds the main distribution area to the north and which divides the area into two along a north-south axis.

The temptation is therefore to cover the area with a rather uniform grid of pipes based on the distance people might be expected to travel for water. We have shown that two other considerations should also be borne in mind when the pipeline distribution is laid down.


IGUNGA DIVISION
NZEGA DISTRICT
Mwaomba
Igurubi
Ibole
Kininginila
Itobanilo
Mwanashimba
Sakamaliwa
Mwanyagula
Mwamashiga
Bukama
Mwajoja
Ibuta
Bungiri
Mbutu
Mbutu R.
Malaiya R.
Bulenya Dam
Igunga
Igogo
Makomero R.
Makomero
Bulenya hills
Main road
Existing pipeline
Village centres
Scarp
Other roads
Rivers
0
6 Km.
Appx Scale

udy of

m.

(i) Outlet locations should where ever possible be in areas of less erodible or at least less fertile soil. Cattle tend to concentrate around watering points and bare areas are formed. Fortunately in a number of locations outcrops of limestone occur on very slight rises. These are useful locations for cattle watering points where little erosion harm will be done.

(ii) That the outlets should be arranged to at least encourage ujamaa and co-operative agriculture. How this can be done will need careful and detailed discussions between all local authorities concerned. The whole question is difficult in that much of the area is now settled and it will be a case of attempting to create co-operative forms from the present system not of starting from a 'clean sheet'. Can the provision of water be used to encourage Ujamaa?

2. Distribution of watering points:-
There is a difficult question here which relates to the balance of distance the individual walks to water and the overall spread of the pipeline.

In planning we really need to know

(a) Density of population in an area at the maximum (The area served by the stand pipe)

(b) Density of cattle in an area at maximum population densities

(c) Projected water use per capita

(d) Projected water use per head of stock.

and to have as guidelines

(a) What under local circumstances is a reasonable walking distance to water?

(b) What is a reasonable waiting time for water when you get to the stand pipe?

With this ideal data available it would be reasonably easy to construct a set of alternative layouts and it would be possible to obtain an optimum use of the water.

3. Water and Health
In a large scheme of this kind it is important that every opportunity is taken to combine the provision of rural water supply with an improvement in the quality of the water. As Bradley and White (In Press) show there are considerable economic difficulties in providing an absolutely pure supply but there are also major dangers which are to be forced when one source provides water for a large population. The streams and other water sources of N.E. Nzega are infected by bilharzia snails and the Bulenya Hills dam and pipeline is likewise infected. Must the Mwamapuli Dam also be an infected area? It seems important to us that the status quo should be improved upon and we understand that purification methods are to be applied in the larger dam.

Investigations on Water Supply in the Area

In addition to our original study of the impact of the Bulenya Hills pipeline, Dr. Ferster of the Bureau has been investigating a series of problems of water use as outlined in the attached questionnaire: (Appendix I)

This survey had the following main objectives:

a) To assess current water use of the Bulenya Hills Pipeline at four different locations and under different conditions of the pipeline.

b) To describe current rural water use (both domestic and livestock) in the remainder of the study area not being serviced by the present pipeline.

c) To make projections on rural water use that will be associated with the proposed agricultural expansion and with the new pipelines.

Miss Conyers in a sample survey of 700 households in the area has attempted to answer the question 2a above on the present density of population. We should be able to obtain information on maximum possible densities from this data and our land use and soil maps at present under construction.

We still have no firm idea of the cattle totals in the area and the question of length of walk to the watering point will probably be settled empirically by the finance available. As a general rule it would seem that the benefits of a coarser network covering a larger area must be weighed against the dangers of over concentration of cattle at watering points and consequent erosion dangers. The menace is very real in this area. Domestic water points should however be made available to as wide an area as possible.

However at a number of outlet points we have noted very considerable waiting times particularly when there have been problems with the pipeline. It may be necessary therefore to provide additional taps at outlet points if a wider net of outlets is envisaged.

Good water supply like health and education is a basic amenity which as many as possible of the citizens of East African countries should enjoy. In Tanzania there has been through the first five year plan and projected for the second an emphasis on rural water development and the results can be seen in most regions of the country. Much however remains to be done and under the inevitable constraints of finance and manpower we need to make every effort to maximise the benefits of our available investments. Perhaps by exchanging views on some of the basic questions raised in this and other papers, the workshop can play a small part in this effort.

APPENDIX 1. RURAL DOMESTIC WATER USE

1. Do you have a metal roofed house?
2. How much water is collected from rain (as a percentage of domestic use)?
   (a) In a normal year?
   (b) In this year 1968-69?

Wet Season:

3. Where is water drawn (source)?
4. How far from the house is this? (in time and linear distance) Specify one way or return journey.
5. How many people draw water regularly for your house?
   Number of children (under 15 years)?
   Number of adults over 15 years?
6. How many trips are made (per day on the average)?
7. How much water is drawn in one trip (estimate in gallons)?
8. What are the hours that water is drawn? (Total time for going, collecting and returning to the house)
   A.M. till
   P.M. till
9. What is the size of the container in which water is stored in your house (in gallons)?
10. Number of times clothes get washing in a week?
    In a month?
11. Approximate number of hours spent in washing clothes each time?

Dry Season:

1. Where is water drawn (source)?
2. How far from the house is this? (in time and linear distance) Specify one way or return journey.
3. How many draw water regularly for your house?
   Number of children (under 15 years)?
   Number of adults over 15 years?
4. How many trips are made (per day on average)?
5. How much water is drawn in one trip? (estimate in gallons)
6. What are the hours that water is drawn?
   A. M. till
   P. M. till
7. What is the size of the container in which water is stored in your house (in gallons)?
8. Number of times clothes get washing in a week?
   In a month?
9. Approximate number of hours spent in washing clothes each time?

FIELD INVESTIGATIONS AND RESEARCH PROGRAMME IN TANZANIA

by Dariusz J. Stanislawski

1. Modern Water Economics Development: the important and necessary factor on the way to the development of all major branches of National economy - Agriculture, Industry, Culture and Health.

Water Development (or rather Water Economics Development) has a special and quite close relationship to all the important branches of the national economy; it can speed up the development but if ignored or misinterpreted it can also bring any development venture to the edge of collapse. This branch of the engineering science is also strongly influenced by the natural and climatic condition which must be observed through the related natural sciences of hydrology, meteorology, hydrogeology etc. With its variety of climatic geological conditions, and also with its relatively short (or even in some areas NIL) periods of observation of these natural phenomena, Tanzania is the very country where the establishment of modern national water development services must be looked upon as an especially important factor to speed up development of the nation.

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2. Changing and Increasing Range of Activities: a difficult challenge for all the Water Economics Development Services, which needs mobilisation and concentration of all resources on a new down-to-darth programme.

The second Five-Year Development Plan outlines the ambitious tasks of development of all branches of Tanzania's economy, with special emphasis put on development of agriculture, increased development of more underdeveloped parts of the country-side, increased local participation of the people in their own development through "Ujamaa Villages" and self-help work.

The present water economic and engineering services are organised into:

a) a full range of professional services for the design and construction of rural piped water supplies.

b) a full range of professional services for the design and construption of small and medium size dams, charcos and flood control works.

c) a full range of professional services for well drilling.

d) a full range of services for the design and construction of irrigation schemes.

e) nation-wide services in hydrology and administration of the water rights.

It must be noted that : 1) the "contractor type" centralized organization of the Water Development and Irrigation Division (WD&ID) went only down as far as the regional level, 2) all constructed structures were handed over to the local (District authorities, 3) hire and renewal charges and vote control system kept staff and equipment movements quite expensive (just to keep efficiency of the contractor type organization.)

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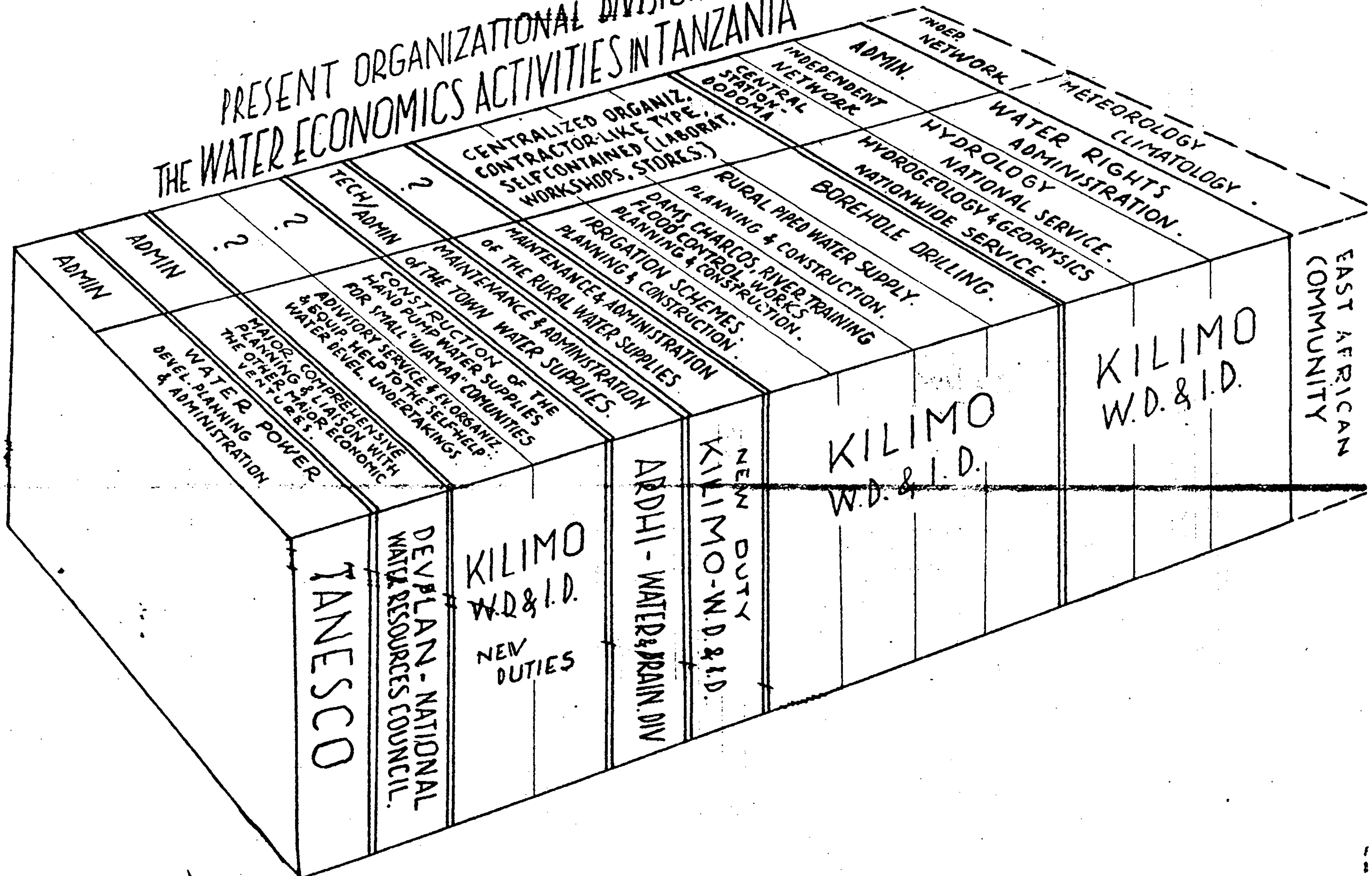
PRESENT ORGANIZATIONAL DIVISION OF THE WATER ECONOMICS ACTIVITIES IN TANZANIA



It has also to be noted that all those above listed activities increased in number and range very considerably over the period of the first Five-Year Development Plan, and Water Development and Irrigation Division is working to its full present staff and equipment capacity.

The New Tasks Are:

a) Taking over administration maintenance and repairs of all rural water supplies in the country from the District Councils as of 1st January, 1970.

b) Construction of a large number of individual ring or blockwork wells with hand pumps for small or scattered "Ujamaa Village" communities all over the country.

c) Advisory service and assistance (eventually the construction equipment) for self help work in the villages on construction of minor water supplies and irrigation schemes.

d) Participation in the activities of the foreign expert teams employed on the preparation of the major water economics projects (such as the Great Ruaha Dam, Stieglers' Gorge Dam, etc.) to assure consideration of all local interests known to the regional and professional staff of the Division.

The first three of the above listed tasks are especially difficult because efficient performance will probably require future expansion of our activities down to the District Level. This will need expansion on the middle technical staff level - just where the biggest shortage occurs.

Challenging also is the time factor. Standardisation and the field testing of both equipment and working methods will be necessary and this is not easy with Tanzania's variety of natural conditions. The same can be said about the organisational experience in collaboration with the villagers and the local authorities in implementing the new tasks.

All this must go together with further modernisation and rationalisation in both the design and construction processes to make also the bigger structures cheaper and better suitable to Tanzanian conditions.

Facing the realities we must now compile together all the tasks and the needs and mobilise all (not only departmental) resources available. A down-to-earth "programme-timetable" of how to win the battle would be the necessary ultimate goal.

3. The Comprehensive Water Economics Development Programme - will have to be based on the facts and needs collected from up-country reports, on the spot enquiries, as well as field investigations and tests. The programme will also have to conform with the anticipated needs of the current second Five Year Development Plan.

The initial proposals concerning the programme are as follows:

3.1 The programme should have a comprehensive, complex character and should include all three basic fields of action: the technical (including the field investigations and tests programme), economical and very important organisational (to create conditions enabling implementation of the whole programme.)

3.2 There would be a big advantage if these programmes could cover the same period of time as the development plan for the whole national economy, the first one covering the period up to the end of 1975.

3.3 The much needed initial programme should be completed as soon as possible and a one year time period looks to be the shortest possible term.

3.4 The programme will be prepared by the special Working Committee, headed by the Director of WD&ID and including senior representatives from all the other governmental and parastatal units concerned with Water Economics and Planning. It would also associate some professional, social, as well as political activities from up-country over its initial stage.

3.5 The first stage of work should be the up-country enquiry, collected if necessary by a visiting team from the consumers side, composed of local government authorities (regional and district), members of parliament (especially from drought affected areas), regional directors of agriculture, and settlers of Ujamaa Villages chosen randomly, etc. At the same time frank opinions should be collected from the regional water engineers and their staff. The enquiry should include wishes and expectations as well as criticisms, facts of evaluation, failures and inefficiences. They could be made confidential on request.

3.6 The completed "programme" should be submitted to the Government for approval and ITS APPROVED VERSION will become the binding directive for action of the Ministries and organisations concerned.

4. The Reason for the Creation of the Field Investigations Unit - Morogoro and Its Initial Programme of Activities

In anticipation of the mounting needs for rationalisation of the rural water supply design and construction process and modernisation of some of the structures, the Director of WD&ID has agreed to establish in Morogoro the Unit which will provide WD&ID with factual reports from the professional level field investigations and observations carried out in the normal up-country site conditions, in collaboration with the University researchers whenever possible.

The following initial field investigations programme was approved on 8th September, 1969:

Cutline of the Field Investigations and Research Unit Programme

1. Programme 'I'.

Field Investigations Programme on the NEW STRUCTURES AND IMPLEMENTS for Water Supplies, Dams and Charcos and River Flood Control and Training Works.

These include the constant flow valve test, infiltration intakes with gravel screen units test, pressure warning system of the tank overflowing, etc.

2. Programme 'II'
Field Investigations Programme on Minor Water Supply and Irrigation Structures suitable for Self-help work in Ujamaa Villages.

These include Bati Inertia Pump Test, Salawe "Shinyanga" Lift Pump, tests on foreign made pumps for shallow and medium depth wells with recommendation of suitability for Tanzania.

3. Programme 'III'

Field Investigation and Research Programme or rationalisation and "Tanzanisation" of the project and planning activities of the new schemes through the investigation of the existing structures.

These include Mlali and Pangawe Water Supplies water consumption pattern investigation.

*"Tanzanisation" means here to make the scheme really designed to suit the local condition and needs.

Field Investigations Unit works in collaboration with the Director of WD&ID and Senior Technical Staff of the WD&ID Headquarters and is organisationally fully integrated into the Morogoro Regional Staff. The testing unit however can undertake investigations in regions other than Morogoro, provided that it is initially agreed to by the Director of WD&ID.

The Field Investigation Unit will prepare reports on the investigated subjects which will be distributed to all Regional Water Engineers after approval by the Director of WD&ID.

5. Some Information about the Actual Stage of Field Investigations at Morogoro.

5.1. The most important action of the Unit is investigation into the water consumption patterns at the Pangawe and Mlali water supplies. The investigations are conducted according to the field programme reproduced below:

RURAL WATER SUPPLIES CONSUMPTION STANDARD INVESTIGATIONS

COMPACT FIELD WORK PROGRAMME (by D. J. Stanislawski)

1. Site Chosen: Pangawe and Mlali water supplies in Morogoro District.

Both water supplies are new, recently completed (June, 1969) and both are also the sites for the University College, Dar es Salaam, Economic Research Bureau's investigations of economic impact of the water development activities.

2. Period of the Present Set of Investigations: August - November, 1969.

The chosen period is a dry season in Morogoro District, and the investigation is to determine the dry season consumption pattern and standard. Further, similar investigations should be carried out in the future on other rural water supply sites in various parts of Tanzania and during other dry periods in order to verify and broaden the results of this investigation.

3. Organisational Lay out of Field Observations.

3.1. Type and Range of the Field Work

CODE	NAME OF OBSERVATIONS	BY WHOM AND WHEN PERFORMED	DATE NOTED ON:
'A'	Every Day Observations	By pump attendant every day including Sundays over the whole official investigation period.	Special Attendant's Logbook, Type 'A'
'B'	Normal Alert Days	By two WD&ID Technical Assistants (with Survey chairman each) in shifts (morning & evening) at least two times each calendar month (i.e. approximately 2 week intervals).	Normal Alert Chart Type 'B'
'C'	Great Alert Days	By the same WD&ID team as above in observation B plus university (or Technical College) student team (one student-observer for each Domestic Water Point) twice over investigation period to estimate the most dry period.	Normal Alert Chart Type 'B' (as above plus Special Great Alert Charts Type 'C' for each Domestic Water Point.

3.2. Particulars of the Data Collected in the Field:

A. Every Day	B. Normal Alert Day	C. Great Alert Day
1. Pump Working Time: Keeping up-to-date records pump working time in the attendant's logbook 2. Tank Water Level Indicator: One daily record at 7:15 am. 3. Water Meter: Only one record ocurring at 7:00 am. Note: All data recorded in the Log book should be written in duplicate (through carbon paper). The original copy will be collected from the attendant by an officer supervising investigations.	All data should be noted on 'Alert Chart B'. 1. Pump time: noted on chart from the pump attendant record. Pumping should start at 7:30am supervision. 2. Tank Water Level Indicator: Should be read every two hours from 7:00 to 19:00 (7 observations from readings. 3. Water Meter: Should be read in 1 hour intervals over the whole day from 6:30 to 18:30.	All data should be collected on'Alert Chart C' and 'Alert Chart B'. 1. All normal Alert B data will be collected as pointed out for 'B'. 2. Domestic Water Points Observation should last the whole day from 6:30 to 19:30. The observer should note on Chart C all the persons collecting water (time, sex, number and type of container) also all observed wastages, without intervening.

Investigations at Pangawe are well advanced with two sessions of the normal alert and one great alert observations. The results are being processed. Unfortunately unexpected difficulties occured at Mlali where two recently installed water meters were found defective. The second meter was new and now is in Dar es Salaam being repaired. However at Mlali some every day and some normal alert observations are being conducted, with special emphasis on tank level and pumping time readings because the meters were unreliable.

For illustration, the curve of the Water Consumption Pattern at Pangawe is attached. It is the result of the first normal alert session between 30th August and 7th September, 1969 (dry season conditions.)

5.2 Other investigations completed are:

a) The report on the Bati Inertia Hand Pump (Tanzania-prototype) construction and test (Programme II) submitted to headquarters.

b) The report on Constant Flow Valve Field test (Programme I) submitted to headquarters.

c) The technical proposals on the Turiani water supply intake improvement and reconstruction of the gravel screen filters at the testing site. (Programme III) submitted to headquarters.

5.3. Several other technical innovations are under construction on the normal rural water supply sites and reports will be produced after operational tests of the structures.

Morogoro 11.11.1969.

Note: This paper has been prepared solely for discussion purposes and as such was authorised by the Director of WD&ID. Any views expressed in it are those of the author and cannot be interpreted as relecting the official views of the Water Development and Irrigation Division or of the Ministry of Agriculture, Food and Co-operatives.

MLALI or / PANGAWE WATER SUPPLY

DATE of INVEST.: 1. 10. 1969 (WEDN)

NORMAL ALERT CHART "B"

Ref. No.: 3/I

Season & weather: DRY SEASON — HOT AND SUNNY DAY

TIME INT.	TIME ENG.	TIME SWAH.	WATER METER READING *	CONSUM. PER HOUR (IN GALLS)	TOTAL CONSUMPTION (IN GALLS)	% OF THE DAILY TOTAL	TIME of PUMPING START TIME	TIME of PUMPING END TIME	TIME of PUMPING HRS	STORAGE TANK LEVEL READ.	STORAGE TANK STORAGE IN GALLS.	Remark *
0	12 MID NIGHT	6										
1	1 AM	7										
2	2 AM	8										
3	3 AM	9										
4	4 AM	10										
5	5 AM	11										
6	6 AM	12	0379335							6'-1"		
7	7 AM	1	0379560	225	225	8.6 / 8.9	7.05 AM			5'-11½"		
8	8 AM	2	0379800	240	465	18.7 / 9.5				6'-0"		
9	9 AM	3	0380120	320	785	31.1 / 12.7				6'-1¾"		
10	10 AM	4	0380332	212	997	39.5 / 8.4				6'-4¼"		
11	11 AM	5	0380473	141	1138	45.1 / 5.6				6'-7"		
12	12 NOON	6	0380640	167	1305	51.7 / 6.6				6'-10½"		
13	1 PM	7	0380744	104	1409	55.8 / 4.1		2.10 PM		7'-1½"		
14	2 PM	8	0380853	109	1518	60.1 / 4.3				7'-5"		
15	3 PM	9	0381025	172	1690	66.9 / 6.8				7'-4½"		
16	4 PM	10	0381218	193	1883	74.5 / 7.6				7'-3"		
17	5 PM	11	0381326	108	1991	78.8 / 4.3				7'-2"		
18	6 PM	12	0381522	196	2187	86.8 / 7.8				7'-0¾"		
19	7 PM	1	0381805	283	2470	97.8 / 11.2				-		
20	8 PM	2	0381860	53	2525	100.1 / 2.2				-		
21	9 PM	3										
22	10 PM	4										
23	11 PM	5										
24	12 MID NIGHT	6				100						

DAILY CONSUMPTION → 2525

1	NAME & GRADE of THE FIRST OBSERVER	A.Y. MTAMBO T.A. TRAINEE	PERIOD of DUTY: 6 AM - 12 NOON	SIGNATURE: SIGN.
2	NAME & GRADE of THE SECOND OBSERVER	S.A. KOMESHA T.A. TRAINEE	PERIOD of DUTY: 1 PM - 8 PM	SIGNATURE SIGN.

COMMENTS & APPROVAL:

7.10.1969

DATE & SIGNATURE (DJ. STANISLAWSKI)

EST.: 3 (IVEDN)

PANGAWE W.S. (MOROGORO)

DOMESTIC POINT CHART "C" FOR SPECIAL GREAT ALERT DAYS

REF. No.: 3/I

SEASON: DRY

WEATHER: (DESCRIBE with DETAILS!) WARM & SUNNY

TIME: INTERNAT.	SWAHILI	PERSON COLLECTING WATER: WOMAN •	CHILD x	MAN l	WHAT CONTAINER IS USED TO COLLECT THE WATER: ROUND METAL BUCKET NDOO	SQUARE PETROL TIN DEBE	SMALL 1 GALL TIN.	OTHER CONTAINERS (WHAT CAPACITY)	WASTAGE OR LOCAL USE of W. W=WASH B=BATH C=CLEAN I=IRRIG L=LEAK	TOTAL CONSUMPTION over 1 HR. (IN GALLS)	HOW WATER IS USED: CARRIED AWAY ↓	LOCALLY AT D.F. AREA ↓	REMARKS AND EXPLANATION EXPL. COVER COLUMN IF NECESSARY
1	2	3	4	5	6	7	8	9	10	11	12	13	14
7	12-1	—	x —	—	—	—	—	xC —	—	-		x	
7-8	1-2	—	—	—	—	—	—	—	—	-			
8-9	2-3	••••• —	—	—	—	—	—	—	—	17.5	•••••		
9-10	3-4	•• • —	x —	—	•• —	—	—	—	•W —	8.0	x••	•	
10-11	4-5	—	—	—	—	—	—	—	lC —	3.5	l	l	
11-12	5-6	—	—	—	—	—	—	—	—	-			
12-13	6-7	•• —	x —	—	•• —	—	—	—	—	7.0	••	x	
13-14	7-8	• —	—	—	• —	—	—	—	—	3.5	•		
14-15	8-9	—	—	—	—	—	—	—	—	-			
15-16	9-10	••• • —	—	—	••• —	• —	—	—	—	14.5	••• •		
16-17	10-11	• —	—	—	• —	—	—	—	—	3.5	•		
17-18	11-12	• —	xx —	l —	• xx —	—	l —	—	—	11.5	• xx l		
18-19	12-13	•••• •• —	x —	l —	•••• •• —	—	l —	—	xC	22.0	l ••• •••	x	
19-20	13-14	—	—	—	—	—	—	—	—	—			
TOTALS: →		24	6	4	24	1	3	–	5	91.0			

I OBSERVER NAME: KHALIFA MBEGU

II OBSERVER NAME: NASORO JUMA

COMMENTS & APPROVAL:

• DATE & SIGNATURE •

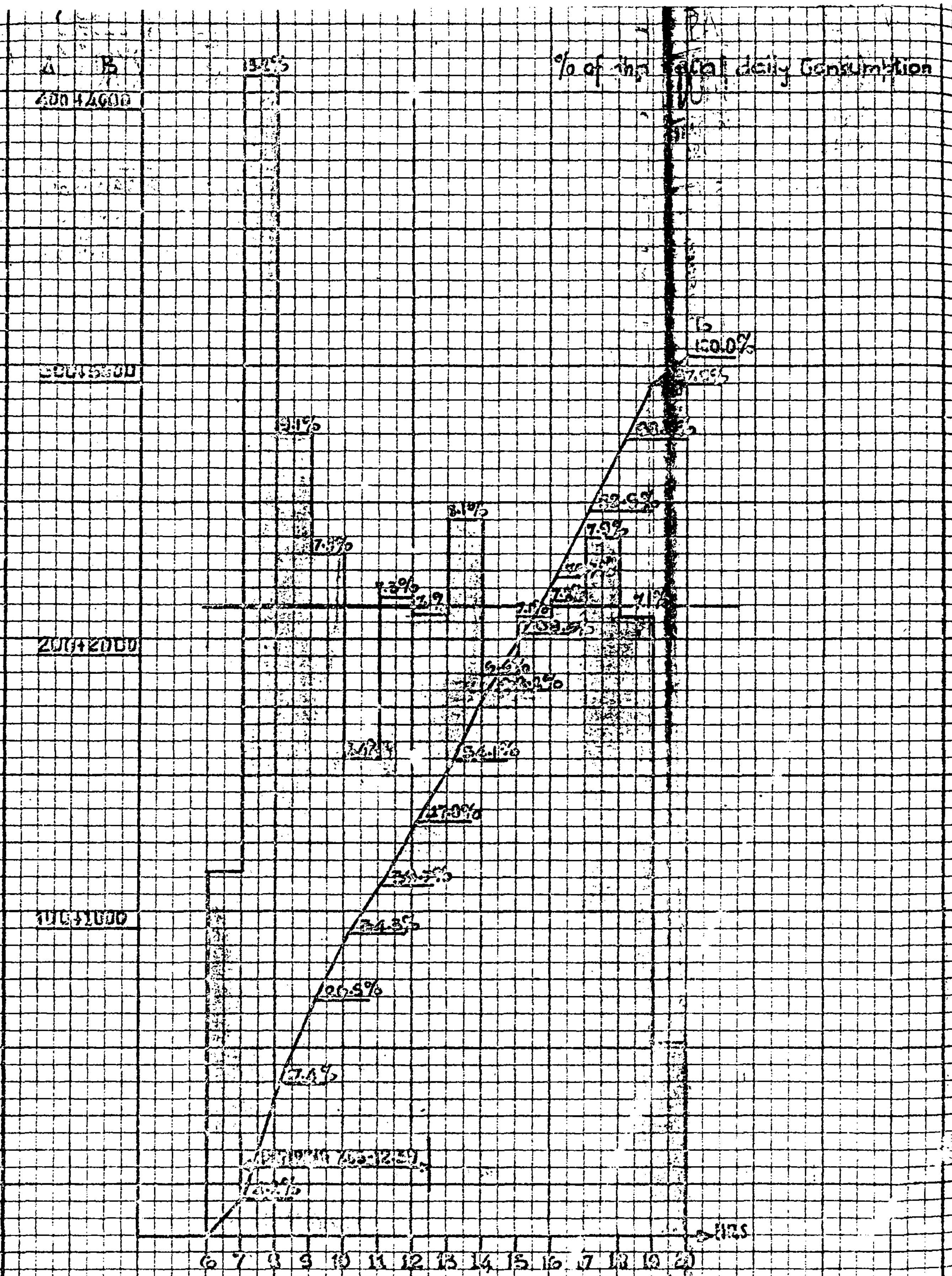
Remark x

SIGN.

SIGN.

67

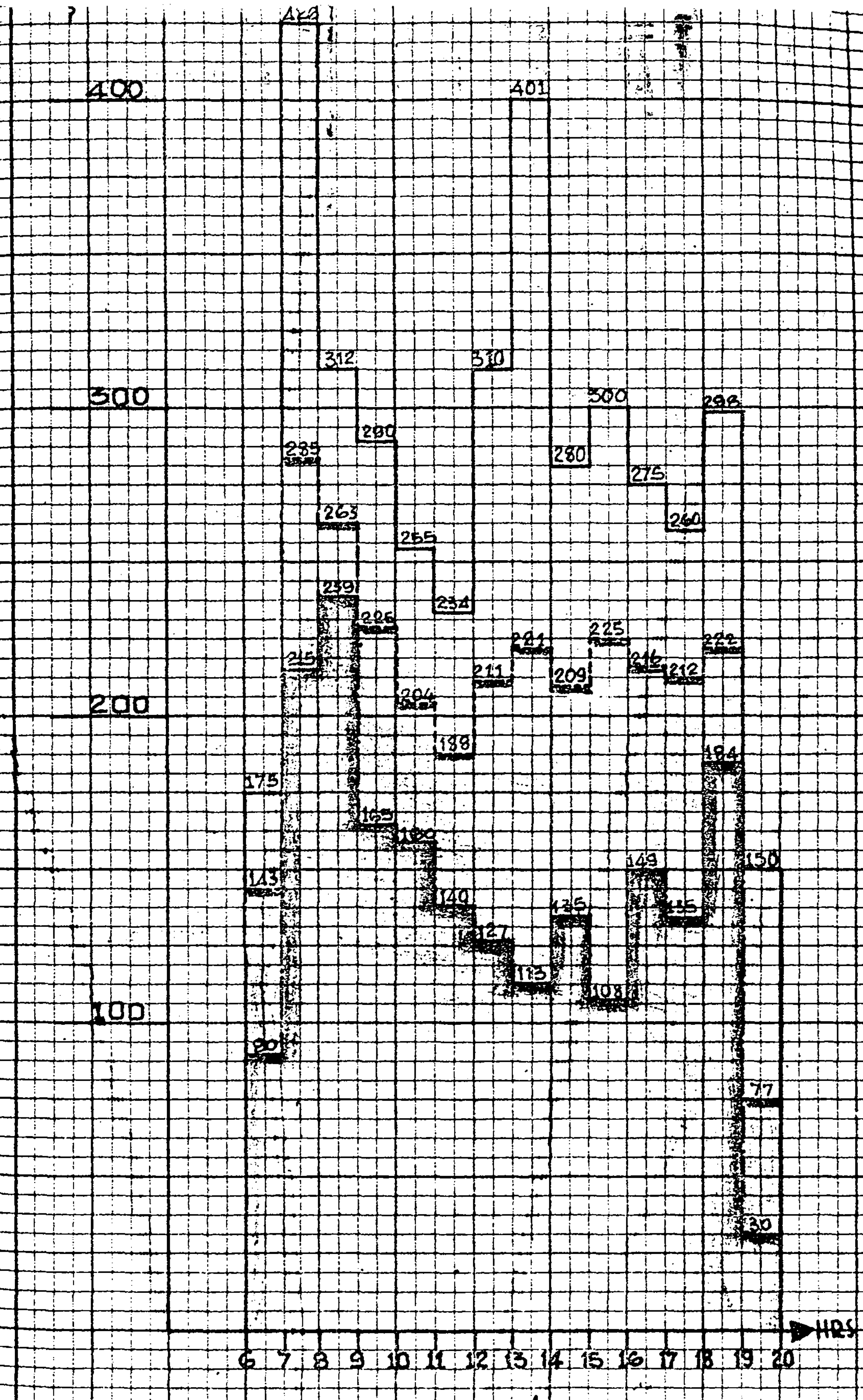
LAWSKI)



SATURDAY 6.8.69 PANGAVE W/SUPPLY

RURAL WATER SUPPLY CONSUMPTION PATTERN
INVESTIGATIONS

L.F. D.J.S.



PANGAWE W/SUPPLY
HOURLY CONSUMPTION
FOR THE PERIOD 30.8.-7.9.19[illegible]

RURAL WATER SUPPLY CONSUMPTION PATTERN INVESTIGA[illegible]

MAX CONSUMPTION
AVERAGE —— " ——
MIN. —— " ——

LE. DJS

SHORT DESCRIPTION OF EAST AFRICAN METEOROLOGICAL DEPARTMENT PROGRAMME OF DEVELOPMENT OF NETWORK OF PRECIPITATION STATIONS

by J. Hrbek

1. Introduction.

The paper presented by EA Meteorological Department cannot be quite well ranked among any of the 3 areas of topics to be dealt with by the seminar. Its contribution is namely of a bit more general character and concerns thus more or less all the three areas. The paper deals with the problems of rainfall measurements in East Africa.

2. Network of simple raingauges

2.1. The present situation

The rainfall data used in most of the research and routine work are provided mainly by the rainfall stations which are registered with EA Meteorological Department. The present network of the simple raingauges is the result of a long and essentially spontaneous development in which the interest of individuals and of institutions to carry out the rainfall observations played an important part. Many rainfall stations have been financed and established privately, and only a part of them, though not a small one, has been equipped by EA Meteorological Department. The EA Meteorological Department activities were generally restricted mainly to the registration of stations, to the advice on how to establish them, and in a limited extent to the instruction on observation, collection, simple scruting, and publication of data. Two essential things were missing in this system:

1. the active organising of the network in the whole.
2. the direct contact with stations exerted in regular, systematic inspections.

Several serious difficulties which we are facing now have resulted from this generally restricted and passive activity of the EA Meteorological Department due to the fact that it neither had the finances nor the manpower to take more and systematic care of the network or precipitation stations.

The resulting difficulties are:

2.1.1. The stations are not equipped in a standard way. Although most of the stations have a standard raingauge of 127 mm diameter there are many non-standard instruments in use. Besides that, there is a mess of British and Metric units in the measuring devices which just renders further processing of data arduous.

2.1.2. The observers are not sufficiently informed about how to carry out observations, how to register the data, and in most cases they do not know very much about how important their work is. Instructions on observation were sent to the stations upon request only, which must have resulted in serious nonuniformity of measurements. Even at those stations which were sent instructions there are many observers not knowing them. As a result of changes of personnel which have happened during the years, they have never seen them and are only very insufficiently instructed by their predecessors.

2.1.3. Many raingauges are not well sited and many of them are in very poor conditions. The picture of the present situation gives the following table showing the results of the random inspection of 46 stations in Kenya.

The following was found:

angle of obstruction less than 30%	- 59%	of stations
gauge defective or non-standard	63%	"
measure defective or non-standard	86%	"
records not last back	82%	"
Nil not recorded	79%	"

The cases when the angle of obstruction was over 60° were not exceptional and even cases with an angle of obstruction 90° were found.

The check of operation of 20 rainfall stations in Tanzania in the Morogoro region discovered similar results. Besides that it was found that the reading of the meniscus level as carried out by most of the observers is incorrect affected by parallax and that the correct hour of measurement is often not respected.

It is impossible to evaluate in an objective way the complex effect of all these negative factors. It is only possible to estimate that the tolerated error of 0,1 mm for totals up to 10 mm and 2% for larger amounts is far exceeded. For example the incorrect reading of the water level in the glass measure itself can easily result in more than 4% error of the yearly total of rainfall.

The writing of daily rainfall totals to the incorrect date brings other serious consequences. It makes impossible the studies of the daily serial rainfall pattern, the check of the daily weather forecasts etc. . . .

There are certainly many well operating stations in the network. Nevertheless the simple scruting of data which is used cannot safely enough separate all the wrong data from the good ones and the high percentage of stations operating with serious deficiences quite naturally makes one a bit suspicious of all of them.

2.1.4. The distribution of precipitation stations is uneven in many parts of East Africa, namely in Tanzania. This is mainly the result of differences in the density of population and of the economic development of different regions. In Tanzania the situation is as follows:

Total number of rainfall stations is now in the neighbourhood of	770 stations
Total land area of the country is about	950,000 Km^2
Total cultivated area and pasture land is estimated to be	350,000 Km^2
1 rainfall station covers an average of the total land area	1,235 Km^2
1 rainfall station covers an average of the cultivated and grazed area	460 Km^2

In some parts of the country, especially in the Southwest the average area covered by 1 station exceeds very much the country's average. In Ufipa District e.g. 1 rainfall station covers as much as 3,500 km^2 of the land area.

The density of network is in many parts of the country below the norms required in WMO guide to Hydrometeorological practices for the design of minimum network. In some parts of the country the density is even below the provisional norms tolerated in difficult conditions, as given in WMO documents.

Another factor affecting the structure of the network was the not well developed coordination of activities among the different authorities operating their own networks of stations..

This is the picture of the precipitation stations network. The data provided by this network are doubtlessly of fundamental character in many research and routine projects of economic importance. To make this picture complete, it must be added that this situation is mainly the result of lack of funds in the past, which limited EA Meteorological Department solely to the passive functions only, inhibiting the most important activity - the inspection- to be carried out.

2.2. The Programme

Only recently EA Meteorological Department could proceed to the more active role in this important field. The main tasks of the present EA Meteorological Department programme are:

2.2.1. To start with the systematic inspection of all rainfall stations registered. The inspection should start in Tanzania in the second half of the year 1970 and all stations in the country should be visited and brought into perfect order by about the middle of 1971. In the following years the inspection should be carried out at the frequency requested by WMO, i.e. each station should be inspected at least once per 4 years.

2.2.2. To equip all stations with standard metric instruments.

2.2.3. To organise the network of rainfall stations. To direct the establishment of new stations equipped with EA Meteorological Department's raingauges into the areas with lack of information, with preference of those areas where intense economic development is planned in the near future. The total number of precipitation stations in the country should be increased from the present 770 to 1150 by the middle of 1974. This programme of extension represents together with the necessary renovation of existing stations an estimated total need of more than 600 new raingauges.

The possibilities to establish new stations in the areas with lack of data are systematically investigated. Suitable schools, missions, private persons etc. are contacted and the Regional and District authorities are consulted. These efforts to establish new stations meet serious difficulties in many areas and EA Meteorological Department uses this opportunity to invite all those who may be concerned to assist and collaborate in this task.

2.2.4. As Swahili becomes increasingly widely spoken the instructions on observations have been translated into Swahili and are being distributed to the Observers.

3. Special network of automatic raingauges for research of tropical rainfall in town areas of Dar es Salaam, Kampala and Nairobi.

A Special network was established in these 3 areas by the Road Research Laboratory in London. EA Meteorological Department participates in the operating of this network. The research is carried out by the RRL in collaboration with the University of London. The main aim is to obtain detailed information about rainfall intensities frequencies in these areas.

4. Summary

Out of what has been said results, that serious deficiences exist in the work of most of the rainfall stations. This is mainly the result of the fact that EA Meteorological Department in the past could never undertake the systematic inspection of these stations. As the precipitation data are of fundamental importance for EA Economy, measures should be taken to remedy this situation. Steps in this direction have been made recently by EA Meteorological Department. It is hoped to achieve a substantial improvement in this within the next three to four years.

FARM WATER SUPPLIES IN SUKUMALAND

by T. Hankins

Farm water supply is one aspect of the Rural Research Project's farm level investigations in Sukumaland. The information is being collected during the 4th of 4 interviews with a sample of some 225 farmers in 11 areas. Most of these interviews are now completed; the remainder will be done by the end of November.

The questions asked in the interviews correspond as closely as possible with those used by Dennis Warner (Economic Research Bureau, University College, Dar es Salaam) in his more extensive study of rural water supplies in Tanzania. The intention is that the information obtained will serve the Project's needs to understand the present situation in Sukumaland and also provide information from this area for Warner's nationwide study.

The information obtained from the interviews concerns the following topics:

- Type and distance of supply
- Reliability of supply
- Method of transport to house and labour involved
- Costs other than transprt labour
- Amount consumed by household
- Major uses
- Perceived quality and treatment
- Site and frequency of personal bathing
- Type and distance of watering places for livestock
- Time involved in moving livestock to water
- Frequency of diarrhea in household; treatment, and perceived causes.

Computer print outs of frequency tallies from the data will be made in January, 1970. Analysis and discussion comparing the different areas and farmers should be completed by June, 1970.

Preliminary readings of the interview forms support the thought that there is considerable variation in (1) the types of supply used in Sukumaland, (2) the reliability of the supplies, and (3) the distances of the supplies from the homesteads. It seems probable that the amounts consumed will also vary, but this remains to be substantiated.

A few calculations of consumption in one of our drier areas (Nygezi, Shinyanga) where people carry water 6 to 8 miles, usually on donkey back, in the dry season suggest the interesting hypothesis that the amount of water brought to the house is as large in the dry season as in the wet season. The amounts used for different purposes will vary, however. Bathing of children and adults who do not go for water is done at the house during the dry season, but less frequently than in the wet season. Also owners having only a few small livestock water them at the house during these months. Amounts used for drinking, cooking, and washing probably do not vary substantially.

INSECTS OF MEDICAL AND VETERINARY IMPORTANCE THAT ARE ASSOCIATED WITH WATER AND SOME ASPECTS OF WATER MANAGEMENT RELEVANT TO THEIR CONTROL

by Graham B. White

The present review paper is not intended to feature any original discoveries made by the East African Institute of Malaria and Vector-Borne Diseases. This contribution to the Workshop sets out only to draw attention to the widespread importance of insects that are associated with water as vectors (i.e. carriers) of diseases of humans and domestic animals. It is hoped that at any future conference various staff of the Institute may present more specific reports on particular insect problems that exist in East Africa in connection with water resources and their management.

The insects of medical or veterinary importance which are directly associated with water in East Africa are all true flies, or Diptera, having females which require blood from a vertebrate animal as food for the development of eggs. Five groups are primarily involved, namely Biting Midges (Ceratopogonidae), Blackflies (Simulidae), Horseflies (Tabanidae), Mosquitoes (Cluicidae), and Tsetse flies (Glossinidae). It will not be possible to discuss all the features of these insects' biology, but I propose merely to outline their life cycles, preferred habitats and known distribution in East Africa, and to give a brief description of the types and prevalence of disease they transmit. I apologise to those present who already understand these problems, for whom the paper probably contains nothing new. At the end I shall outline certain well-proven methods of water management for the reduction of such insect population.

To commence with the Ceratopogonidae (Biting Midges), there are small flies (length 0.6 - 5.0 mm.) which breed in damp soil. The larvae feed on humus in the top few millimeters of earth, development taking between a month and a year according to species. It is when large expanses of unflooded damp soil occur, such as around marshes, along water courses, in mangrove orchards and along the sea-beach tide-line, that production of flies can reach annoying levels at some seasons. The female midges feed crepusculary (i.e. at dawn and dusk), their bites usually causing a disproportionately large weal on human skin. In many parts of Africa certain species of biting midge, notably Culicoides austeni, transmit the parasite Acanthocheilonema perstans, which is a filiarial worm responsible for a human blood disease of low pathogenicity. This desease exists in many parts of Uganda, western Kenya and northwestern Tanzania. Ninety percent of persons are said to be infected in some parts of Uganda. A similar worm, Dipetalonema streptocerca, is also transmitted by Culicoides in West Africa, but has not been recorded nearer to here than the Congo. The group and its associated diseases have been very little studied in East Africa as yet.

The Simulidae (Blackflies) are small flies (length 1-5 mm.) that breed always in running water. The eggs are deposited on vegetation overhanging the water or on stones, twigs, or logs beside or just beneath the surface. The larvae of most species attach by their tail to a submerged surface, usually in a semi-sheltered position where eddies of the current will supply planktonic food. Lavae of Simulium neavei and related species regularly attach to the legs of freshwater crabs throughout their growth. These species are common in the fast-flowing streams of many East African highland districts. When fully grown, which may take weeks or months depending on species, temperature and food supply, the larva turns to a pupa attached to the same substrate. The adult fly merges after several days, rises to the water surface, climbs vegetation, dries itself and flies away. Female flies inflict extremely painful bites and certain species always prefer the blood of man. Worms of the genus Onchocerca are transmitted by various Simulium flies, the species Onchocerca volvulus causing the disease "onchocerciases" in man. This disease is prevalent in certain mountainous areas of East Africa, where it is transmitted by flies of the S. neavei species complex, particularly S. Woodi. Rates of human infection are over 50% in some areas and at least 520,000 people in Tanzania are thought to be infected. Human onchocerciases is a chronic condition in which irritation and toughening of the skin and perhaps small swellings of the groin and trunk are the most noticeable effects. Progressive debilitation of the patient may occur over many years and ocular complications may eventually cause blindness. No efficient therapeutic drugs are available. The disease has been controlled by eradication of Simulium neavei from streams in certain limited foci around Kakamega in Kenya by adding DDT to the headwaters. In Uganda, as well as large area of West and Central Africa onchocerciasis is transmitted by the species Simulium damnosum which does not attach to crabs in the larval stage and which breeds often in larger rivers, the larvae being particularly abundant among boulders and on the spillways of dams etc. A small control experiment aganist S. damnosum near Ifakara in Tanzania was largely unsuccessful.

The Tabanidae (Forseflies) are the least significant group under discussion although they definitely warrant inclusion. There are many species, ranging from 7-15 mm. in length, most of which usually attack wild animals. They are frequently encountered by man when in the vicinity of such animals, or cattle, and often enter the windows of a slow-moving vehicle after mistaking it for a potential host. The eggs are deposited on vegetation near water and larvae may be found in many types of mud or wet sand beside streams, ponds and ditches, each species having its own preference. Larvae are predatory, feeding on worms, molluses and insects, and may be cannibalistic. Growth and metamorphosis takes several months or a year, the pupae being formed at a rather higher, drier and hence safer level in the soil. Horseflies of the genus Chrysops are vectors of the human disease "loiasis" in West Africa and the Congo. The disease is caused by worms of the species Loa loa which survive for many years in man causing fluctuating tissue swellings, lymphatic disorders and sometimes damage to the eyes. Although loiasis is unknown in East Africa at present there are several species of man-biting Chrysops occurring throughout Uganda and in the northern and southern highlands of Tanzania which might well

Trypanosomiasis, but no concise information on these in East Africa is available to me.

Culicidae (mosquitoes) are undoubtedly the insects of greatest general importance in the present context. They are fragile and familiar insects found almost wherever water exists. It seems unnecessary to describe their life history except to point out that all species have aquatic larvae, most species can undergo one life cycle in under two weeks, and each female mosquito usually produces over 100 eggs every 2-4 days. There are over 300 species of mosquito in East Africa, of which less than 10 are known to be of medical or veterinary significance. Many more species are a nuisance when biting, but arenot good disease-vectors for physiological or behavioural reasons. The taxonomic division of mosquitoes into two groups, anophelines and culicines, also serves to distinguish between malaria vectors (anophelines) and malaria non-vectors. Representatives of both anophelines and culicines transmit a variety of filarial worm diseases, notably Elephantiasis (caused by the worm *Wuchereria bancrofti*) of man, as well as many virus infections relatively few of which have been properly investigated medically. Mosquitoes of the genus *Anopheles* breed predominately in open waters, viz: swamps, pools, stream and river margins. There are two main vectors of malaria throughout East Africa: *Anopheles gambiae*, which favours small collections of water such as ground pools of rainwater, wet foot-prints, freshly flooded ditches and borrow pits; and secondly *Anopheles funestus*, which tends to breed at the margins of older water such as swamps, dykes and rivers, wherever some emergent grasses, sedges or other foliage provide shelter for the larvae. Rice shambas and similar activities with shallow standing water provide an ideal situation initially for *A. gambiae* breeding, followed by conditions suitable for *A. funestus* as the level of vegetation rises. Culicines of the genus *Culex* breed in virtually all types of water, although by far the most significant species in East Africa, *Culex pipens fatigans*, is restricted to domestic conditions where it breeds in water-storage tanks and barrels, old tins and pots, and most abundantly in flooded latrine-pits. This species alone in urban coastal districts, and together with *A. gambiae* and *A. funestus* in rural areas, is probably responsible for the majority of Elephantiasis transmission. Rates of human infection with this disease are as high as 20% in many coastal areas of Kenya and Tanzania. Other culicines of the genus *Aedes* are the vectors of certain viruses and filariae, but their relevance is limited in the present context since they breed mostly in small water collections in the tree-holes, leaf-axils, coconut shells, etc.

The last group, the Glossinidae (Tsetse Flies), is not primarily dependent on water or damp soil for breeding in the manner of the previous groups, but one important species, *Glossina palpalis*, characteristically frequents heavy vegetation along the margins of streams, rivers, and lakes. This fly resembles a "Blue-bottle" in size and the females, which are painful biters, are one of the vectors of sleeping sickness, particularly the form caused by Trypanosoma gambiense ("Gambian Sleeping Sickness"). Flies reproduce and multiply slowly, the eggs hatching within the mother fly and larvae being extruded singly when nearly fully grown and pupating soon afterwards among dry stones or sand. At best a female fly produces 8-10 larvae over 10-12 days. Gambian sleeping sickness is an occupational hazard of fishermen, boatmen and water carriers working in endemic areas, particularly near overgrown parts of lakeshore. The principal affected areas, are around Lakes Albert and Edward and the Nile in Uganda, north-eastern Lake Victoria in Kenya and the northern and southern parts of Lake Tanganyika in Tanzania. Glossina palpalis is also an effective vector of Trypanosoma Grucci which causes the disease "nagana" in horses, mules, cattle, sheep, dogs and much wild game. The disease, as in human trypanosomiasis affects the nervous system, the blood and certain glands, causing progressive emaciation and eventual death.

Any conscientious water engineer or administrator who bears in mind the preceding facts will doubtless find common sense ways of reducing the availability of breeding places and habitats for disease-carrying insects. It is not difficult to plan all water supply, irrigation and drainage works bearing such aspects in mind. However, large areas of natural lakes, waterways, and swamps exist all over East Africa which have never been appreciably altered by man. Between these extremes we have the countless ordinary activities such as farming, housebuilding and road-building, each requiring its own water supply and drainage, where the operators can themselves directly influence the numbers of harmful insects thriving in their immediate environment. Some very broad generalisations can be given regarding the most effective physical means of minimising insect breeding. The paramount rule is to keep the banks of all bodies of water steeply sloping and clear of vegetation both within the water and along the banks. If no weeds grow in the water then mosquito larvae are more exposed to predacious insects and fish. (Special "larvivorus fish" of the genus Gambusia and others can even be introduced to water for the purpose of consuming mosquito larvae.) Absense of vegetation along banks reduces the availability of resting places for all insects within easy access of the water. The cutting back of vegetation for a belt 20 feet wide is of particular value against Glossina Palpalis. Keeping banks steeply sloping and relatively smooth minimises damp soil areas suitable for the larvae of Ceratopogonidae and Tabanidae. Such rules apply as much to small ditches and streams as to larger ponds and reservoirs. Whenever natural customs are employed in construction of reservoirs or water-courses they should be straightened by a process of cutting and filling. Not only does this avoid the creation of creeks or meanders, but shortens the shoreline and should steepen the banks. Areas of swampy ground in any location should be drained by channelling, even if flooding is inevitable during heavy rains. The regular damming and periodic flushing of ditches, streams and small rivers at weekly intervals can be of great value for washing away mosquito larvae, Simulium larvae and silt where horseflies and biting midges might breed.

The use of chemical insecticides is indispensible in districts with a high human population, where vast numbers of insects may otherwise build-up if blood-feeding is easy. It must be remembered, though, that most insecticides are also toxic to man and should not be applied to drinking water or food-crops prior to harvest. Certain formulations of DDT added to the headwaters of streams are the only proven means of adequately controlling Simuliidae. Anopheles mosquito larvae are often easily controlled by spraying an insecticide-film onto the edges of water surfaces. Two commodities for this pupose on sale in East Africa are "Malariol" and "Flit MLO".

It requires courage and co-operation for water, health and veterinary authorities to work well together on these matters. Often it is simpler for waterworks to be constructed without consideration of disease implications. Many other engineering activities, such as road construction, should similarly be undertaken always with a view to avoiding the creation of unnecessary dams, flooded borrow-pits, and so forth. Throughout East Africa there is a shortage of competent advisers available to study and report on such aspects when required. I must point out that although our staff is small, the East African Institute of Malaria and Vector-Borne Diseases is a Community Orgnization always willing, in principle, to help where possible by giving consultant advice. Those of us who view these problems from the scientific angle can see the benefits accruing to the population as a whole if abatement of insect-borne disease features on the itinerary of all water workers.

CONTAMINATION OF RURAL WATER SUPPLIES: THE ISMANI EXAMPLE

by Joachim Kreysler

Introduction

One common index of water pollution is the coli-form count, which is the number of organisms growing on ENDO-agar with a metallic sheen during 24 hours at an incubation temperature of 36°C. It has been assumed that this is a fairly close approximation to the number of fecal coli organisms from warm blooded animals in the water. Fecal organisms grow only at body temperature. Since tropical water supplies very often reach higher temperatures, the total coli- count is not an absolutely reliable method to determine the intitial fecal pollution.

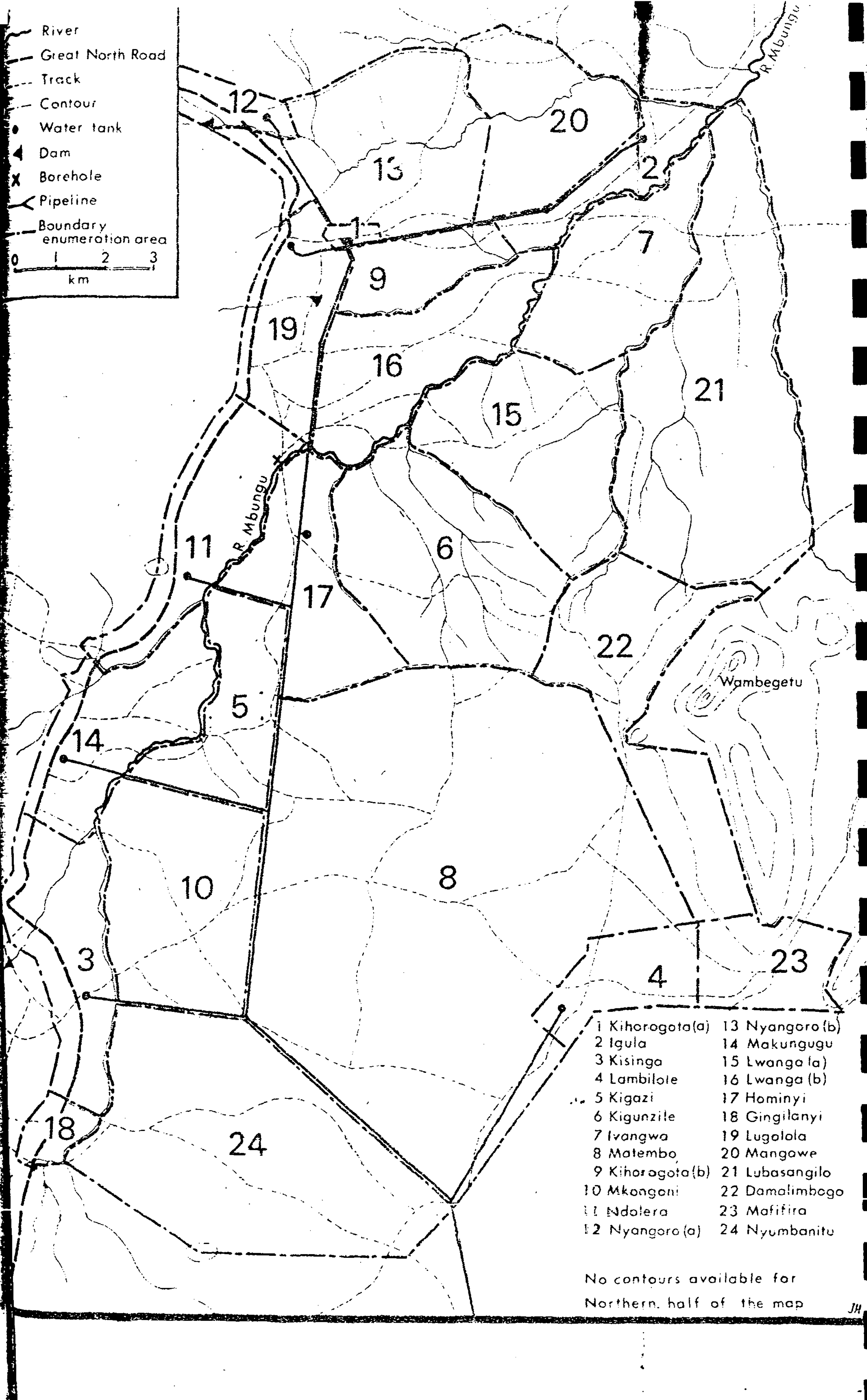
Since many saprophytes (Klebsiella aerogenes) also grow in red colonies in ENDO-medium and generally in much larger numbers than coliforms, differentiation is sometimes difficult. In 1965 GELDREICH (1) developed a far more selective method for fecal coli determination; a first account of the suitability of this method for East Africa has been given by BRADLEY and EMURWON (2).

When our team tried this method under field conditions we faced a number of difficulties which made it impossible to employ this admittedly more accurage method in a recent survey in Ismani (Iringa Region). The major difficulty was that the GELDREICH agar does not keep under tropical temperatures. Another obstacle was to establish a water-bath with a reliable temperature of 44.5°C. In the field. Since the major objective of the Ismani water assessment is to compare water pollution in the dry and the rainy season we decided to use the more orthodox ENDO-agar method before the rains start in December.

The Water Supply in Ismani

Ismani is an area in the north of Iringa with a high maize growing potential (the 1968 production was over 15,000 tons) of about 200 square miles. The population in the area is very mobile with people moving into the area in the planting and harvesting seasons. This rather unstable population might also be a reason for the large amount of illegal land-rent etc., FELDMANN (3). In order to increase the number of stable population it was decided to build a domestic water supply for the area in two stages. In the first stage a 44 mile water pipe was established with a capital input of 3 million Tanzanian shillings (loan from the Swedish Government). In the second stage it is planned to supply seven villages with pipe-lines and taps for every 2,000 people (according to the Regional Water Engineer, Iringa). At present eight 20,000 gallon tanks have been built with one or two taps attached. Along the pipeline a number of so-called wash-outs exist which are opened once or twice a week for cleaning purposes. This water is utilised to a large extent by the neighbouring population for domestic use. According to our information the traditional water sources like bore-holes, dams, dug holes and a well are not used any more.

Water is taken from the Ngera River 17 miles east of Iringa near the main road in the village of Lugalo. The intake is fenced with barbed wire and the river is partially dammed. Within the compound two silting tanks have been established. No other measures for water purification have been taken. During our sampling on the spot cattle were observed drinking and bathing in the river. Several women were washing clothes just above the inlet.



River
Great North Road
Track
Contour
Water tank
Dam
Borehole
Pipeline
Boundary enumeration area
0 1 2 3
km
R. Mbungu
R. Mbungu
Wambegetu
12
20
13
2
7
9
19
16
21
15
11
6
17
22
5
14
8
10
23
3
4
18
24
1 Kihorogota(a)
2 Igula
3 Kisinga
4 Lambilole
5 Kigazi
6 Kigunzile
7 Ivangwa
8 Matembo
9 Kihorogota(b)
10 Mkongani
11 Ndolera
12 Nyangoro(a)
13 Nyangoro(b)
14 Makungugu
15 Lwanga(a)
16 Lwanga(b)
17 Hominyi
18 Gingilanyi
19 Lugalola
20 Mangawe
21 Lubasangilo
22 Damalimbogo
23 Mafifira
24 Nyumbanitu
No contours available for Northern half of the map
JH

sufficient for a population of 48,000 at 10 gallons per person.

The Sample and Method

During our survey in November 1969, 79 samples were taken from 21 water sources. These included three samples from the intake, 20 samples from four different taps along the pipeline, 9 samples from three wash-outs, 22 samples from household supplies taken from taps, 15 samples of household water taken from wash -outs and six samples from two different sources of the Iringa town supply. The water was collected in thoroughly rinsed plastic bottles. Immediately after returning to Iringa the water was filtered ranging in quantity from 0.1 to 25 millilitres. Quantities below 5 millilitres were diluted with a sterile phosphate buffer solution with a pH of 7.2. Water bottles of which several water samples had to be taken at a 24 hour intervals were stored in the fridge at a temperature of 0. °C.

The medium supplied by MILLIPORE (4) in powdered form was prepared at the beginning of the survey and kept also in the fridge under sterile precautions. A comparison was made with agar supplied in a liquid form in ampoules. The superiority of the fresh preparation was revealed by better visible mettalic sheens of the coli-forms. The MILLIPORE monitors were incubated at exactly 36°C. for 24 hours in a portable MILLIPORE incubator. Evaluation of coli-counts was done with a magnifying glass and a flashlight as additional source of light which made the distinction between the different types of colonies very easy.

Results

The counts of the different water samples are presented in the form of logarithmic histograms in the following table.

Table 1: Degrees of Coli-Count Pollution in Different Water Sources of the Ismani (Iringa) pipeline.

Source	No. of Samples	Number of Coli-Forms per 100 ml. water, No. f Samples							
		0-2	3-8	9-32	33-128	129-500	501-2000	2-8,000	above
Intake (river)	3						3		
Taps	20			2	12	5	1		
Washouts	10							8	2
Household from tap	22				6	3	5	3	5
Household from wash out	15								15
Iringa town	6	3			3				
Total	76	3		2	21	8	9	11	22

taps. The number of coli-form colonies per 100 millilitres of water ranged from 32 to over 20,000. The highest incidence was found with five samples in the over 20,000 group. This finding can be explained by the fact that the water is stored for 1 to 6 days in mainly open containers which are rarely cleaned. It can be safely assumed that at least during the hot period the water reaches a fairly high temperature which furthers the multiplication of bacteria existing in the tap water. It is therefore evident that the different storage time accounts for the great variation in pollution together with the difference in the pollution of the storage containers.

Water taken from the taps revealed also a high variety of pollution ranging from 8 - 1,000 colonies. However the average number of colonies was found to be relatively low (between 32 and 62 colonies per 100 millilitres). If this is compared to the three samples taken at the source it can be seen that obviously the sedimentation tanks have a positive effect on reducing the coli-contamination. In all three samples from the river between 500 and 1,000 colonies per 100 millilitres of water were counted.

It therefore can be seen that proportionally very high contamination was found in samples of the wash-out water. All ten samples taken revealed a contamination rate of more than 2,000 colonies per 100 millilitres of water. An even higher contamination rate was found in water from wash-outs stored at home. All 15 samples had pollution rates of over 20,000 colonies per 100 millilitres of water. The Iringa town supply showed no pollution in three samples and only very few coli-forms were found in three others. However, the pollution is negligible if compared with the Ismani supply.

Discussion of Public Health Implications

It can be assumed that the Ismani pipeline supplies a population of 20,000 to 30,000 people with drinking water. A relatively high pollution at the source is slightly improved by initial sedimentation. However, the wide range of coli-contamination of fresh tap water is indicative of a potentially high pollution under changing circumstances: a possible infestation with Salmonella Typhii at the unprotected inlet (Ngera River) can easily lead to a typhoid epidemic. A pipeline is not like a flowing river where the water is cleaned by means of the sandy river bed, which acts like a sand filter. The danger of an epidemic is also increased by the fact that water hygiene is unknown to the population involved. Out of 14 heads of households interviewed only one insisted that the drinking water of his family is being boiled before consumption. As stated above, the high contamination rate of household supplies from tap water is due to a number of reasons; the most important of which is probably the long storage time at relatively high temperatures.

We also found out that it is a general belief in the area that all tap water is purified before it reaches the people. Needless to say the areas of particular danger will be found surrounding the so-called wash-outs.

Corresponding to our findings are the diagnostic statistics of the Ismani dispensary. Even if one assumes that diagnostic procedures at a relatively low medical level are not sufficient for a clear cut statistical evaluation of disease-patterns, it is striking that 10.8% of the 4286 patients attending during September/October 1969 had either diarrhoea, dysentery, or a disease of the digestive system.

It is likely, that during the rainy season the water will be contaminated to an even higher degree. We would therefore recommend that measures be taken to protect the population of Ismani from the danger of a highly polluted water supply. It would be imperative to run the water through a filter system before it reaches the consumer in order to keep the bacteriological contamination low at the outlets.

A concentrated effort should be made by Rural Development Workers and Public Health Assistants to convince the people that "water is not clean just because it comes out of a pipe!" They must carry the message to the people that boiling drinking water is important. It is also recommended that part of the money allocated for extension of the present water system should be used for the hygienic protection of the existing source.

It is sound policy to provide as many of the rural people as possible with water, before one can think of supplying clean water. However, the situation of Ismani must be viewed differently from the public health point of view because of the magnitude of the project being planned. Hazards from the public health aspects are of a different dimension when a population of 20,000 to 30,000 people is supplied with water from one source as against a borehole which is utilised by some hundred people.

Summary

During November 1969 a bacteriological survey was carried out on the Ismani (Iringa Region) water supply. Seventy-six samples were taken from 19 different sources. These included samples from the source (river), fresh water taps, wash-outs, and samples of water stored in the homes of the population for different periods of time.

For the assessment, the ENDO-agar method for total coli-count was employed. The lowest contamination was found in fresh water taken from the taps. Very high pollution rates were seen in samples from storage containers when the water was taken from so-called wash-outs.

It is recommended that measures for filtration be taken when the second stage of the expansion of the present water system is carried out. A concentrated effort in the health education field should be made to convince the population of the area that tap water is not automatically clean and that drinking water has to be boiled under the present conditions of the Ismani supply. Only in this way will one be able to avoid the pending danger of a larger scale epidemic of one or the other water borne diseases.

References:

(1) Geldreich, E. E., Clark, H. F., Huff, C. B., Best, Lois C.,"Fecal-Coliform Organism Medium for the Membrane Filter Technique," Journal, AWWA, 57:2 (1965).

(2) Bradley, D. J., Emurwon, P. "Predicting the Epidemiological Effects of Changing Water Sources, Part I. A Quantitative Approach, East African Medical Journal, 45:5 (1968).

(3) Feldman, D., personnal communication (1969).

(4) Millipore Corporation, Microbiological Analysis of Water. Application Report AR-81, p. 7., Bedford, Massachusetts, USA, (1969).

WATER QUALITY STANDARDS IN TANZANIA

by P. J. Mcdati

1. Chemical and Bacteriological Examination

The quality of most waters in Tanzania today is judged from the chemical analysis point of view only. From some experience, this Laboratory believes in the correlation of chemical and bacteriological examinations of waters so much that it is thought an opinion should never be expressed on the purity of water, however agreeable the results of the chemical analyses, without a knowledge of its bacteriology. In fact, for supplies whose origin and history are well known, the routine control of purity should be maintained by bacteriological investigations, with only occassional chemical examination checks for special purposes, e.g. concerning treatment. Report of the combined chemical and bacteriological tests should then taken the following forms:-

See the Form C.L.7, entitled Water Analysis Report, appended herewith.

2. Particulars to be Supplied with Samples

An insight into the history of the water sample and its source often assists the authority concerned with recommending or condemning waters in this difficult task. Indeed the purpose of the cumbersome exercise of analysing these waters may be defeated or made unnecessarily difficult, in the absence of detailed information concerning the water sample. From some experience, the Ministry of Health may soon introduce a C.L.8 Form entitled Water Analysis Request, similar to the ones appended herewith, at the back of which will be printed detailed instructions of how to collect and submit water samples. These forms should be duely filled by every sender of a water sample and sent along with it, upon receipt of which, this Laboratory hopes to be in a better position to give a more balanced report of the water in question; and perhaps this may give rise to less condemnations of water sources most of which are indispensable.

3. Water Standards used in Tanzania

These are based on the "International Standards for Drinking Water", published by the World Health Organisation, in 1958, with minor modification and addition, as seen in the attached list entitled "Water Specifications". It is my personal belief that lowering of these Standards further than this, may be difficult and hazardous; and if necessary, these should be lowered because of some substantial proof of the harmlessness of lowering them, rather than principally to save a little more money which should be used for small rural water treatment systems. A glance at the "Water Supply for Rural Areas and Small Communities" published by the World Health Organisation, in 1959, and other sources of literature would be well worth the time of anyone who wishes to scrutinise quality standards for rural or any other waters, with intent to modify them.

4. Need for and Costing of more and nearer Water Analytical Facilities

a. Granted that bacteriology must be part and parcel of any decent water quality control system a water analyst may care to adopt, proud possessors of the latest literature of this subject may be aware of the Millipore Filter method of microbiological analyses of liquids and gases. With a Field Monitor comprising a complete microkit for sampling and culturing the collected bacteria, as well as a portable incubator, a sanitarian can perform all, if necessary, or most of the bacteriological analyses of his water <u>in the field</u>. I am given to understand that the price of such a complete microkit ranges from Shs. 3000/= to about Shs. 4000/=, and each test costing approximately Shs. 4/= for expendables etc., and relatively little knowhow, to operate. I would strongly recommend equipping say all the Regional Health Officers with such portable kits with which to test microbiologically rural waters which are otherwise impossible to transport "under ice so that they reach the Dar es Salaam Bacteriological Laboratory within 24 hours of being taken."

b. A small mini Laboratory comprising one spacious room with 2 technicians in every Regional Hospital should also be set up to cater for the more urgent chemical analyses of waters intended for use by the ever growing Ujamaa Villages, National Service and T.P.D.F. Camps etc. Assuming each Regional Medical Officer could spare one room for this purpose, and this Laboratory keep supplying the requisite reagents for the analyses, the Government would need only to recruit and pay salaries of these two ex Form IV technicians, who after a crash programme of training here, may require about Shs. 500/= per month, each i.e. £600 for two technicians per year.

c. Such schemes, including the training of technicians could be completed within one month of obtaining the funds, for the equipment, and rooms in Regional Hospitals, Once started, such schemes would cut down the enormous money and man hours spent in transporting water samples to Dar es Salaam for chemical analysis and those few ocassional ones which come by air for bacteriological analyses.

An important and indispensable commodity like water surely warrants an expenditure of about £8000 per annum per Region.

Telegrams: CHEMLAB
Government Chemical Laboratory

Telephone: 22055
P. O. Box 164
Dar es Salaam.

In reply please quote:

.... 19......

Ref. No. ....received on..............Lab. No. ....

Requested by ....Your ref. No. ....

Collected on ....at.......a.m./p.m., at .... °C

Name and address of site ....

Sampling position and depth ....

Source...

Treatment ....

Physical Examination

Appearance .... Taste ....

Turbidity .... Colour ....

Sediments .... Odour ....

....

pH .... Conductivity at 25°C .... Micromhos/cm

Chemical Examination

Milligrams per litre

Ammoniacal Nitrogen .... Carbonate Hardness ....

Albuminoid Nitrogen .... Non Carbonate Hardness ....

Nitrite Nitrogen .... Total Hardness, as $CaCO_3$ ....

Nitrate Nitrogen .... Calcium ....

Permanaganate Value (in 4 hrs using N/80 $KMNO_4$) ....

Residual Chlorine (on receipt) ...... Sodium ....

Chloride, as Cl. .... Patassium ....

Fluorido, as F. .... Lead ....

Total Solids .... Iron ....

Total alkalinity as $CaCO_3$ .... Zinc ....

Phenolphthalein alkalinity .... Copper ....

Sulphate ....

Bacteriological Examination

Number of colonies per ml. growing on nutrient agar

(a) in 1 day at 37°C ....

(b) in 3 days at 25°C ....

Coli-aerogenes M.P.N. per 100 ml. ....

Escherichia Coli, I.M.P.N. per 100 ml. ....

Clostridium welchii in 100 ml./10 ml. ....

REPORT

Dar es Salaam

....

Reporting Officer

WATER ANALYSIS REQUEST

Telegrams: CHEMLAB
Telephone: 22055

Government Chemical Laboratory
P.O. Box 164
Dar es Salaam.

In reply please quote:
Ref. No. ....

PLEASE COMPLETE AND FORWARD WITH SAMPLES TO THE LABORATORY

1. Address of Site ....
2. Population supplies with water:-
   (a) Total ....
   (b) Children under 5 years ....
3. Point and depths at which the sample was taken ....
4. Whether direct from the main or via intermediate storage tanks ....
5. Sources of Water:-
   *(a) If not permanent, state what seasons water is available ....
   *(b) Public Supply:
   Name of water Authority ....
   *(c) River Supply:
      (i) Name and condition of the river ....
      and distance from source of intake ....
      (ii) Whether sewage or other animal polution above the intake is known to contaminate ....
   *(d) Spring Supplies:
      (i) Nature and conditions of collecting tank is provided ....
      (ii) Nature of water bearing stratum ....
   *(e) Well and borehole Supplies:
      (i) Diameter and depth of well ....
      and approximate age ....
      (ii) Whether covered and bricked above ground level ....
      (iii) Whether pump is provided ....
      (iv) Depth and condition of lining ....
      (v) Nature of soil and water bearing stratum ....
      (vi) Whether recently disturbed ....
      (vii) Distance from nearby drains, cesspools, and other sources of polution ....
   *(f) Ponds:
      (i) Diameter and depth of pond and approximate age ....
      (ii) Nature of soil surrounding it ....
      (iii) Nature and extent of lining ....
      (iv) Whether used for other purposes e.g. swimming, washing, etc. ....

* Complete only where applicable.

6. Variations in appearance, odour, or taste of water at different times, e.g. after heavy rainfall ....

7. Date of last rainfall ....

8. Type, size and condition of:-

(a) Mains and services ....

(b) Storage tanks ....

9. Detailed of any treatment given to the supply at site, eg. Filtration, Chlorination, etc. ....

10. Reason for sampling ....

11. Is the water at present used for drinking ....

12. Any further information ....

13. Date and time of sampling and name, rank and address of sampling officer ....

....

....

14. Diagram of site. Show drainage and fall of land (Not required for Main Public Supplies)

17. Analyses required (if less or more than what C.L.7 forms indicates)

....

....

Back of Form C. L. 8

Ministry of Health and Social Welfare

Telegrams: CHEMLAB
Telephone: 22055

Government Chemical Laboratory
P. O. Box 164
Dar es Salaam.

In reply please quote:

Ref. No. ....

DIRECTIONS FOR THE COLLECTION OF SAMPLE OF DRINKING WATER FOR ANALYSIS

Please note that:-

(a) It is essential that samples for both chemical and bacteriological examination are taken at about the same time from each sampling position.

(b) The following procedure for collecting these samples should be strictly adhered to, if the results of their analyses are to be worth the paper they are written on.

(c) All samples should be collected and forwarded to this Laboratory as soon as practicable.

(d) The container of the box holding the samples for bacteriological examination should be packed with ice (approximately 14 lbs.) within four hours of sampling. This precaution reduces the multiplication of bacteria present at the time of sampling, during transit to the Laboratory.

(e) Accompany each bottle with a secure label of the type shown below:

WATER SAMPLE

Submitted for ....examination
by ....
of ....
taken from ....
....
at ....am/pm. on...............................19....
at ....°C
by...

(f) Samples intended for dissolved oxygen determination should be collected in a narrow necked bottle with a well fitting ground glass stopper to avoid aerial oxygen contamination.

(g) Samples intended for residual Chlorine determination should be in a dark ground stoppered bottle in order to stop the chlorine from reaching the direct light.

1. SAMPLES FOR CHEMICAL EXAMINATION

Collect at least 2 litres (0.44 gallons) in the large Winchester Quart bottle supplied.

Directions:

(1) Before collecting the sample, rinse the bottle three times with the water, and then fill it to the brim and stopper it tightly. This is especially important for samples intended for Dissolved oxygen determination, which require no contact with atmospheric air after sampling.

(2) Samples from a tap or pump: Allow water to flow to waste for a few minutes, to clear stagnant water lying in the service pipes. Then fill the bottle, directly from the pump or tap, allowing the water to overflow 2 or 3 times its volume, and then stopper it securely.

(3) Sample from a tank, well or a stream: Fill the bottle by ploughing its neck well below the surface, or use a clean dipper, if necessary. Take extra care to avoid drawing water from the surface or disturbing sand or sediment at the bottom.

2. SAMPLES FOR BACTERIOLOGICAL EXAMINATION

Collect at least 100 mls. (0.176 pints) in the small bottles supplied for this purpose. The bottles are clean, sterile, and contain a little Sodium Thiosulphate solution for neutralising chlorine which would otherwise kill all bacteria which were present at the time of collection. The empty sampling bottle should not, under any circumstances, be opened until the sample is taken. After collection of sample, keep the bottle securely stoppered, in ice.

Directions:

(1) Hold the bottle in one hand with the fingers as far away from the neck as possible.

(2) Remove the stopper, holding it with the fingers only, and making sure that at no time the stopper is placed on the ground or allowed to touch anything.

(3) Hold the open bottle away from breath and do not allow the neck or mouth of the bottle to be touched.

(4) Fill the bottle, without rinsing, in the manner described below and replace the stopper in the bottle securely.

(5) Sample from tap or pump: Clean the inside of the tap or pump outlet with a clean cloth. Heat the metal by burning a piece of cotton wool soaked in methylated spirits so that it becomes unbearably hot to touch. Run or pump water to waste for a few minutes and then fill the bottle directly from the tap or pump outlet.

(6) Sample from a tank or stream: Invert the opened bottle and gently push it under the surface, then turn it so that the bottle can fill. This prevents inclusion of surface dust. Turn the mouth of the bottle towards the current, or if none exists push the bottle gently forward under the surface.

(7) Sample from a well: A pail or can, thoroughly washed, should be attached to the existing rope or chain by a short length of wire. The pail and the wire should be sterilised by heating both inside and outside with a blow lamp. Lower the pail to draw water, and withdraw it without touching the sides of the well. Place the open sample bottle on a clean surface, and fill it by pouring the water cautiously from the pail.

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TANZANIA WATER QUALITY STANDARDS

BACTERIOLOGICAL QUALITY

Treated Water: The coliform density should not exceed 10 MPN (Most Probable Number)

Untreated Water: The coliform density should not exceed 20 MPN. If very much more, treatment should be considered.

Where necessary, faecal streptococci or anaerobic Spore-forming organisms e.g. Cl. Welchii, should also be determined.

CHEMICAL AND PHYSICAL QUALITY:

Chemical substances affecting the water potability.

	Permissible	Excessive
Total Solids	500 mg/litre	1500 mg/litre
Iron (Fe)	0.3 mg/litre	1.0 mg/litre
Manganese (Mn)	0.1 mg/litre	0.5 mg/litre
Copper (Cu)	1.0 mg/litre	1.5 mg/litre
Zinc (Zn)	5.0 mg/litre	15.0 mg/litre
Calcium (Ca)	75.0 mg/litre	200.0 mg/litre
Magnesium (Mg)	50.0 mg/litre	150.0 mg/litre
Sulphate (SO_4)	200.0 mg/litre	400.0 mg/litre
Chloride (Cl)	200.0 mg/litre	600.0 mg/litre
Mg + Sodium Sulphate	500.0 mg/litre	1000.0 mg/litre
Phenolic Substances (as Phenol)	0.001 mg/litre	0.002 mg/litre
Phenolphthalein Alkalinity (as $CaCo_3$)		1.5 mg/litre + 0.4 times total alkalinity
Total alkalinity produced by chemical treatment		35 mg/litre (as CaCo
Free Chlorine		1.0 mg/litre
Free Chloroamine		2.0 mg/litre
Total Hardness (as $CaCo_3$)		350.0 mg/litre
Permanganate Value (oxygen absorbed)		4.0 mg/litre

Toxic Substances:

	Maximum allowable concentration
Arsenic, as As	0.2 mg/litre
Lead, as Pb	0.1 mg/litre
Cyanide as CN	[illegible]1 mg/litre

Chromium, as Cr IV	0.05 mg/litre
Selenium, as Se	0.05 mg/litre
Fluorides as F	2.00 mg/litre
Nitrates, as NO_3	100.00 mg/litre

Radiological Requirements

Alpha - emitters	10^{-9} uc/ml.
Beta - emitters	10^{-8} uc/ml.

Physical Requirements:

	Permissible	Excessive
Colour	5 units Pt/Co scale	50 units
Turbidity	5 units Turbidity	25 units
Taste	Unobjectionable	-
Smell	Unobjectionable	-

WATER RESOURCES AND BILHARZIASIS TRANSMISSION IN THE MISUNGWI AREA, MWANZA DISTRICT, NORTH-WEST TANZANIA[1]

by F.S. McCullough, V.M. Eyakuse, J. Msinde, and H. Nditi

INTRODUCTION

It has often been stated that bilharziasis is a "man-made" disease and the role of irrigation has been given, perhaps excessive, prominence as the villain of the piece. At Misungwi (see Map I) where there are at present no major irrigation schemes, bilharziasis is very clearly a disease exacerbated by man's activities, in that transmission is incurred in such waterbodies as dams, ponds, furrows and rice fields made by the local populace. Originally the potential snail hosts at Misungwi were restricted to such truly natural habitats as streams, seepage pools and swamps. Later, when new habitats became available the snails colonized them.

Bilharziasis is certainly a disease the spread of which is promoted by man, but the critical point is that it is the water-use habits, rather than the waterbodies (whether they be artificial or natural), which determine whether or not transmission takes place. It is, for example, often forgotten that the potential snail hosts are quite harmless if the schistosome miracidia do not reach them by way of mankind's unsanitary habits. Similarly, it is too frequently overlooked that the molluscan intermediate hosts play a passive, inadvertent role in the schistosome life-cycle. Such inaccurate terms as "snail fever" tend, of course, to perpetuate this misconception, in the lay mind at least. It is surprising, therefore, that while water-usage habits play an important, even critical role, in the transmission of bilharziasis, the results of both quantitative and/or qualitative observations on this key topic are largely lacking. There is no doubt that of all the phases of the schistosome cycle that between man and the snail host is the least understood. Perhaps the main reason for this omission is that staff working on bilharziasis problems have not been trained in community research methods which require a sound knowledge of both sociology and the principles of statistics.

The preliminary observations, described in this paper, on the relationship between the water resources and the transmission of bilharziasis at Misungwi have been made in connection with the programme of the bilharziasis pilot control project (Tanzania-39) initiated in mid-1967.

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[1]This is a reprint from East African Medical Journal, Vol. 45, No. 5.

The project area

The project area (Map I) comprises about 65 sq. miles around the settlement of Misungwi, situated about 30 miles south of Mwanza. This area is regarded as being representative of much of Sukumaland; it is rural in character and supports a scattered population now estimated at 11,146.

The major physical and cultural features of Sukumaland have been described by Rounce (1949) and Malcolm (1953), while the water resources, with special attention to irrigation potential, have been detailed by Gibb (1956).

Although surveys of the overall prevalence of bilharziasis in random samples of the population at Misungwi have not yet been carried out, the prevalence of urinary bilharziasis in local schoolchildren is over 80 per cent and transmission is believed to be incurred in small, often temporary, man-made waterbodies. There is recent evidence that intestinal bilharziasis is also endemic, but its prevalence, relative to that of S. haematobium, is probably very low. The medical and public health importance of bilharziasis in the Bukumbi area, immediately to the north of Misungwi, has been fully dealt with by Forsyth and Bradley (1966) and at Usagara village by Jordan (1961), where the major factors in the transmission of S.haematobium have been extensively investigated by Webbe (1962).

OBSERVATIONS AND DISCUSSION

The types and location of the waterbodies at Misungwi

A polyvalent survey is being carried out in the project area in order (a) to locate, describe and measure the sites of potential transmission, (b) to determine the presence or apparent absence of the snail hosts in the waterbodies, (c) to record the water-use and number of dwellings associated with the habitats, (d) to plan possible control procedures and (e) to record the boundaries of the sub-administrative areas. To date about a third of the entire project area has been surveyed, mainly during the dry season, but also, for comparison, under rainy season conditions. The main categories of waterbody in the area surveyed are: flood plain, dam, seepage pool, pond, drinking pond, stream, residual pool, furrow and bunded (usually rice) field. During the dry season (June-October) it is estimated that there are at least 20 habitats per sq. mile, of which 72 per cent are ponds and drinking ponds (42 per cent and 30 per cent respectively) while the remaining categories of habitat each comprise less than ten per cent of the total number of waterbodies. During the rainy season, however, it is calculated that there are at least 50 habitats per sq. mile of which 48 per cent are ponds and drinking ponds (31 and 17 per cent respectively) and 39 per cent are bunded rice fields and furrows (23 and 16 per cent respectively). The considerable proportional increase in the number of rice fields and furrows during the rainy season assumes greater significance when, firstly, it is realized that our categorization is based on "blocks" of rice fields, in each of which there may be from five to 50 individual rice fields. Secondly, as will be mentioned later, there is now strong evidence to show that rice fields and furrows are the most favoured habitats of Bulinus (Physopsis) nasutus, principal snail host of S.haematobium in Sukumaland.

If it is assumed that the area surveyed is representative of the project area, it can then be predicted that there are well over 3,000 waterbodies in the project area, of which more than 50 per cent will be positive for the snail hosts of S. haematobium.

It is estimated that the ratio of houses to habitats in the area surveyed is about I:I. As ponds, including those for drinking, account for about half of the total number of habitats, an attempt was made to measure them. The average cubic capacity of 143 ponds (see Fig.I) is 368 cu.ft., but the majority are less than 200 cu. ft. in capacity. As indicated also in Fig. I, about 50 per cent of all ponds are 200 cu. ft. or less, about 40 per cent are between 200 and 1,000 cu. ft. and only about ten per cent are more than 1,000 cu. ft. Our present results also show that about half of the ponds are likely to dry up during the long dry season, June-October; the drinking ponds, however, are much more permanent and probably less than ten per cent of them dry out during a normal dry season.

The location of the waterbodies follows a consistent pattern as shown in the diagrammatic cross-section of a typical shallow valley (Fig.2). During the dry season almost all of the waterbodies are located on the middle and upper slopes of the valley; during the wet season these are supplemented by vast numbers of rice fields, many of which are then located at the bottom of the valleys. The potential bilharziasis transmission sites therefore occur, particularly during the dry season, in a comparatively small proportion of the overall surface area. The location of the waterbodies is, of course, governed by the geology of the area, particularly the soil catena, which in turn influences the agricultural practices and the water-usage patterns of the people. The classification of the Usukuma soils (see Rounce, 1949) is complex, but from the viewpoint of the potential bilharziasis transmission sites the following soil types play a dominant role. In the middle and upper slopes the presence of waterbodies is associated with ilag. type soils which support crops well during the dry season and in which rice may be cultivated when this soil occurs in seepage areas. To a lesser extent the waterbodies are also located in itagolo soil which is a shallow sandy clay loam belonging to the hard-pan group and in which sweet potatoes and rice may be cultivated. In the floor of the valley, apart from the seasonal streams and residual pools, the mbuga (heavy black or grey clay) soils, because they are frequently calcareous and are of slow permeability and because they receive excess water from the surrounding higher lands during the rains, can provide waterbodies (mainly bunded fields) ideally suited to the maintenance of the snail hosts. The importance, however, of these waterbodies as transmission sites of bilharziasis is equivocal and this subject will be discussed later.

The presence of apparent absence of the snail hosts in the different types of waterbody at Misungwi.

During the dry season, 362 potential transmission sites were recorded and classified in the area surveyed. The presence or apparent absence of the snail hosts in the different categories of waterbody is shown in Tables I and 2. Bulinus (P.) nasutus was found in 48 per cent of the habitats recorded and this species is undoubtedly the most widespread of the potential snail hosts of S. haematobium in the Misungwi area where it is most commonly found in rice fields, furrows and seepage pools.

This snail species was also found in 56 per cent of the dams, 45 per cent of the ponds and 31 per cent of the drinking ponds (Table 2). B. (P.) africanus, which likewise is a proven snail host of S. haematobium, was found in only four habitats, two dams and two large residual pools in the Misungwi stream. B. (P.) coulboisi is also relatively rare and was found in only four habitats all of which were--probably significantly--dams; there is mounting evidence that this species is resistant to local strains of S. haematobium. Biomphalaria pfeifferi, a snail host of S. mansoni, is surprisingly common and widespread in the area surveyed and was recorded in 12 per cent of the habitats. B. pfeifferi seems to favour the same types of habitat as those preferred by B. (P.) nasutus (see Table 1) and from the ecological viewpoint these two species have much in common, though the latter has obviously evolved further towards an amphibious mode of life. The distribution of Lymnaea natalensis was also recorded and it appears--lake B. (P.) africanus and B.(B.) coulboisi-- to prefer large, mostly permanent, waterbodies.

Table 1

Showing presence or apparent absence of snail species in different types of habitat in part (about one-third) of the Misungwi area surveyed during the dry season

Types of habitat*	No. of habitats recorded	B. (Physopsis) nasutus		B. (Physopsis) africanus		B. (Bulinus) coulboisi		Biomphalaria pfeifferi		Lymnaea natalensis	
		Found	%	Found	%	Found	%	Found	%	Found	
Dams ("hafirs")	31	17	54.8	2	6	4	13	6	19	3	
Ponds	137	65	47.5	-	-	-	-	11	8	2	
Drinking ponds	98	29	29.6	-	-	-	-	8	8	2	
Rice fields	20	18	90	-	-	-	-	1	5	-	
Ditches/furrows	40	23	57.5	-	-	-	-	12	30	2	
Seepage pools	6	5	83	-	-	-	-	1	16.7	1	1
Total	332	157	47	2	0.6	4	1	39	12	10	

*Residual pools in stream beds and dried up habitats not included.

Showing the presence or apparent absence of Bulinus (Physopsis) nasutus in different types of habitat in part (about a third) of the Misungwi area surveyed during the dry season.

Type of habitat	No. of habitats observed	No. of habitats in which B. (Physopsis) nasutus were found	Percentage
Dams ("hafirs")	32	17*	56
Ponds	152	68	45
Drinking ponds	112	35	31
Rice fields, ditches, furrows, seepage pools	66	56	85
Total	362	176	48

* 3 of the dams contain B. (B.) coulboisi alone.
2 of the dams contain B. (Physopsis) africanus alone.
5 of the dams contain Biomphalaria pfeifferi in conjunction with B. (Physopsis) nasutus.
1 dam contains Biomphalaria pfeifferi alone.

During the rainy season, apart from the very considerable increase in the number of habitats, it is of interest and probably significant that the percentage of the different categories of new habitat positive for B. (P.) nasutus closely approximates that recorded during the dry season (Table 3). This finding further confirms that rice fields, furrows, and seepage areas are the most favoured habitats for B. (P.) nasutus. In the Misungwi area this species is much less commonly found in dams, ponds and drinking ponds, though the former two categories may well be the most important sites of transmission of S. haematobium as they are more frequently used by the people in a manner conducive to the spread of vesical bilharziasis.

Water-use activities at Misungwi

Some preliminary information on water-use activities in the project area has been collected and can be summarized as follows:

Bathing and washing

These activities are carried out either inside or outside the waterbody. The location of large stones, especially used in connection with these activities, usually provides an indication of the intimacy of contact with the water and thus to pollution and

Table 3

Comparison of number of habitats (potential transmission sites) recorded during the dry and rainy seasons in representative areas at Misungwi.

	Type of habitat					
	Dam	Pond	Drinking pond	Bunded Field	Furrow	Seepage pool
No.of habitats recorded during dry season	12	36	29	3	16	1
Percentage of dry season habitats positive for Bulinus (Physopsis) nasutus	40	53	25	80	79	-
No.of new habitats recorded during rainy season	1	42	9*	48	20	1
Percentage of new habitats positive for B.(P.)nasutus	-	48	23	85	90	-

* 2 of the drinking ponds were newly dug, (i.e., after the dry season survey).

bilharziasis transmission. These activities are carried out mostly in small ponds, less commonly in the other types of waterbody. Frequently, shallow, temporary ponds are dug near the houses for use as washing and bathing sites during the rainy seasons. Cattle are often watered at the sites used for washing and bathing. These waterbodies are not used for drinking. If they are deep and free of emergent vegetation, they can also be used for swimming.

Drinking

The drinking water supply is taken from special ponds which, if close to other waterbodies, are sited above them. Though the water in the drinking ponds appears no more clean than that in other waterbodies, every attempt is made to prevent overt human or animal pollution. The drinking water supply can be used for washing and bathing, but in that case such activities are conducted outside the waterbody. During the dry season the pond used for drinking may be a considerable distance from the dwellings.

During the wet season, however, ponds close to the houses may be reserved for drinking. It is believed that drinking ponds are of relatively little importance as transmission sites, even though they may often harbour the snail hosts. If pollution of drinking ponds does occur, it is the children who are most likely to be responsible. There is some evidence that drinking ponds may sometimes be abandoned for a variety of reasons and their transmission potential is then altered.

Swimming

For obvious reasons swimming most often takes place during the hot season in dams and deeper ponds which are relatively free of surface vegetation. This activity appears to be mostly restricted to children who may travel a mile or more to swim in a favourite waterbody. It also seems that children will spend a longer time swimming than adults, who usually only enter the water for a short time before soaping their bodies at the side of the habitat. Groups of adults may immerse themselves, especially after work, in the early afternoon and during the millet-beating season (May to July) in order to get rid of the dust. Millet-beating is a communal activity reserved for males. Swimming is undoubtedly of major importance in S. haematobium transmission because (a) it stimulates urination and (b) egg output is highest in children who swim much more than do adults.

Cattle watering

All types of waterbody, except drinking ponds, are used for this purpose, especially in the wet season. However, dams and large ponds are the main centres for cattle watering and the stock may be herded to several waterbodies during the course of one day.

Sisal and gourd soaking

These activities are less common and usually take place in small ponds, often seepage pools, but the edges of large ponds can also be used for this purpose.

Irrigation

Shambas (small plots) of sweet potato, cassava, sugar cane, bananas, etc. are usually located in seepage areas and are often irrigated from a pond. The waterlogged furrows are a favourite site for snail breeding and irregular transmission may occur in them.

Rice culture

As shown in Fig. 2, the rice fields are located either in the floor of the valleys or in the middle and upper slopes of the valleys in areas of pronounced seepage. The relationship between rice culture and bilharziasis transmission is unknown and it is hoped to study this aspect in the future.

Brick-making

The ponds made for this purpose occur close to the houses, often inside the bomas. They are invariably temporary, but may harbour the snail hosts. They are seldom filled in and may be used for bathing and washing in the wet season.

Cleaning out of waterbodies

Some larger ponds, dams and especially drinking ponds are periodically cleared of vegetation and also deepened. This activity is carried out in order to make the water more attractive for swimming and drinking and takes place mostly when there is water in the habitat. The more frequent cleaning of the drinking ponds may be a reason why fewer of them seem to harbour the snail hosts (see Table 1). While a few families, or even a single one, are responsible for keeping drinking ponds free of vegetation, the cleaning out of the dams is carried out, sometimes annually, by the Kisumba* at the request of the headman of the local area. Both drinking ponds and dams are cleaned out when they are relatively full of water. There is some reason to believe that if the entire surface inch of soil could be carefully removed from temporary ponds, as soon as they have become dry, a considerable measure of snail control could then be achieved.

Waterbodies in relation to the spread and control of bilharziasis at Misungwi

In view of the large number and wide variety of habitats at Misungwi there is need to try to locate the sites of transmission as accurately as possible prior to the implementation of control measures. All previous investigations in the Mwanza District have indicated that transmission is

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*A so ciety of young, male adults who carry out communal work at the request of the headman of their area. The Kisumba society is of ancient origin among the Wasukuma. This society may prove useful when environment control measures are being implemented at Misungwi.

incurred in small seasonal ponds or pools and that peak transmission, as judged by the infection rate in the snail hosts corresponds to the end of the main rains and the period immediately afterwards, i.e. April-August (Webbe 1962, Webbe and Jordan 1966). Apart from dams, ponds and/or pools, it is not known to what extent other categories of waterbody were studied. Moreover, Webbe and Jordan (loc.cit) also state that "Most snails with S. haematobium were found in June, July and August with maximum monthly infection rates of 12.5, 7.7 and 12.6 per cent respectively. High cercarial infection rates were found in individual foci and 50-80 per cent of samples of more than 200 snails were frequently found infected". During the present dry season survey (July to September) at Misungwi very few snail hosts were found shedding mammalian schistosome cercariae. As shown in Table 2, B.(P.) nasutus were found in 176 out of 362 habitats belonging to different categories. Infected snails of this species, however, were recorded in only eight of the 176 habitats (four per cent) and out of 6,172 B.(P.) nasutus collected in the area surveyed only 23 specimens (0.3 per cent) shedding mammalian schistosome cercariae were recorded. The significance, if any, of the paucity of habitats with infected snails and the very low rate of infection in the snails collected at a period when peak infection rates could be expected, requires further study in view not only of its epidemiological implications, but also because of its prospective role in the assessment of control measures. Furthermore, during the present survey (July-December) the number and categories of waterbody harbouring infected B.(P.) nasutus is as follows:

Category of waterbody	No.recorded	No. harbouring infected B.(P.) nasutus
Dam	40	2
Pond	261	4
Furrow	62	4
Rice field	117	3
Drinking pond	130	2

Although the contribution of the different types of waterbody, based on the activities carried out in them and on the number of harbouring infected snails, to the transmission of bilharziasis requires to be investigated in much greater detail, our present results on this aspect are somewhat discouraging from the standpoint of snail control, which at Misungwi is a much more complex problem than earlier envisaged.

It can be stated quite categorically that eradication of the snail hosts at Misungwi is not feasible. Perhaps snail control by a combination of molluscicides and environmental control (modification of the habitats) may be practicable, particularly if the transmission sites are not diffuse and can be categorized with reasonable accuracy and if full co-operation is forthcoming from the local populace. If, however, there is further unequivocal evidence that the transmission sites are diffuse and do not belong to a particular category (e.g. ponds), there is then some reason to suggest that the most effective control measure may be by chemotherapy.

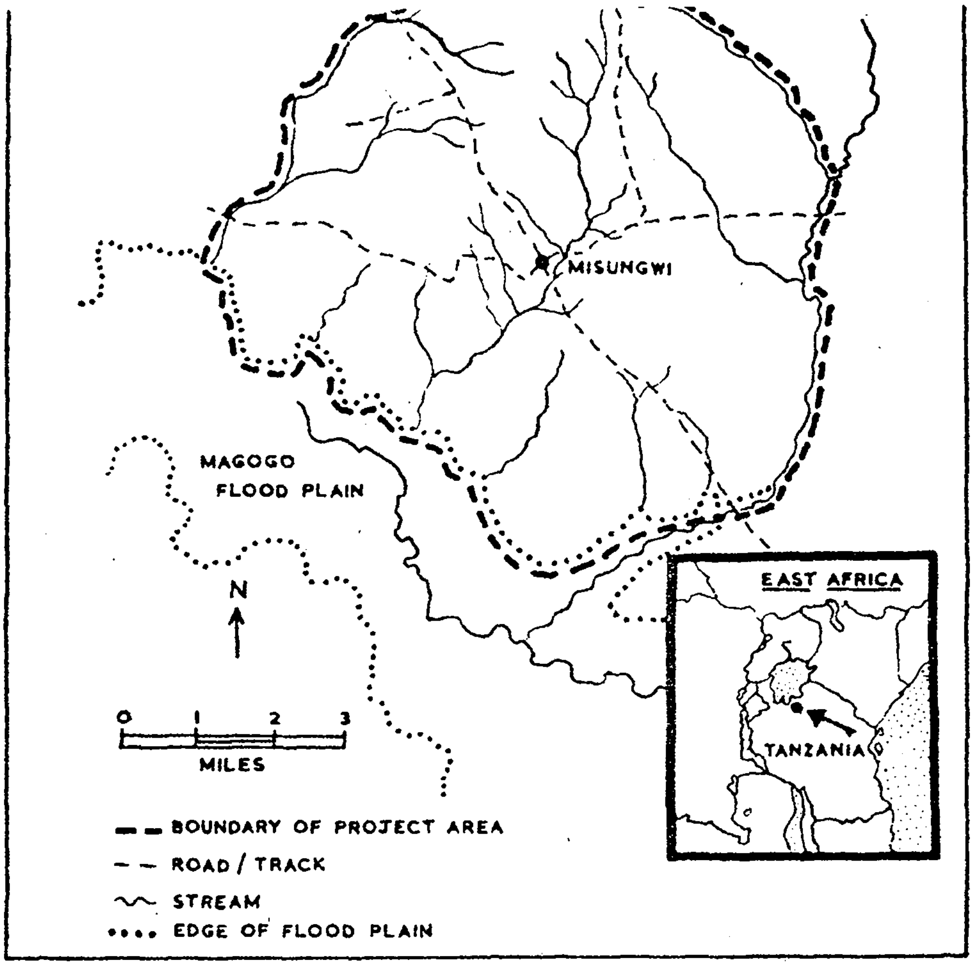
Another observation at Misungwi, which will also have a strong bearing on the efficacy of subsequent control operations, is that the great flood plain of the Magogo River, forming much of the southern boundary of the project area and more than 10,000 acres in extent, is a vast repository for the snail hosts of both vesical and intestinal bilharziasis (Ma 2). Moreover, there is evidence that it is much used by the populace for cultivation, cattle raising and fishing. Clearly, any method of snail control in the Magogo flood plain would be impractical at the present time and probably the only solution to bilharziasis control in such an area would be by chemotherapy. Gibb (1956), in a survey of the water resources of the Nile Basin in Tanganyika, has indicated that about 8,300 acres of the Magogo flood plain would be suitable for reclamation and irrigation (Map 2). Should Gibb's proposals ever be implemented--and population pressure alone is likely to make the reclamation of such "mbuga" (open) lands an imperative in the future--the need to consider bilharziasis control measures in the early planning stages of the scheme is obvious as the ingredients for hyperendemic bilharziasis, both intestinal and vesical, already exist in the Magogo valley.

In the Misungwi area, because of the excessive number of habitats, the high degree of adaptation of <u>B.(P.) nasutus</u> to the vast number of shallow waterbodies, especially those of a seasonal kind, the high density of the human population and the apparent intensity of use of the habitats, it is believed that <u>S. haematobium</u> infection has reached peak levels of endemicity and that these factors in combination account for the serious health consequences of vesical bilharziasis as reported by Forsyth and Bradley (1966) in north Sukumaland. The number of habitats at Misungwi is excessive because at least a third of the ponds are no longer needed by the populace and only about a tenth of the rice fields are now cultivated each year. As shown in Table 4, the acreage and production of paddy in the lake region (though not in Tanzania as a whole) fell markedly after 1952 when the cotton acreage rose rapidly under the stimulus of higher prices.

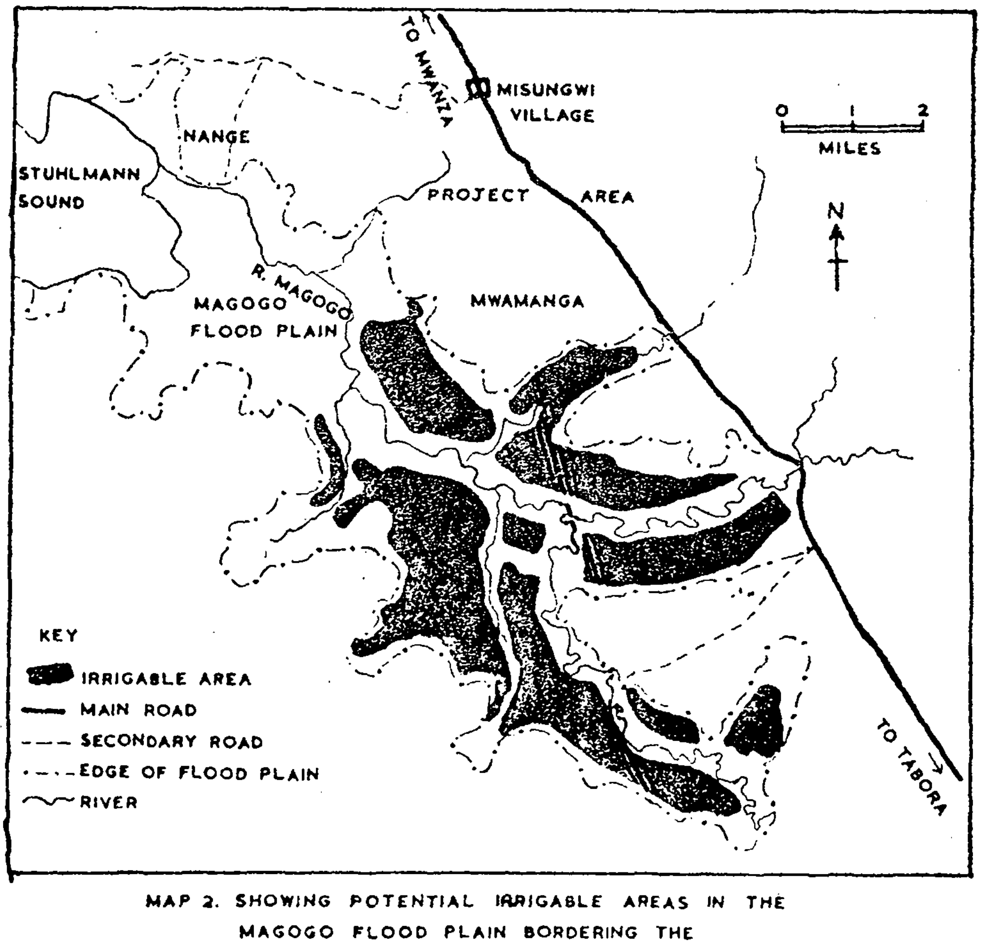
At the present time at Misungwi rice is seldom grown as a cash crop, but is produced mainly for local consumption. The old rice fields, however, are extant and presumably contribute not only to the spread of bilharziasis, but also to malaria and filariasis. It is now evident that all surplus waterbodies should either be filled in or drained. In this sense, as earlier mentioned, bilharziasis at Misungwi is a man-exacerbated disease and full co-operation from the local populace will therefore be required if the infection is to be adequately and economically controlled under Tanzanian conditions. For this reason one of the aims of the pilot project at Misungwi is to assess the willingness of the people to co-operate in control measures within the limits of their material and other resources.

SUMMARY

The results of preliminary observations on the water resources and bilharziasis transmission in the Misungwi area of north-west Tanzania are described. A bilharziasis pilot control project (Tanzania-39) is being initiated in the Misungwi area which is representative of much of Sukumaland. Information on the various categories of water-body and their relative frequency during both dry and rainy seasons is summarized. During the dry season there are at least 20 habitats per sq. mile and this estimate is more than doubled during the rainy season. The location of the waterbodies follows a consistent pattern in the valley profile and is governed by the soil catena which in turn influences the agricultural practices and water usage habits of the people. The presence or apparent absence of the snail hosts in the different types of waterbody is described. The most favoured habitats of B.(P.) nasutus, principal snail host of S. haematobium in the area, are furrows, bunded (rice) fields and seepage pools, all of which are often seasonal. This species is less commonly found in dams, ponds and drinking ponds, though the former two categories of habitat may be the most important sites of transmission. The contribution of the various categories of waterbody to the transmission of bilharziasis in the area is still unknown and further study of this problem is imperative prior to the implementation of control measures. At Misungwi the problem of snail control is much more complex than was earlier believed and the full co-operation of the local populace will be imperative if the infection is to be controlled adequately and economically under Tanzanian conditions. The main water-use activities in the project area are summarized, but there is need for more qualitative and/or quantitative observations on this key aspect of the problem.

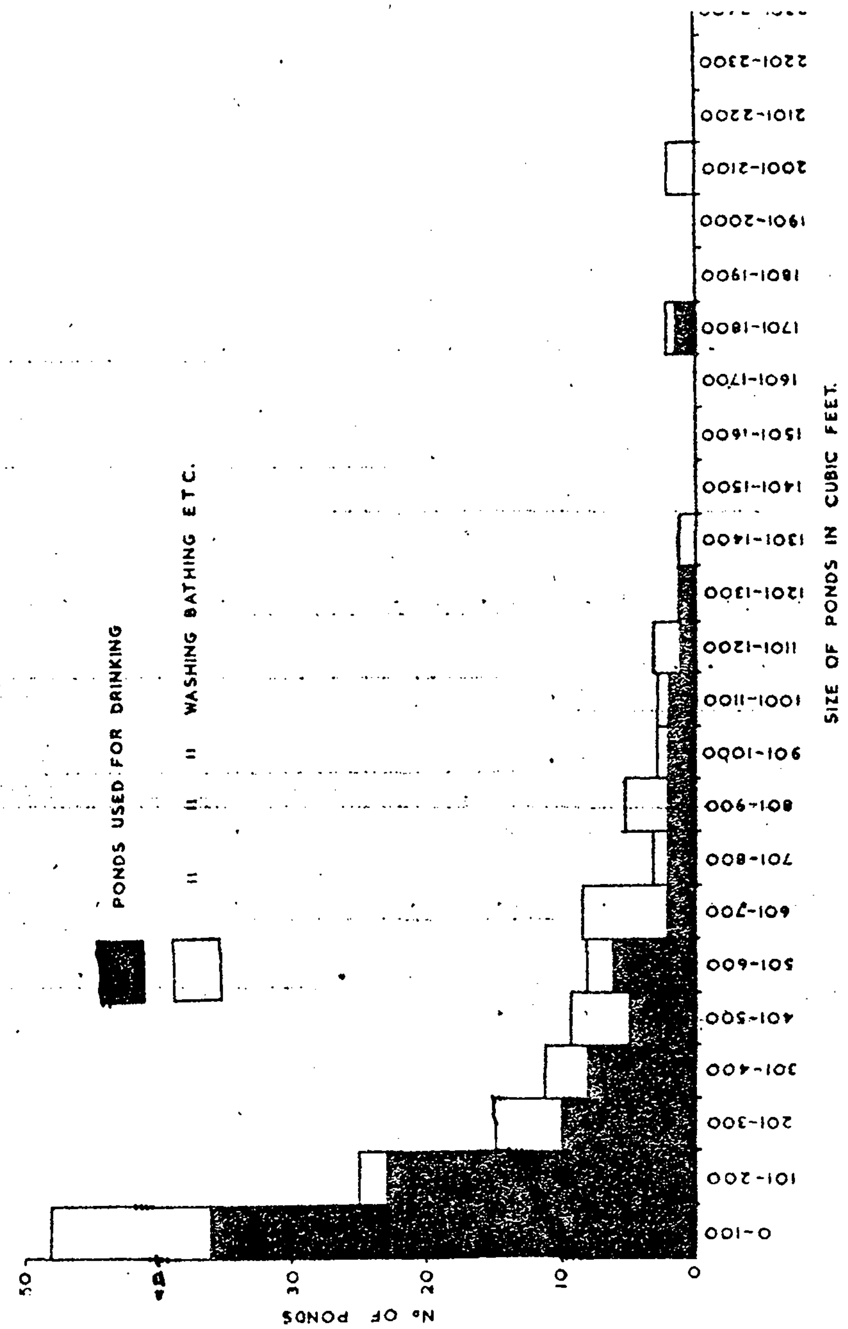


Map 1 Showing the project area at Misungwi



MAP 2. SHOWING POTENTIAL IRRIGABLE AREAS IN THE MAGOGO FLOOD PLAIN BORDERING THE PROJECT AREA.

FIG. 1. HISTOGRAM SHOWING RELATIONSHIP BETWEEN NUMBER OF PONDS AND THEIR CAPACITY IN CUBIC



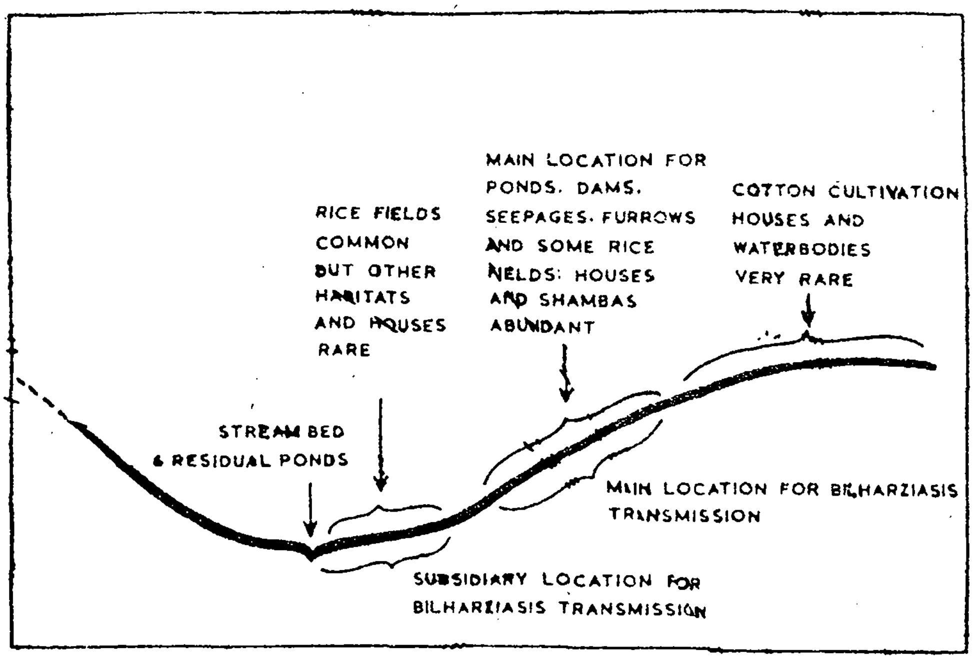


FIG. 2. PROFILE OF TYPICAL VALLEY IN THE MISUNGWI AREA SHOWING LOCATION OF WATERBODIES AND BILHARZIASIS TRANSMISSION SITES

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TEACHING OF BETTER WATER SUPPLIES TO MEDICAL AUXILIARIES

by Vincent van Amelsvoort

The teaching of better water supplies to medical auxiliaries is often limited to the time honoured triad of boiling, filtration and chlorination. The feasibility of these methods for rural areas is seldom, if ever, discussed. Boiling is often impractical, because of the great distance women have to walk to fetch their firewood. The only sensible advice may be to put the water pots in the dying fire after the evening meal has been prepared. Filtration by candle-filters is beyond the economical means of most peasants. Chlorination at home has similar disadvantages, and gives moreover a bad taste to the water.

Although Medical Auxiliaries should realise the technical superiority of these three methods, additional simple measures should be taught:

1. Keep water pots in a cool place.

2. Clean waterpots regularly and throw old water out before fetching fresh water.

3. Do not let water buckets used for drawing water from a well, lay down on the earth, but keep them on the rim of the well and hang them in the kitchen.

4. Do not spit near wells.

5. Do not wash clothes near a well, but have a washing slab made at some distance from it.

6. Fetch drinking water in early morning or late evening in bilharzia infested waters.

For household use, the three-pots-system should be explained in detail. It is based on sedimentation and the disappearance of some organisms after water has been kept for 48 hours. This method moreover is within the economical means and cultural pattern of the rural population.

For exceptional circumstances simple iodinization of drinking water should be taught to medical auxiliaries.

ESTATE AND THE EVALUATION OF CONTROL USING DIAGNOSTIC METHODS ON THE LOCAL POPULATION

by Alan Fenwick

Routine molluscicide application have been adopted for the control of Biomphalaria pfeifferi snails (the vector of Schistosoma mansoni) on a 9,000 acre sugar estate at Arusha Chini in Northern Tanzania. The aim of the molluscicide treatments is to keep the snails at a low level in order to break the transmission of the disease within the estate boundaries. Snail counts have shown that the dosage regimes used have been successful in keeping the snails below the population density level at which snails can be detected. The chemicals used are Frescon at 0.025 ppm driped for 5 days every 7 weeks into the headwater of the irrigation system, and Bayluscide sprayed at 2-4 ppm. into all drainage ditches every 8 - 10 weeks. Any other snails found in small pools etc. during the rains are destroyed by Bayluscide focal spraying.

Although snail counts indicate that the molluscicides are being successfully utilised the true criterion of success will be a significant effect upon the transmission of S. mansoni. With the molluscicides to be used routinely during the period January 1st 1968 until 1971, an effort is being made to measure the bilharzia transmission during this period to try and demonstrate a drop in transmission.

This is being done in 2 ways:

1. New workers:
   All new employees to the estate are tested on arrival. Those found negative are then re-tested every six months to find how many contract the disease. As a reference the work of Foster (1967) is being used. He found that over 60% of 140 workers found negative in Aug/Sept. 1962 were positive by May, 1963.

   If the molluscicide is effective this figure should be greatly reduced during the present work.

2. Young children:
   A prevalence survey of S. mansoni in young children is being carried out by testing 5 children from each of 8 camps born in each year 1962-69. After 18 months to 2 years this survey will be repeated.

   If the molluscicide has been successful a decrease in prevalence for each age group can be predicted.

Combimbined chemical snail control and drug treatment against Bilharzia.

In addition to the above work which is exclusively molluscicide use and evaluation, a second experiment is being carried out, in which molluscicide assessment is the work of T.P.R.I. and treatment of estate personnel with drugs is being done by the estate doctor. This is to evaluate not only snail control by molluscicides but a combination of this with mass diagnosis and treatment of all people on the estate. The former being to prevent new infection and re-infections, the latter to find and treat existing cases.

This will be evaluated by 2 prevalence surveys (19[illegible] and 1971) using random selection of samples. Between the two surveys as many as possible of the 5,500 residents will be examined for Bilharzia and those found positive will be treated.

The results so far are promising. The small number of new workers so far follwed up have largely remained free of infection. The 1969 prevalence survey shows an infection rate of 60% in field workers, 33% in non-field workers and 25% in wives. All these levels would have been higher if new arrivals after 1 January 1968 had not been included in the survey and if people had not been receiving treatment during 1968 after routine examination in the hospital.

References:

Foster R. (1967)

Schistosomiasis on an Irrigated Estate in East Africa, 2 Epidemiology, Journal of Tropical Medicine and Hygiene Vol 70, No. 159.

AMBILHAR AMONG THE WAMBUGWE OF HANANG DISTRICT - NORTHERN TANZANIA - A PRELIMINARY REPORT[1]

by M. A. O. Kipuyo

Introduction

The aim of this preliminary report is simply to narrate the various activities in the field of our staff who conducted a three month's mass treatment campaign of urinary schistosomiasis among the Wambugwe tribesmen in Hanang District, Northern Tanzania. It does not in any way claim to be a technical report with trials and controls, the use of placebos etc, or even provide definite figures of the success or failure of the treatment. On the other hand it attempts to give the various problems encountered in the field in organising a mass campaign of this magnitude, and especially the public health problems that were actually more important than originally thought. Finally a few facts and figures have been provided just for a preliminary assessment of the campaign.

Background Information

Way back in 1967, when the Tanzania Government officially embarked on the policy of settlement schemes in rural areas the question of settling the Wambugwe was discussed at a meeting of the Regional Development and Planning Committee at Arusha. It was noted that the Wambugwe were very highly infected with bilharzia and the Regional Medical Officer was asked to investigate and advise on how to eradicate the disease completely from this tribe.

During the 1967 population census it was also noted that the population of the Wambugwe had fallen considerably from 35,000 people in 1932 to 15,000 in 1967, and this was considered a very significant fall which probably was related to the high rate of bilharzia infection in the tribe. This is why in fact the Government thought it better to re-settle these people i some other healthier area eg. Sangaiwe.

So a preliminary survey was conducted in the area in October 1967, mainly among school children. Out of 1852 urine specimen examined 468 were found positive for schistosoma haematobium an infection rate of 250 per 1000. Out of 1513 stool specimen examined only four were found positive for schistosoma mansoni.

Definitely this is a very high infection rate and the disease mainly confined to the Geinto-urinary tract.

A snail population survey was later done in the same area and 5 species of snails were found viz. physopsis globosus, which harbours schistosoma haematobium, biomphalaria pfeifferi which harbours schistosoma mansoni, lymnaea natalonsis which carries fasciola hepatica (liver flukes in cattle) and melanoides tuberculata and indoplanorbis spp which do not harbour any disease carrying organisms. However the snails were not seen in great numbers concentrated in one place but were distributed all over the whole area. This made the pinpointing of transmission sites impossible, and snail control over the whole area impracticable.

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[1]Report originally prepared for the Principal Secretary, Ministry of Health and Social Welfare, Government of Tanzania, 22 October 1969.

So the question of a mass treatment campaign was therefore considered. The problems of course were who was to finance the campaign, who was to conduct the campaign and what type of drug was to be used.

Planning the Campaign

(a) Finance - At first it was thought that money and or drugs could be obtained from voluntary sources but this later proved to be impracticable. The Government had just announced the Arusha Declaration and the policy of socialism and self-reliance, so the then Minister for Health committed himself firmly that the Ministry would take up part or the whole project and an initial sum of Shs. 20,000 was promised. It was not until May, 1969 that the money was actually made available.

(b) Choice of drug - After consultation with Dr. R. Davis, Director of the Schistosomiasis Research Centre Tanga it was decided that Ambilhar (Nitrothiamidazolo by CIBA) would be the drug of choice for a mass campaign like this one, provided a reasonably competent medical or para-medical person supervised it.

(c) The field team was made out as follows:

Dr. Mathew Mambea - Senior Assistant Medical Officer of Health was made in charge of the team and all the field operations.

1 Medical Assistant
1 Senior Health Officer
1 Health Officer - part time
3 Health Auxiliaries
1 Male Nurse Grade B
1 Male Assistant Nurse
1 Nursing Assistant
4 Microscopists
1 Labourer
3 Drivers
2 Medical Students (Makerere) - part time
6 Rural Development Assistants - part time. These were seconded from the Ministry of Local Government and Rural Development and attached to the campaign for two weeks.

Other people who took part in the campaign but not actually members of the team were:

The Arusha Regional Commissioner - The Hon. Mr. Mwakangata MP
The Area Commissioner Hanang - Mr. Muro
The Regional Medical Officer - Dr. Kipuyo
Local TANU leaders, Divisional Executive Officers, and 10 cell leaders.

(d) Transport comprised of three land rovers all provided by the Regional Medical Officer Arusha. Petrol and other running expenses were borne by the Regional Medical Officer Arusha and debited to the appropriate vote of Plants and Vehicles. Arrangement was made with the local merchants so that the field team could purchase petrol locally by using Government LPOs.

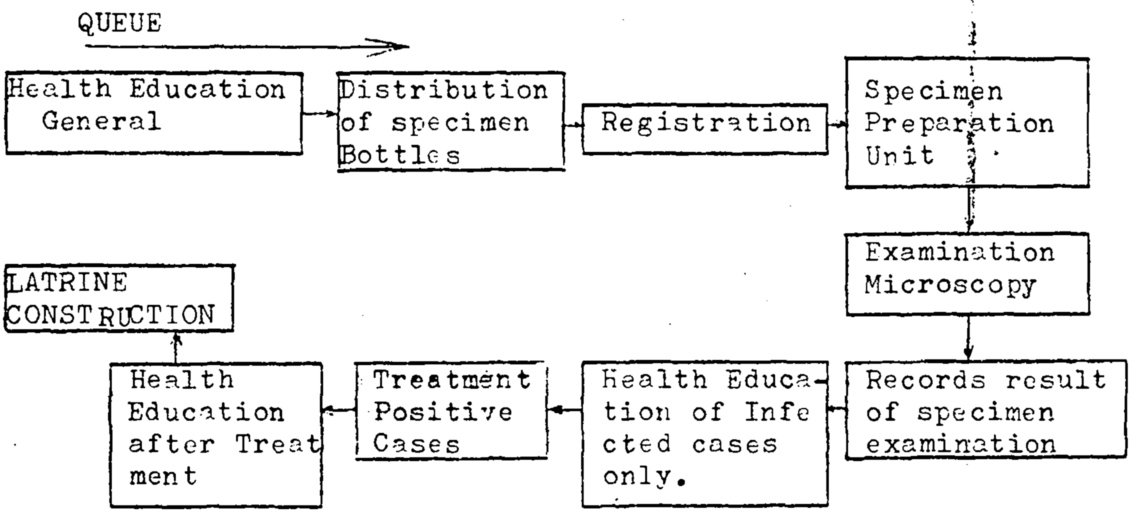
(e) Field equipment consisted of simple safari kit together with four microscopes, contrifuge machines, weighing scales, microscope slides, test tubes, specimen containers and a tape recorder.

The Campaign Itself

The aim of the present campaign was first to re-examine the whole population again, treat all the positive cases and most important launch a health education campaign to educate these people on how to avoid getting re-infected - especially by building and using pit latrines.

To achieve good results we had to have good co-operation with the local leaders and the people generally. So a general meeting was called at Magugu on the 2nd July and the people were told about the aims and objects of the campaign. There was such a good response and enthusiasm that 13 examination and treatment centres were proposed. The actual examination and treatment started on 9th July, 1969.

The actual organisation at an examination and treatment centre was the most important factor in conducting this campaign. Poor organisation at any centres could only have resulted in obtaining poor results and a poor response from the public. So a typical examination and treatment centre was organised as follows:



The first thing was a lecture on bilharzia, what it means to have bilharzia, how it is contracted and how important it was that everybody should get examined and treated. Then every participant was given specimen containers for stool and urine and then sent to registration for taking in particulars and issuing an identification number.

From registration, the patients went out to obtain specimen of stool and urine which surprisingly enough they produced without any difficulty. They then went to the specimen preparation centre where a Male Nursing Assistant helped them to prepare stool specimen ready for examination and centrifuged the urine, smeared the deposit on a microscope slide and then handed it back to the owner - ready for examination.

The examination carried out was microscopic and a positive result was obtained only if the characteristic egg of schistosoma haematobium or mansoni was seen. There were four microscopists so if one was not so sure he could always consult another. It was not possible to ascertain whether the eggs were viable or not because the hatching test for miracidia was not performed. This was due to the time factors.

From examination the patient proceeded to records which is actually the same station as registration, and here all the results of the stool and urine were entered in the register. All positive cases were informed that they had bilharzia and their names were entered in a separate treatment register. Their weights were taken and recorded and then passed over to the second Health Education centre which was also the treatment centre. Before issuing the tablets (Ambilhar) the particpants were given a briefing on how they contracted the infection and what was necessary for them to do in order to avoid getting it again. Here it was stressed that they take a full course of Ambilhar which was of seven days duration for adults and five days for children. Treatment was administered twice a day - in the mornings and evenings. Every time a person took the tablets a tick (V) was marked against his/her name - until the full course had been administered. Those who failed to turn up regularly for treatment were admitted to the nearby dispensary of Magugu - first as a punishment and more important to make sure that they took their tablets regularly. Any complications resulting from the treatment were admitted to the dispensary ad observed.

All the other positive cases for hookworm, Ascaris tapeworms and urinary infections were treated on the spot and were also advised on how to escape being re-infected.

After treatment, there was another Health Education Centre where the Health Officers dealt more fully with environmental sanitation and the importance of constructing pit latrines. Particulars were taken of all people, including the negative cases, who did not have pit latrines, and these were followed up later in their own homes and showed how to construct simple pit latrines. The village headmen and 10 cell leaders were entrusted with the responsibility of insuring that all people within their 10-cell unit and villages had pit latrines. They were also entrusted with the responsibility of making sure that all people under their jurisdiction attended for examination and treatment. In fact it was through these 10 cell leaders and village Headmen that the field team depended for organisation and guidance. Thanks to them all for their co-operation.

Complications and Set-backs

1. The first complication encountered was in organisation. First was getting the staff used to working fast in the field and then getting the local population mobilised to the treatment centres. This was only temporary and everybody soon got used to doing the right thing at the right time and being at the right place at the right time.

2. Working in the field was another problem which most of the field staff had not got used to. Waking up at 6 am with only 1 cup of black coffee for breakfast and then working up to 6:30 - 7:00 pm sometimes without a lunch break was quite hard going. Walking on foot for miles under the scorching sun while hungry and thirsty was not very pleasant either but most of the men in the field managed to adopt themselves very well to the circumstances. They all deserve credit for a magnificent job.

3. At one time the Ambilhar tablets were in short supply and could not be obtained in Dar es Salaam, so the field team ran out of drugs - for five consecutive days. The situation was however improved when more supplies were received through Nairobi and from the Round Table of Arusha - thanks for their generous donation.

4. Treatment complications were very few indeed. Only four patients were observed to have had mental changes after treatment. Three showed manic signs, (i.e. very talkative, singing and violent sometimes) and one showed signs of depression. One woman who was 36 weeks pregnant had a premature and precipitate labour but it is thought that the pregnancy was nearing term anyway.

Other changes observed were weakness, sleepiness, nausea, vomiting, diarrhea and dizziness.

Facts and Figures

Umbugwe	Approximate area	=	250 - 300 sq. miles
	Population 1967 census	=	15,257
	Population Density	=	50 per sq. mile

Physical features - flat grasslands with swamps especially near lakes Manyara and Burungi - otherwise dry.

Preliminary Survey 1967

Number of urine specimen examined	=	1852
Number of urine specimen positive for schistosoma haematobium	=	468
Infection rate	=	250 per 1000
Number of stool specimen examined	=	1513
Number of positive for sch. mansoni	=	4

1969 Survey

Number of urine specimen examined	=	12,756
Number positive for sch. haematobium	=	2,499
Number of stool specimen examined	=	7,394
Number positive for sch. mansoni	=	12
Number of people treated	=	2,451
Number of people not treated or who absented from treatment	=	60
Number of people re-examined 2 weeks after treatment	=	817
Number of positive cases 2 weeks after treatment	=	185
Number of negative cases 2 weeks after treatment	=	632.

Latrine Construction

Number of households inspected	=	3,838
Number of households without latrines	=	3,820
Number of households with latrines	=	18

Number of latrines constructed

Class A = 1,518

Class B = 1,484

Class C = 581

Not done at all. = 255

N.B. Class A are those pit latrines which were completed with a superstructure, roof, door, cover etc. Class B were completed with superstructure but without proper doors, roofs or covers. Class C were only pits dug without a superstructure.

Conclusion

From the foregoing it is evident that the campiagn achieved some measure of success.

1. Mobilising 12,756 people out of a population of 15,257 for examination - i.e. 83.6% of the population of Mbugwe have now been examined.

2. Treatment of 2,451 people out of 2,511 cases who proved to be positive was very good I must say. It means 97.6% of all positive cases have received the treatment.

3. The drug ambilhar proved to be very potent and safe for a mass treatment campaign with a preliminary cure rate of 77.3%. This of course is subject to revision when a follow up is done in three months time.

4. The pit latrine campaign was very successful indeed. Latrines being so important in the interruption of the life cycle of the parasite and therefore prevention, this is considered the only real achievement with some definite value that the field team managed to make. However the latrines have got to be used, but this will be another problem.

The health education lectures, talks etc. were well understood by the people and hence the rush in building and using pit latrines. There is right now a problem of how to get good water for drinking and washing because the Wambugwe would not go near the swamps again for the fear of being re-infected. They are ready to build protected wells if only they could get assistance from the Government.

5. Finally this campaign has taught us how much one can achieve through proper organisation, hard work and co-operation with the local leaders and people generally.

BUTYL RUBBER SHEETING IN WATER CONSERVATION AND STORAGE

by Paul Barker

Introduction

In rural water supply schemes, there are several ways in which the water can be supplied to the end user. From the source (e.g. a stream, river or lake, etc.) the water may either be pumped direct to the user or via a water storage tank or reservoir from which water is drawn off (often by gravity) as required. Over the years, various types of storage methods have been used for example, steel tanks, concrete or stone tanks, etc. But these methods are usually expensive and need special erection techniques. Less than two years ago a new material became available in East Africa which is already making a considerable impact on water storage techniques. This material which is called BUTYL RUBBER SHEETING is not only verydurable - it has been in use in the USA now for over 20 years - but it is also not expensive and is easy to use and apply.

Before discussing some of the plaees where Butyl Sheeting is already being used for water supply, it is worthwhile discussing some of the properties and general uses of this material in order to see how its use in water schemes has made it so acceptable.

Butyl Rubber Sheeting

Butyl Rubber Sheeting is a high quality material manufactured and fabricated according to strict specifications in England and France.

The Butyl Sheeting specification was developed during trials with the U.S. Department of Agriculture who laid some canal liners in Utah in 1948. After twenty years this material isstill providing excellent service and there has been virtually no deterioration of the properties. These trials showed that Butyl Sheeting is unaffected by sunlight, weather, heat and cold, ozone, farm chemicals, fertilizers, mould and bacteria, and it is also resistant to root penetration.

The Properties of Butyl Sheeting

1. Tough
   It will withstand rough handling during installation.

2. Flexible
   It is flexible and will conform to shape without damage.

3. Elastic
   It will stretch over 500% before breaking.

4. Impermeable
   It is many times more impermeable to liquids and gases than other barrier materials.

5. Resistance to extremes of temperature
   It does not become stiff at low temperatures and it remains servicable at temperatures up to 250°F.

6. Resistance to its environment
   Butyl Sheeting is virtually unaffected by farm chemicals, acids, alkalis, fertilizers, mould and fungal growth, bacteria, soil acids, farm effluent, oxygen, ozone, sunlight, weather, heat and cold.

7. Resistance to ageing
   Butyl Sheeting is more resistant to ageing than any other rubber in general use. As a reservoir liner, the life expectancy of Butyl Sheeting is in excess of 25 years.

Where Butyl Sheeting is in Use Today

Butyl Sheeting is now being used extensively in the U.K. and in Europe in the fields of water conservation in agriculture and in grain storage. It is also being used in other countries, e.g. Greece, Cyprus, Lebanon, Egypt, Libya, Nigeria, Botswana and Madagascar and, of course, in Uganda, Tanzania and Kenya.

The Uses of Butyl Sheeting

The use of Butyl Sheeting for the lining of reservoirs is now well established in many parts of the world where seepage losses can be very high.

Sheets of virtually any size can be manufactured - the only limitation is the weight that can be conveniently handled on site. Sheeting is 0.030" thick is normally used for lining reservoirs and sheets measuring 100' x 120' (1 ton) are available in East Africa. These can be cut up as required for smaller reservoirs or joined together on site using special adhesive and tape for larger reservoirs. There is literally no limit to the size of reservoirs that can be lined.

Generally, a site is excavated and the earth removed is used to build up the banks. The angle of the banks depends on the soil type and stability, but slopes greater than 45% (1:1) are not normally recommended. An anchor trench is dug around the top of the banks and the surface of the excavated area is checked for protruding roots, large stones, or holes which must be filled and compacted. Butyl Sheeting can be laid rapidly into the excavated area. The corners are not cut normally but folded into darts and the edges are then buried in the anchor trench. When the reservoir is being filled, excessive tensions on the sheeting at the rim of the reservoir should be relieved. Final compaction of the anchor trench should be carried out preferably when the reservoir is full. The banks should be grassed to prevent any erosion.

Tank Liners

Butyl/Mesh tanks (5,000, 10,000 and 20,000 gallon capacity) are also available as complete, ready to erect kits. These tanks can be erected very quickly and easily (in less than two hours) on firm, level ground. An outlet pipe is provided for gravity emptying. It is these tanks which could be the most useful in rural water supply schemes - depending, of course, on the amount of water required - since above 20,000 gallon sizes, the lined excavation technique is preferable.

Earth Dams

Butyl Sheeting can be used as a seepage barrier in earth dams. Almost any local soil which can be compacted is suitable for the dam itself.

Water Storage Bags (Pillow Tanks)

Butyl Sheeting is fabricated into water storage bags of capacities ranging from 250 - 3,500 gallons. These are supported by a polypropylene net and can be laid on any flat area. Bags are also available which contain baffles to prevent surging, and these are suitable for the transportation of water on trucks. When empty, they can be rolled up into a relatively small pack. These are particularly useful for emergency water supply.

Some Examples of Butyl Sheeting Installations

1. Wasine Island, Kenya

Village water supply previously relied on carrying water by boat from the mainland. A Water Development Department/U.S.A.I.D. project designed a rain catchment/storage scheme involving the use of a 70,000 gallon butyl lined tank complete with cover to prevent contamination and evaporation. The construction of the catchment and excavation for the storage was carried out by the villagers themselves.

2. Kilungu - Nr. Machakos, Kenya

Villagers previously had to walk several miles for water. Water Development Department dammed a small stream, gravity filled a 15,000 gallon butyl tank and pumped the water to another tank on top of a hill and the village was supplied with water by gravity from the tank.

3. Menengai - Nr. Nakuru, Kenya

Forestry villagers collect water from the roofs of their houses in a 10,000 gallon butyl tank. Previously, water had to be carted five miles.

How to Obtain Butyl Sheeting

The Kenya Farmers' Association (Co-op) Ltd. in Nakuru, Kenya, carry stocks of butyl sheeting and it can also be obtained through the Tanganyika Farmers' Association, Arusha or the Uganda Farmers' Trading Association in Kampala. Complete ready-to-erect butyl/mesh tanks can be supplied and also made to measure sheets for any size of reservoir or tank. Advice on design installation techniques, etc. is also supplied.

Summary

1. Most rural water supply schemes will involve the use of a reservoir or tank.

2. Butyl Rubber lined tanks are considerably cheaper than conventional steel or concrete tanks.

3. Advice on the use of Butyl Rubber in the field of water conservation and storage can be obtained from the Kenya Farmers' Association (Co-op) Ltd., P. O. Box 35, Nakuru, Kenya.

by George Cotter

In a paper entitled Programmes for Rural Water Supply Development in Tanzania,[1] Dennis Warner cited five Tanzanian and one Kenyan program. All six programs seek to improve or develop rural water supplies according to different techniques and different levels of capital input. Of the six, the Shinyanga Lift Pump is the least expensive by far. The total cost of a five foot deep cement block well with a cement cap, or cover, and pump is about EA Shs 130/00 ($18).

This reflects the fact that its application is limited to tapping available ground water where the land has either rock or clay strata within approximately 25 feet of the surface. These impervious strata form a saturated layer of soil above them which when tapped amounts to a spring-fed water source near or somewhat below the ground level. There are some areas where such ground water does not exist or where it is so deep that it requires sophisticated boring, piping and pumping to recover it. The Shinyanga Lift Pump cannot be adapted to such conditions. However there are many areas where ground water does exist and can be developed into a safe, clean water supply using this inexpensive system. Perhaps 90% of all traditional water supplies (e.g. shallow wells, water holes, opened springs, etc.) exist simply because they take advantage of available ground water. The least expensive way to make these water supplies safe is the Shinyanga Lift Pump.

The Pump in Operation

The pump is made of 1½-inch plastic pipe or tubing. It has two "valves". The lower valve is a plastic ring with a steel ball resting in it. It acts as a foot valve (see drawing, C). The upper valve is a 1½-inch plastic disk (plunger) with holes drilled through it. It is fitted with a 1½-inch circular flap of inner tube rubber (see drawing, A and B), and bolted on to a ½-inch bar which is the pump handle.

The action of the pump is as follows: when the plunger is pushed down the steel ball seats in the plastic ring making a foot valve. The water trapped above the foot valve is forced through the holes in the plunger pushing up the rubber flap fitted on the top of it. When the plunger is lifted the rubber flap seats sealing the holes in the plunger, thus the water above the plunger is lifted the height of the stroke. Below the plunger vacuum sucks new water through the foot valve.

A 12-inch stroke will lift the water in the pipe 12 inches, two strokes - 24 inches, three strokes - 36 inches and so on until the water flows out the spout on the top of the pump. The pump delivers about 3 imperial gallons or 1 bucket in 30 seconds.

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[1] Dennis Warner, Programmes for Rural Water Supply Development in Tanzania, prepared for the Annual Conference of the Christian Rural Fellowship of East Africa, September, 1969.

The Pump Parts

The parts of this pump as detailed in the drawing are available from any sizeable hardware store with the exception of the plastic plunger, plastic ring and steel ball. These may be obtained by mail from Fr. Cotter in Shinyanga.

The fabrication of these parts is straightforward except for two operations which might be new for those using plastic pipe for the first time. The top end of the pipe must be "flared" (see drawing). This is done by immersing the top end of the pipe in hot oil until soft then immediately forcing it over a 1½-inch galvanized pipe. The result is a flared or expanded top which will seat exactly in the short six-inch length of galvanized pipe extending downwards from the coupling imbedded in the cement cap or cover.

The second operation is to crimp or squeeze in place the plastic ring which acts as a seat for the steel ball making a foot valve. Once the length of the plastic pipe has been determined the lower end is immersed in hot oil until soft, the plastic ring is inserted an inch or two up the pipe, and common radiator hose lamps are used to squeeze the pipe above and below the ring position. The hose clamps can be used again and again as the pipe will not return to its origianl shape once it has cooled.

The easiest way to handle the hot oil is simply to have a paint can of used engine oil. This can be reheated indefinately.

The Cement Parts

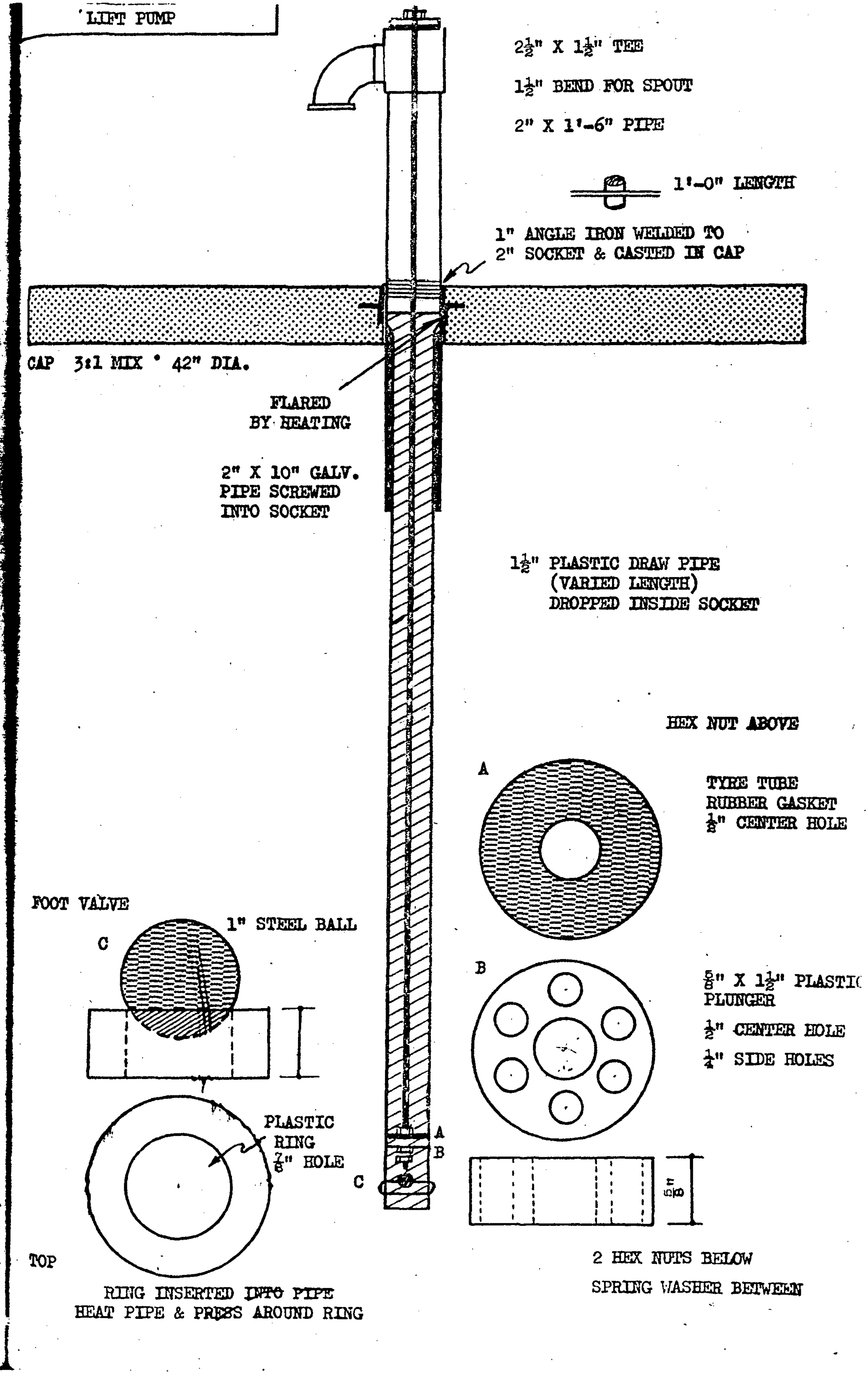
The cement parts, their fabrication, and use in construction is shown in figures 1 through 7. Anyone with the minimum experience of cement work can make them.

The cover or cap (see fig. 1, 2 , 3 , 4 as well as drawing) is cast with a 2-inch pipe coupling submerged in the center. This may be done at the site or elsewhere. It weighs about 200 lbs so can be easily transported by light pick-up or Land-Rover.

The blocks (see figs. 5, 6, 7) are such that when 9 blocks are laid they form a circle which is strong enough to stand without mortar. They are made from a 10/1 sand/cement mixture. There are two different sizes permitting the successive courses to narrow as they rise.

Well Construction

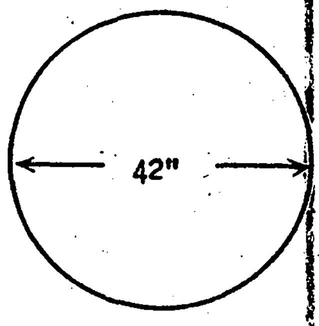
After the spring has been dug out, the first or bottom course of 9 large blocks is laid level. The second course is 8 large and 1 small block, the third course is 7 large and 2 small blocks, etc.k until the course of 9 small blocks (see figure 7) is reached. This course may be repeated to obtain any height desired. Alternatevely the bottom course


LIFT PUMP
2½" X 1½" TEE
1½" BEND FOR SPOUT
2" X 1'-6" PIPE
1'-0" LENGTH
1" ANGLE IRON WELDED TO 2" SOCKET & CASTED IN CAP
CAP 3:1 MIX • 42" DIA.
FLARED BY HEATING
2" X 10" GALV. PIPE SCREWED INTO SOCKET
1½" PLASTIC DRAW PIPE (VARIED LENGTH) DROPPED INSIDE SOCKET
HEX NUT ABOVE
A
TYRE TUBE RUBBER GASKET ½" CENTER HOLE
B
⅝" X 1½" PLASTIC PLUNGER
½" CENTER HOLE
¼" SIDE HOLES
⅝"
2 HEX NUTS BELOW
SPRING WASHER BETWEEN
FOOT VALVE
1" STEEL BALL
C
PLASTIC RING ⅞" HOLE
TOP
RING INSERTED INTO PIPE
HEAT PIPE & PRESS AROUND RING
A
B
C

THE CAP

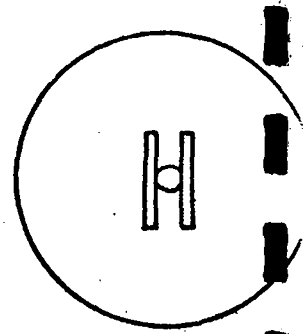
2" PIPE COUPLING WELDED TO 1" ANGLE IRON BRACKETS

(1)



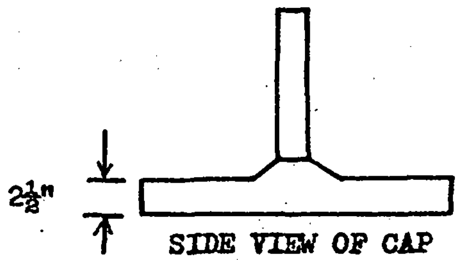
A RING OF SHEET TIN USED AS A FORM FOR CEMENT.

(2)



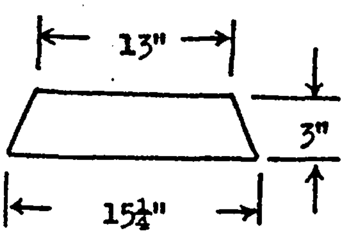
COUPLING WITH PIPE INSERTED SUBMERGED IN 2½" OF CEMENT (CEMENT: 3:1 NONREINFORCED).

(3)

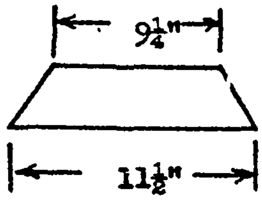


SIDE VIEW OF CAP

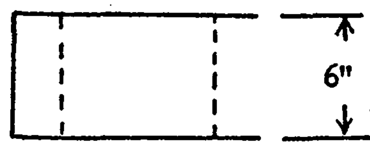
(4)



TOP VIEW OF LARGE CEMENT BLOCK

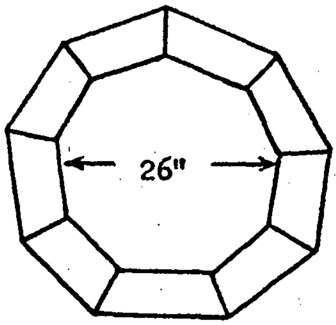


TOP VIEW OF SMALL CEMENT BLOCK

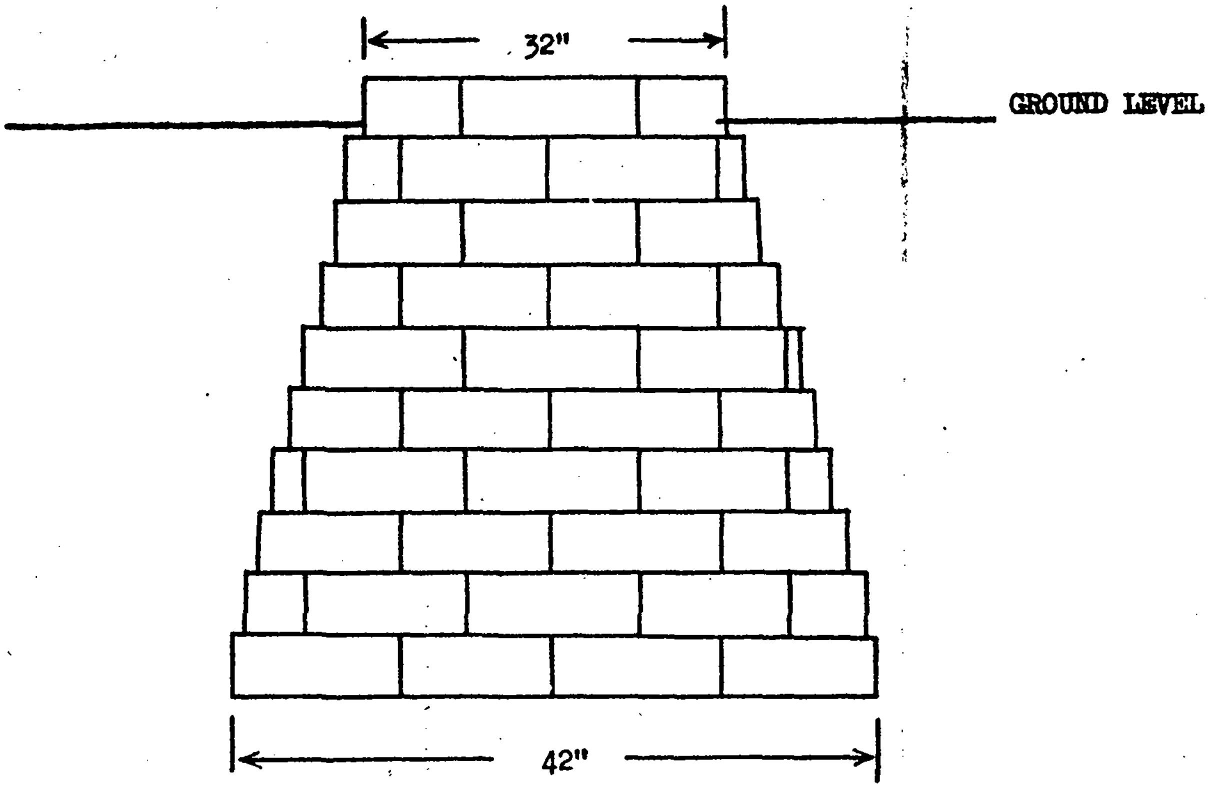


SIDE VIEW OF A BLOCK

(5)



TOP VIEW OF WELL
(6)



SIDE VIEW OF WELL

(7)

of 9 large block or any other course may be repeated to "stretch" the height of the well. Wells already made vary from 5 to 18 feet in depth.

As each course of blocks is laid, clean filtering sand is packed behind or outside the blocks forcing them to lock together in a circle.

The time required to dig out a five foot well, build up the blocks and pack the sand outside them is four hours for five men. A few minutes are needed to assemble the pump at the site, then the cap is placed in position on the well.

Conclusions

The advantage of this type well is that the blocks can be made at the site, they need not be transported. Also they are easy to handle and can be assembled quickly into the well casing. The cap, whether made at the site or transported is light and yet once placed on the top course of blocks cannot be tampered with by individuals and efficiently seals the well from contamination.

The pump is simple and practically indestructible. The only maintenance it requires is to change the rubber plunger flap twice a year. This is cut from bicycle or automobile tyre tube. The pump can be dissembled by inserting a hoe handle between the spout and upright galvanized pipe and simply unscrewing. Lastly, the hex nuts which hold the plunger and flap in place on the lift rod can be loosened by a standard bicycle or ox plow spanner. Thus unskilled people can carry out this maintenance.

Over forty of these pumps have been installed in the Sukumaland area. Except for the first "trial" model they were all paid for by the local people whose labor also installed them. They are in daily use and are maintained by the people.

So far private individuals alone have been responsible for the introduction of these pumps. It is recognized that Government agencies and departments cannot operate on this small scale. Nonetheless this pump does work quite satisfactorily and does in fact clean up the very water sources which at present cause most of the waterborn sickness and suffering in the rural areas. Thus at the present time the Shinyanga Lift Pump is an inexpensive, actual solution to the problem of contaminated or dangerous rural water supplies.

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INERTIA HAND PUMP[1]

by R. W. Dawson

I. Purpose of the Machine

To pump water, by hand, from streams, furrows and shallow wells for small scale irrigation and domestic use.

II. Specifications

The pump consists of a vertical sheet metal tube to which is joined, near the top and at an angle of about 60 degrees, another short tube. This second tube has a rubber faced flap valve over its mouth. A wooden handle is attached to a bracket at the top of the pump.

The tubes are constructed from galvanised sheet metal of the heaviest gauge that can be easily worked by a tinsmith. The valve and bracket are made from the metal of discarded oil drums and the rubber valve facing made from an old vehicle inner tube.

III. Operation

The pump is placed in the water, the handle being pivoted on some convenient point nearby. The entire pump is raised and lowered in the water at a rate of about 80 strokes per minute. Each stroke is about 6 to 8 inches (15 to 20 cm.). On the up stroke the valve closes and water is lifted and on the down stroke the valve opens and water is forced out of the spout.

IV. Scope of test

To manufacture and examine three sizes of pump with reference to their ease and cost of manufacture, robustness and efficiency of operation.

Four pumps were manufacture - 3-inch (8 cm.), two 4-inch (10 cm.) and one 6-inch (15 cm.).

The 3-inch pump was manufactured using some galvanised irrigation piping and all the joints were brazed.

Of the two 4-inch pumps one was made from 26 S.W.G. galvanised down piping which proved to be much too thin as the main tube collapsed the first time the pump was used. The other pump was made from 22 S.W.G. galvanised sheet and proved to be satisfactory. Joints on both pumps were soldered.

The 6-inch pump was made from 22 S. W. G. galvanised sheet using soldered joints. Proper hook type joints were not used when forming the main tube with the result that the joints did not hold when the pump was put into operation. If proper joints are made, solder should be strong enough though brazed or welded joints would be better. Old lorry or tractor tubes should be used for the flap valve rubber as smaller tubes do not provide a large enough flat area of rubber. It would also be advisable to strengthen the main tube by soldering or brazing on to it at about 12 inch (30 cm) intervals sheet metal rings ½ in. (1 cm) wide and 6 in. (1[illegible] cm) internal diameter.

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[1]This paper was originally prepared at the request of the Ministry of Agriculture, Food and Co-operatives, Government of Tanzania. Development Report 2/68/69, Tanzania Agricultural Machinery Testing Unit, Arusha, 4 July 1969.

Hydrocholoric acid will have to be used when soldering the joints and great care should be taken to wash it off again as quickly as possible after the joint has been made. A coat of paint would also help to prevent rusting.

Some practice in using the pump is necessary before the correct stroke rate and length of stroke to give the maximum output are achieved.

The best output achieved from the 3-inch pump was 26 gallons per minute (118 L./min.) at a lift of about 7 feet (215 cm). (The pump could not be tested at its full lift as no sufficiently deep well was available). The pump worked well and there was very little leakage of air past the valve on the up stroke. The pump should be capable of lifting water 11 to 12 feet (335-365 cm) and the output at this height should be 20 - 25 gallons per minute (91-114 L./min.)

The maximum ouput achieved from the 4-inch pump was only 15 gallons per minute (68 L./min.) at a lift of about 6 feet (185 cm), which was considerably lower than expected. The reasons for the low output were thought to be bad seating of the valve rubber with consequent leakage of air past the valve on the up stroke, a badly made hinge so that the valve did not swing feely and lack of practice in using the pump. Tests carried out by the N.I.A.E. in the U.K. indicate that this pump should be capable of pumping up to 40 gallons per minute (18 L/min) at a lift of about 6½ feet (2 m).

As mentioned earlier the 6-inch pump was badly made and the joints did not hold when the pump was put into use. As a result no output figures were taken but tests carried out at the N.I.A.E. indicate that it should be capable of pumping up to 75 gallons per minute (340 L./min) at a lift of 3½ feet (1 m.)

All the pumps are easy to use and one person should be able to continue pumping for quite long periods.

The cost of manufacture of the 3-inch pump is shown below.

22 S.W.G. galvanized sheet steel, 15.5 ft^2 @ shs. 1/80 per ft^2	=	Shs 28/00
Solder, 1¼ lbs. @ Shs 5/50 per lb.	=	7/00
Miscellanous - hydrocholoric acid, metal for flap, old vehicle tube, bolts etc.	=	5/00
Labour, 2 days @ Shs 10/00 per day	=	20/00
		60/00
Overheads @ 25% of above		15/00
Cost of manufacture		Shs 75/00

The cost of the two larger sizes will be approximately the same.

VI. Conclusion

No difficulty was experienced in manufacturing the pumps and they can be made by any local artisan who has available the following soldering or gas welding equipment; drill and bits, hammer, hack-saw, tinsnips, anvil and cold chisel.

If they are manufactured from 22 S.W.G. galvanised sheet steel they should be reasonably robust.

If the joints in the main pipe are being soldered hook type joints should be used and sealed by soldering. Brazing or welding of the joints will make a stronger job.

After some practice the operator will discover the best method of operating the pump and then outputs of about 25 gallons per minute (114 L./min.) at 12 feet (3 m.) lift to about 70 gallons per minute (318 L./min.) at 3½ feet (1m.) lift should be obtainable.

VI Recommendation

The Inertia Hand Pump, being cheap, simple, easy to construct and reasonably robust can be recommended for use in pumping water from shallow wells, streams and furrows for small scale irrigation and domestic use in Tanzania.

Plans are available from Tanzania Agricultural Machinery Testing Unit for three sizes of pumps:

- 3 - inch (8 cm) for lifts up to 12 feet (4 m.)
- 4 - inch (10 cm) for lifts up to 6½ feet (2 m.)
- 6 - inch (15 cm) for lifts up to 3½ feet (1 m.)

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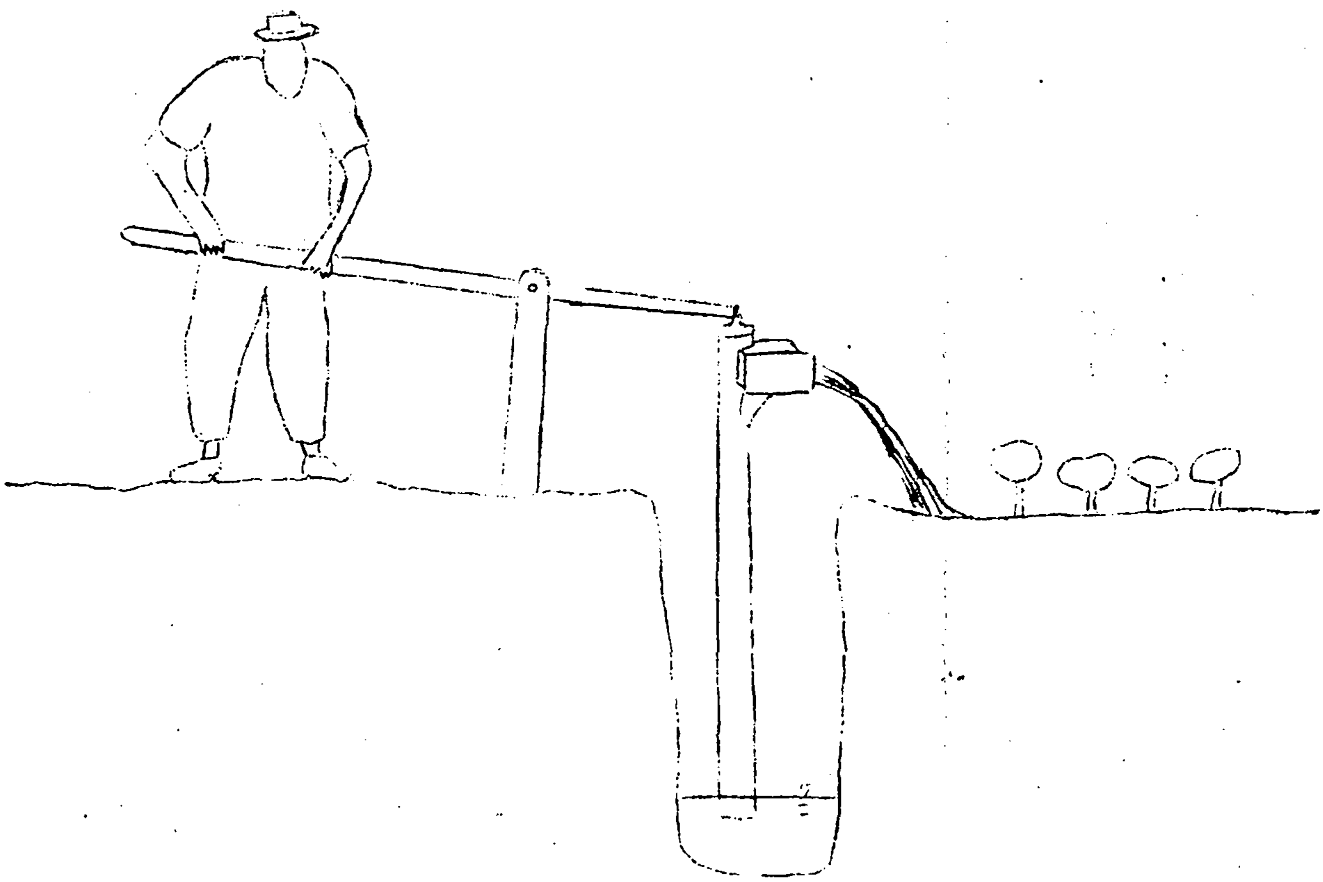


Polythene pipe Chart in Rural W.. S.

by Dennis Warner

It is a fact that in rural areas of many of the developing countries design and implementation of small water supply projects are carried out, not by engineers, but by local government personnel, schoolteachers, missionaries, or individual farmers.

For this reason there is a great need for readily-available, simplified techniques of design and selection of the materials used in typical projects. In the field of rural water supply such technical aids could be a series of pipe design charts covering a wide variety of field conditions.

The chart shown here is an outgrowth of a request by a Peace Corps Volunteer in Lesotho (Southern Africa) for a method of selecting small diameter plastic (polythene) pipe for water supply projects in mountain villages. The only chart available to him was based on the Hazen-Williams equation,

$$V = 1.318\, C\, (d/4)^{0.63}\, (h_L/L)^{0.54} \qquad (1)$$

where V is the velocity, C is a coefficient of pipe roughness, d is the pipe diameter, h_L is the head loss, and L is the pipe length. Unfortunately, this equation is not considered valid for pipe diameters of less than two inches.

By making two assumptions, that of smooth pipes and a constant water temperature, the illustrated chart for small diameter plastic pipes was developed for the variables of discharge, head loss, velocity, and pipe diameter.

The basis of the chart is the general relationship for turbulent pipe flow given by the Darcy-Weisbach formula,

$$h_f = f \frac{L\, V^2}{d\, 2g} \qquad (2)$$

where h_f is the frictional head loss in feet, f is a friction factor, L is the length of pipe in feet, V is the mean velocity in feet per second, d is the pipe diameter in feet, and g is the acceleration due to gravity in feet per second per second. The Assumption of smooth pipes allowed the use of the Blasius equation for friction factor,

$$f = \frac{0.316}{(N_R)^{0.25}} \qquad (3)$$

in which N_R is Reynolds number within the range of 3000 to 100,000.

With the assumption of an average water temperature of 50° F., the corresponding kinematic viscosity of 0.0000141 square feet per second reduces Equation (3) to

$$f = \frac{0.0194}{(Vd)^{0.25}} \qquad (4)$$

which, in turn, can be used to reduce Equation (2) to

$$h_L = 6.72 \frac{V^{1.75}}{d^{1.25}} \qquad (5)$$

feet per second, and d is pipe diameter in inches.

Head losses due to entrance constrictions, pipe fittings, and valves usually are considered to be negligible in rural water supply projects involving extensive pipe length with few water distribution taps. Consequently, for design purposes, Equation (5) can be taken to represent the entire head loss in the system.

Values of pipe discharge are not included in Equation (5) but can be found from the general relationship

$$Q = 122.3\ Vd^2 \qquad (6)$$

in which Q is the discharge in imperial gallons per hour, V is velocity in feet per second, and d is pipe diameter in inches. Solutions of Equation (5) and (6) can be combined into a table of values of Q, h_L, V, and d. By plotting these variables on log-log paper, as shown in the illustration, the intersecting curves of velocity and pipe diameter result in straight lines and thus can be determined with only two points.

As an example of the use of this chart, assume there is a demand for 350 gallons per hour at a site having an allowable head loss of 60 feet over a distance of 1000 feet. The corresponding pipe diameter from the chart is 0.90 inch with a flow velocity of 3.2 feet per second. Therefore, the project design should call for a pipe diameter of the next larger available size, or 1.0 inch.

Although chart accuracy and range are dependent upon the ability of Equation (3) to predict accurately the friction factor, the chart is relatively insensitive to temperature variations from the assumed constant value of 50° F. For example, values of h_L obtained from Equation (5) vary less than 5% from the theoretical values calculated for the temperature range of 38° F. to 64° F. Furthermore, chart range, which is limited by the allowable variation of Reynolds number in Equation (3), also is relatively insensitive to temperature changes. At 50° F. the chart is valid for pipe diameters between 0.5 and 2.25 inches and velocities between 1.0 and 9.0 feet per second, while at 60° F. the valid range is only slightly reduced to pipe diameters between 0.5 and 2.0 inches and velocities between 1.0 and 8.0 feet per second.

References:

John K. Vennard, Elementary Fluid Mechanics, 4th ed., New York: John Wiley & Sons, Inc., 1961.

Robert W. Abbett, ed., American Civil Engineering Practice, Vol. I., New York: John Wiley & Sons, Inc., 1956.

V (ft/sec)	$V^{1.75}$
0.50	.298
0.75	.604
1.00	1.00
1.5	2.03
2.0	3.36
3.0	6.83
4.0	11.30
5.0	16.7
6.0	23.0
8.0	38.0
10.0	56.2

d (in)	d^2	$d^{1.25}$	$\frac{6.72}{d^{1.25}} V^{1.75}$
0.25	.0625	.177	38.0 $V^{1.75}$
0.50	.250	.420	16.0 $V^{1.75}$
0.75	.562	.698	9.63 $V^{1.75}$
1.00	1.00	1.00	6.72 $V^{1.75}$
1.25	1.562	1.322	5.08 $V^{1.75}$
1.50	2.25	1.660	4.05 $V^{1.75}$
1.75	3.06	2.013	3.34 $V^{1.75}$
2.00	4.00	2.38	2.82 $V^{1.75}$
2.25	5.06	2.76	2.44 $V^{1.75}$
2.50	6.25	3.15	2.13 $V^{1.75}$

EQUATIONS

$$h_L = 6.72 \frac{V^{1.75}}{d^{1.25}}$$

$$Q = 122.3 \, Vd^2$$

NOTATIONS

Q = discharge in imperial gallons per hour

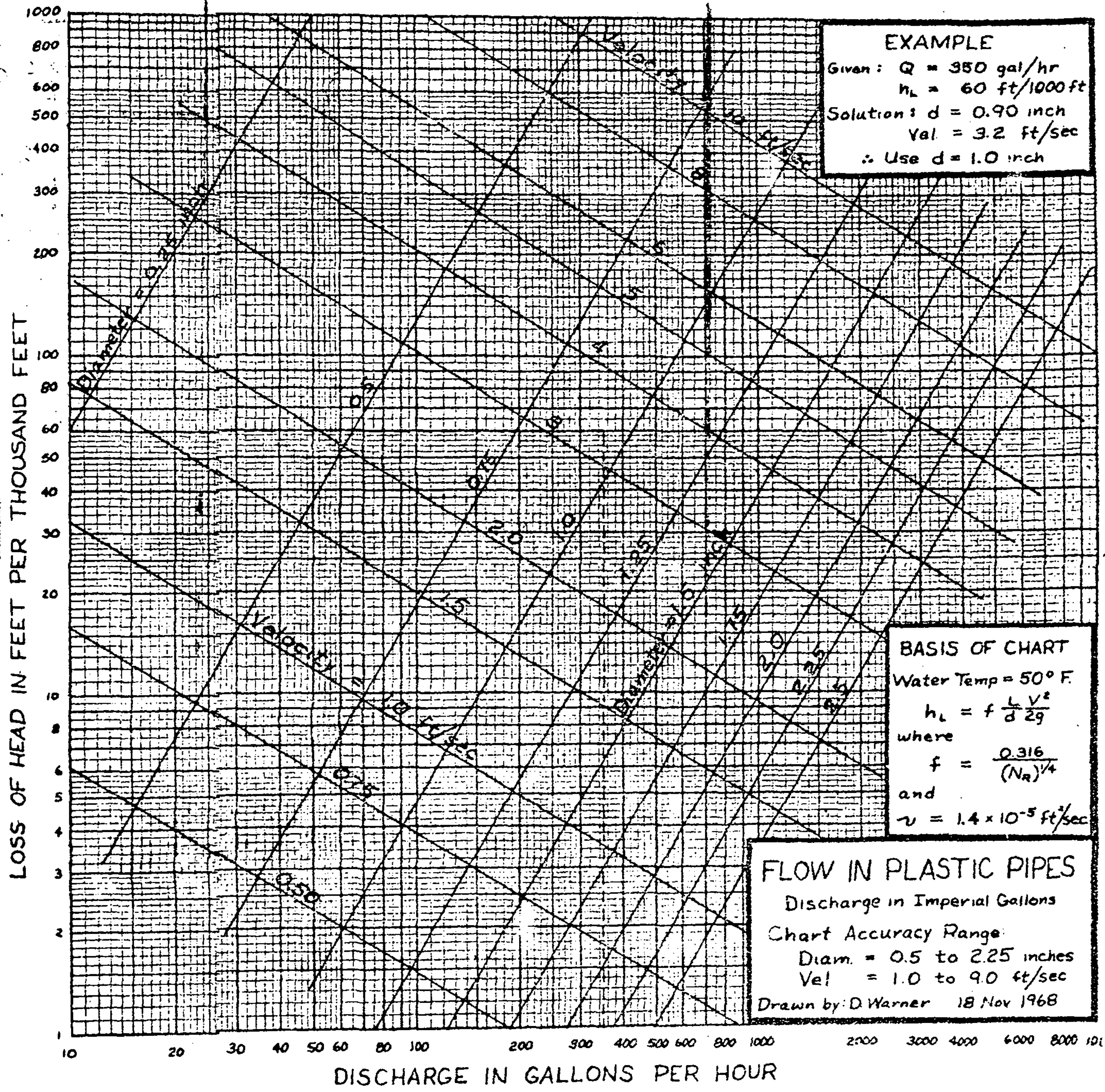
h_L = frictional head loss in feet per 1000 feet

V = flow velocity in feet per second

d = pipe diameter in inches

VALUES OF d, V, h_L, and Q USED IN PLOTTING POLYTHENE PIPE FLOW CHART

d	V=0.50		V=0.75		V=1.00		V=1.5		V=2.0		V=3.0		V=4.0		V=5.0		V=6.0		V=8.0	
(in)	Q	h_L	Q	h_L	Q	h_L	Q	h_L	Q	h_L	Q	h_L	Q	h_L	Q	h_L	Q	h_L	Q	h_L
.25	3.82	11.32	5.73	22.93	7.6	38.00	11.47	77.1	15.3	127.7	22.9	260.	30.6	429.0	38.2	635.0	45.8	874.0	61.2	1440.
.50	15.3	4.77	22.9	9.66	30.6	16.00	45.9	32.5	61.2	53.8	91.8	109.3	122.	181.	153.	267.	184.	368.	245.	608.
.75	34.4	2.87	51.6	5.72	68.8	9.63	103.	19.55	138.	32.4	206.	65.8	275.	109.	344.	161.	412.	222.	555.	366.
1.00	61.2	2.00	91.8	4.06	122.	6.72	184.	13.60	245.	22.6	367.	45.9	489.	75.9	612.	112.	734.	155.	979.	255.
1.25	95.6	1.52	143.	3.07	191.	5.08	287.	10.31	382.	17.1	573.	34.7	765.	57.4	955.	84.8	1150.	117.	1530.	193.
1.50	138.	1.21	206.	2.45	275.	4.05	413.	8.22	551.	13.6	826.	27.7	1100.	45.8	1376.	67.6	1650.	93.2	2200.	154.
1.75	187.	1.00	281.	2.02	374.	3.34	562.	6.78	748.	11.2	1120.	22.8	1500.	37.7	1870.	55.8	2250.	76.8	2990.	127.
2.00	245.	0.84	367.	1.70	490.	2.82	735.	5.72	980.	9.48	1470.	19.3	1960.	31.9	2450.	47.1	2940.	64.9	3920.	107.
2.25	310.	0.73	464.	1.47	619.	2.44	929.	4.95	1240.	8.20	1860.	16.7	2480.	27.6	3100.	40.8	3720.	56.2	4960.	92.7
2.50	382.	0.63	573.	1.29	764.	2.13	1147.	4.32	1530.	7.15	2290.	14.6	3060.	24.1	3820.	35.6	4580.	49.0	6120.	81.0



EXAMPLE
Given: Q = 350 gal/hr
h_L = 60 ft/1000 ft
Solution: d = 0.90 inch
Vel = 3.2 ft/sec
∴ Use d = 1.0 inch
BASIS OF CHART
Water Temp = 50° F.
$h_L = f \frac{L}{d} \frac{V^2}{2g}$
where
$f = \frac{0.316}{(N_R)^{1/4}}$
and
$\nu = 1.4 \times 10^{-5}$ ft²/sec
FLOW IN PLASTIC PIPES
Discharge in Imperial Gallons
Chart Accuracy Range
Diam. = 0.5 to 2.25 inches
Vel = 1.0 to 9.0 ft/sec
Drawn by: D. Warner 18 Nov 1968
LOSS OF HEAD IN FEET PER THOUSAND FEET
DISCHARGE IN GALLONS PER HOUR
Diameter = 0.25 inch
Diameter = 1.0 inch
Velocity = 1.0 ft/sec
Velocity = 10 ft/sec

DOMESTIC POINT AND LONG CATTLE TROUGH IN KILIMANJARO REGION, TANZANIA[1]

by M. A. Crawford

Introduction

From 'Objectives and Strategy' (related to Water Development) in Tanzania's Second Five Year Plan, we can read in Clause 90 "..... In the immediate future therefore there is a great need to ensure that the scarce resources available during the Plan period are used to maximum benefit. For this purpose the highest priority will go to low cost projects which provide benefits to maximum numbers of people, while more expensive projects bringing large benefits to relatively small numbers of people must command relatively lower priority .....".

To those familiar with water supply projects in Tanzania this means emphasis on the 'Social service' type of project (such as those at present financed under the Swedish Credit agreement) as opposed to the private or for that matter, public service. In practical terms this means that fundamental mode of supply to the consumer will be via the domestic point.

I felt therefore that the domestic point was worthy of study. Rather than to prove or disprove a particular issue, the study we prepared involved the collection of various random pieces of information in the hope that it would become noticeable which items 'affected' the pattern of the domestic point - if indeed there was such a thing as a pattern. Perhaps I should specifically mention at this point that this study was not "an assignment" and therefore I felt it was not possible to tackle the matter on a grand scale, as expenditure had to be kept to a minimum. The sites were of a 'type' as far as possible and were selected largely because of their relative proximity to Moshi. It was possible therefore to collect results each morning, which enabled trends to be seen at an early stage and suspicious results to be checked before any damage was done. Also, of course, additional information could be arranged almost immediately, if required. I felt also that rainfall could be considered as common to all sites.

General

The sites could be described generally as follows:

(a) near main road - prominently exposed (Sholo V)
(b) near main road - semi-secluded (Msaranga)
(c) routine domestic point - mountain area (Mbokomu)
(d) routine domestic point - low land area (Rau)

Staff used could not conceivably be Technical Assistants due to our other commit ments, but daily paid staff were specially selected. In particular, Mr. Ngateu (Ag. Inspector Works) who supervised the field works, and Mr. Kusare (Costing Clerk) who computed the results were of invaluable assistance in the exercise. Detailed records have been kept from 6 a.m. until 6 p.m. and 'night' consumption noted also.

The exercise has been in progress for just over one month and weather conditions have varied considerably over that period.

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[1] The views presented in this paper are only those of the author and are not intended necessarily to reflect the views of the Water Development and Irrigation Division.

Luck has not been with us all the while, as the meters being used were not all serviceable 100% of the time.

A minor study was also made of one cattle trough, where information was collected relating to cattle, sheep and goats. This augmented an earlier study on the same subject made one year ago.

Since there were no specialists attached to the exercise, I thought it best that no attempts be made at questioning water users. Observers, therefore, silently observed, and recorded what they saw. Observers were instructed not to interfere with water usage, e. g. if they noticed that a tap was left running they had to overcome their natural instinct to turn it off.

This, therefore, sets the scene for the investigation. As the results came in, running checks were kept on 'trends', and in most cases general results were predictable. For example, the more people who came, the more water used. However, some interesting facts were also noted.

Latterly, records of the following were kept:

1. (a) Total number of visitors to the domestic point
   (b) Number of male visitors to the domestic point
   (c) Number of female visitors to the domestic point
   (d) Number of children visiting the domestic point

   (Hourly figures observed also)

2. (a) Total consumption from 6 a.m. to 6 p.m.
   (b) Amount carried away by hand
   (c) Night consumption
   (d) Amount carried away by drum
   (e) Amount used at domestic point

   (Hourly figures observed also)

3. Rainfall and weather conditions at the cattle trough, records of numbers of cattle, sheep and goats - together with water consumption were kept.

The records are not completely comprehensive and results naturally have to be tailored to those which can be computed or assumed from a combination of these records, and bearing in mind that there was no questioning carried out.

Comments on Results

One of the most interesting facts to emerge, it seems to me, was the apparent lack of any regular social patterns. There seems to be no particular wash-days; weekends on some occasions are busy and some quiet - and this seems to be the case regardless of weather. There is no significant increase of children visiting the domestic point at weekends. These facts appear to be as true for 'prominent' domestic points as they are for the more secluded type.

It would seem that rain has little effect when it is falling, but consumption drops the following day, indicating perhaps that the former method of supply from rain storage is preferred to the walk to the domestic point when possible. (This point may also relate to my later comments on private connections.) The effect of rain was greater at the more remote domestic points. Also after rains there is a drop in demand for those who take water by the 44 gallon drum.

the results do indicate that it is rather a gathering point, as usually if the number of women visitors increase this is generally accompanied by an increase in the numbers of men and children.

Regarding use of water at the domestic point, sexes and age groups did not persistently save or waste water. When washing clothes it is reported that women did make use of the washing slabs provided. Apparently women do not find it convenient to use the washing slabs during times when a number of people would like to collect water, however.

The 12th, 13th, 14th, 25th and 26th of November were selected for a more detailed study of hourly consumption figures. Results for the other days are available, but these were chosen because of their varying weather condition - respectively sunny and hot, rainy mid-day, cloudy, sunny particularly cloudy. Here some fairly regular pattern does emerge and the indications are that the peak consumption times are at 8-9 a.m. and 2 p.m., and also minor peaks in the late morning and about 5 p.m. The lowest consumption period is 3-4 p.m. with another low point about mid-morning. A check was made of peak flow as related to average flow and of the 20 results obtained in this selection, only on four occasions did the peak flow slightly exceed 4 times the average flow, and the average ratio was found to be 3:1.

An attempt to find the estimated consumption per capita was a difficult exercise, if only the available readings were to be utilised. For example, the total consumption divided by the total number of debes carries away would give an 'unreal' answer, etc. On this point therefore we applied an academic approach (rather than a straight-forward interpretation of figures 'read'). The population density was noted from the recent census, and applied pro-rata to an assumed ½ mile diameter "sphere of influence" of the domestic point. The figure was used as the divisor to the total consumption. Results using this method indicate a consumption per head figure of about 13 gallons. (This figure does not include the Mbokomu domestic point. Unfortunately from the census figures available we are unable to isolate the Moshi 'suburb' of Kiborilonі, an area which has an independent supply. For our purpose therefore the population figures may be said to be distorted.)

A comparison was made of the 'amount used on the spot' and the 'total amount carried away'. The percentage used on the spot was greatest at the remote domestic point but over the four domestic points under review for the period of the review, the proportions were very near to 50/50. It was not really possible with the scope of our investigation to detail the purposes for which this was 'used', i.e. washing of legs, washing of clothes, 'pure' waste etc. and therefore it is not possible to put a relative cost on the savings if no-waste valves were in operation. In financial terms it is obvious that a considerable saving could be made, however. Local people have an objection to the no-waste valves; it is that children are unable to operate them, and the extent to which children are used to collect water is evident from our records.

Before leaving the question of domestic point usage, it is perhaps worth noting that in Kilimanjaro my interpretation of the mood of the people here is that in the foreseeable future demands for private connections will increase dramatically, and it may be prudent to anticipa this demand in the planning of future projects in this Region.

Perhaps the most interesting results of all come from our brief investigation at a standard long cattle trough. About one year ago I carrie out experiments over a very brief period at this same cattle trough, and the results indicated that, assuming a water consumption rate of 5 gallons per day for cattle and 1 gallon per day for sheep and for goats, the actual consumption was much lower than one might have expected, viz. theoretical consumption was 8 times greater than the actual consumption. The results of the present test have again indicated approximately the same proportions.

If these results were to be confirmed nationally the implications are considerable. If we are attempting to design for the cattle carrying capacity of an area and then applying figures which are, say, 8 times too great, then we are promoting overgrazing proportionally to this degree. Not only that, but the pipe sizes will be larger than necessary (assuming the hydraulics will allow reduced sizes). However, it should be noted on the question of pipe size that peak flow was approximately 8 times the average flow. Nevertheless, the indications are that smaller pipes with storage at the trough may provide considerable economy in future projects.

One further point is that the cattle trough is obviously for cattle. Goats and sheep, particularly those not fully grown, have great difficulty in benefiting from the water troughs as the walls seem to be rather high. It is interesting to note that the number of cattle using the watering point has approximately trebled in one year. In my opinion it is important that for each cattle trough there is a domestic point placed so as to be easily visible from the cattle trough.

Conclusion

This is a subject which, in my opinion deserves further detailed study thoughout the territory. This paper only summarises the trends of our investigation in Kilimanjaro Region. I hope also it stimulates discussion for the workshop.

Moshi: December, 1969.

THE DEVELOPMENT OF [illegible]

RURAL WATER SUPPLY PROGRAMME IN KENYA

by B. Z. Dianant

1. PREFACE

1.1 Assistance: A piped water supply is one of the major promoters of health and standard of living in a community. The majority of people living in developing countries belong to the rural areas, but only a small portion of these people enjoy piped water supplies whereas the rest have to obtain their water from remote and unsafe natural sources. However, the installation of a piped water system is a costly operation beyond the affording of any rural community, and even if assistance is obtained, whether by the central Government or by an international body, it is almost impossible to carry out such development.

Considering the important public health aspect of this matter and the considerable expenses involved in handling it, World Health Organisation (WHO) has agreed together with the United Nations Children's Emergency Fund (UNICEF) to establish special programmes to assist Governments in developing countries to implement rural water supply projects.

One of these programmes has been operating in Kenya since 1960. During this period hundreds of rural water supply schemes have been developed in the country with the aid of WHO professional personnel and UNICEF assistance in materials. These activities were conducted by WHO Project Kenya-0002, within the frame of the "WHO/UNICEF Assisted Environmental Sanitation Programme".

1.2 Assessment: In 1968, the Project has carried out an assessment of this Programme. This assessment has shown that a very urgent need for a large expansion in the present development of rural water supplies was existing in Kenya, to such an extent, that all present development activities performed by the U.N. organisations as well as by other bilateral bodies and the Government itself, in this field, did not even cope with the needs of the natural rural population growth.

Following these findings the methods of the Project's activities have been reviewed, and a reorganisation plan has been designed based on past experience and future needs, with the purpose of increasing and spreading the number of demonstrative rural water supplies designed and assisted by the Project.

The reorganisation plan has been based on the following main aspects related to the Programme:

- The character of the Programme
- Long-term planning
- Standardisation
- Training
- Co-operation with Government and other bilateral bodies
- Maintenance
- Future development

2. THE CHARACTER OF THE PROGRAMME

2.1. Demonstration: It is clear that the WHO/UNICEF assisted rural water supply programme was not meant and did not intend to replace or fulfill the duties of a rural water supply authority. The character of this programme has been mainly demonstrative, with the aim of assisting in creating only the nucleus of the rural water supply scheme, with the hope that further growth and development would be performed with and through local means and efforts.

This basic concept has been influencing the Project's rural water supply programme in two ways, related to the size and the location of the schemes. The size of the assisted schemes has been restricted to a maximum of 1,500 people connected to a single rural water supply, and as far as location was concerned, the schemes were distributed and scattered over all the Districts of the country in distances of not less than 30-50 miles from each other, with the view of spreading the demonstration effect of these schemes as wide as possible.

This policy has been followed along the first 7 phases of the programme (see 2.3 below). However, the recent 8th phase, designed for the 1970-71 period, has adopted a slightly different policy based on the integrated approach in rural development.

The 8th phase, has been taking an integrated part in the new Five Year National Development Plan (1969-73) by assisting in the design and development of 46 small rural water supplies in six selected pilot development areas in Kenya chosen by the National Plan to perform the first stage of rural development.

2.2. Contribution: The local matching aid towards UNICEF's contribution has been within the range of 50-60%, of the cost of the schemes, mainly in respect of labour, construction and local materials. In the recent 8th phase of the Programme, the local contribution has been considerably increased up to 75-80% due to the Ministry of Health special allocations for rural water supply development, within the environmental sanitation development plan.

2.3 Phases: The Programme has been divided since its commencement in 1960 into phases of planning, which were usually designed upon annual periods. Eight phases have been developed up to date embracing over 450 rural water supply schemes developed in all parts of Kenya. Over 500,000 people are included in these schemes which involved UNICEF contributions worth over US$800,000.

2.4 Request: During the period of implementing each phase, new schemes are being proposed by the Health Inspectors in the Districts for the coming phase. The sites of the proposed schemes are visited, and when found to be feasible, they are approved by the Ministry of Health, and the detailed engineering design and costs are carried out. During each phase's work, a general estimation of the prospected UNICEF contribution for the coming phase is discussed with the UNICEF representative, and accepted as a guide line for future planning. The detailed cost lists for the proposed rural water supplies are divided into UNICEF's contribution and the local matching aid, and are so submitted by the Government to UNICEF with a request for assistance in the construction of the schemes.

2.5 Installation: The construction work starts with the arrival of the materials shipped by UNICEF from abroad. The materials are addressed to the Ministry of Health, and are considered to be Government property until they are installed in the site, after which they become the property of the local authority, which assumes the full responsibility for running and maintaining the new supply.

3. LONG-TERM PLANNING:

3.1 Expansion: The first Phases of the programme were divided into yearly periods. Following the above-mentioned assessment which indicated urgent need for increased activities in development of rural water supplies in the country, it has been decided to design a long-term development plan. A three-year term has been anticipated to fit in the frame work of the project. It has been further decided, considering the possibilities of the project and its available man-power, to place an annual target of 100-110 new rural water supply schemes to be accomplished during each of the three years of the plan. These schemes will be assisted by UNICEF and by the Ministry of Health, as well as of course, by the local matching aid of the local authorities and the people benefiting from the water supplies.

3.2 Long-term Proposals: When the layout of the three year plan was completed and accepted by the Ministry of Health, a circular was distributed among all Medical Officers of Health, Provincial and District Health Inspectors, in the six Provinces and 34 Health Districts of Kenya, explaining the plan and asking to list on a special form attached to the circular proposed rural water supply schemes for the coming three years. The proposals had to be numbered according to order of priority. The information that had to be supplied in the form included: Name of location, size of population, proposed water source, means of delivery, estimated distance and estimated head between the source and the village. Only estimations were asked in this stage, in order to facilitate the accumulation of this important information.

When the filled forms reached eventually the Ministry of Health, a total of over 600 proposals were counted. Out of these were chosen the first group of schemes for the first annual stage of the new Plan (or Phase VII) of the programme. For the first time all the 34 Health Districts in the country were represented in one single Phase. These selected schemes were processed according to the new standard design, that has been developed by the project in order to enable mass-processing of large numbers of new schemes according to the three year plan outline.

4. STANDARD DESIGN

4.1 Simplicity: According to the three year plan, the annual number of new demonstration rural water supply schemes had to be almost tripled, compared to previous phases of the programme. With the existing limited man-power available in the project, such increase could not have been achieved without altering existing procedures of processing and design of rural water supply schemes into a standardized and clearly classified and defined system. By the use of simple standards and procedures the health inspectors staff in the country can be easily trained to follow and practice the standard design system of rural water supply schemes from the first stages of choosing the site and surveying the schemes to the final submission of the detailed request followed by the Country Council's committment to take over and maintain the assisted schemes.

4.2 Standards: Following are the main factors upon which the standardisation of the design has been based:

(a) Size: The size of the rural water supply scheme should not exceed 1,200 people connected to the scheme. In arid areas where the population is nomadic, the maximum figure can be raised to 1,500 people.

(b) Future Growth: The population census figures for the communities living in the locations of schemes, should be increased by 25 percent in the design to allow for future population growth, and consumption increases.

(c) Machinery: All machinery installed in the schemes, such as pumps and engines should be, as far as possible, of the same make, to facilitate future service and maintenance. The project has hence been using in most schemes Blake pumps and Lister engines. Dug well have been supplied with Craelius handpumps.

(d) Consumption: Water consumption rate of 10 gallons per day has been decided to be the basic design figure.

(e) Pumping Rate: The following daily pumping periods for the design of the pump and piping have been fixed according to the size of the scheme: 7 pumping hours per day per scheme serving up to 500 people; 8 hours for 501-750 people; 9 hours for 751-1,000 people; and 10 for more than 1,000 people. These standards will also contribute to future growth needs by allowing longer pumping periods in due course, with the same pump.

(f) Reticulation: In addition to the main pipe, reticulation allowance was made according to the following standard: 2 feet of 1 inch pipe and 1 foot of ½ inch pipe, per every person connected to the scheme.

(g) Waste-not-valves: One ½ inch Waste-not valve allocated to every 100 people connected to the scheme.

(h) Water Metres: In order to encourage water rating in the new schemes, meters were included in the design as follows: one meter for the main, and one ½ inch meter for every 100 people connected to the scheme.

(i) Fittings: Fittings comprise a wide variety of small items. Since the piping arrives with couplings, and in order to simplify the design, it has been decided to include fittings in one cost figure being 3% of the value of the piping in the scheme. This item has been placed therefore in the local contribution section.

(j) Survey Equipment: The use of the altimeter has been introduced to determine the pumping head. The Health Inspectors have been equipped each with pocket altimeters purchased by the Ministy of Health for this purpose.

(k) Barbed Wire: Two rolls supplied for each scheme for fencing and protecting the intake site.

(l) Reinforcement and Roofing: Quantities of iron bars, weldmesh sheets, and aluminium sheets, necessary for the schemes have been determined according to the capacity of the storage tank where most of these materials are used and can be easily picked up from a standard table.

(m) Design Forms: The design as a whole has to be performed in special forms prepared by the project. The form is divided into four parts covering details on site and area, the Hydraulic design, the cost list, and the sketch. The Health Inspectors were trained to calculate and fill the tables, prepared by the project. More details on the form and the table set are included in the following charter five on training.

4.3 Water Treatment

A trickling chlorinator and/or a slow sand filter have been included in every rural water supply designed by the project. Surface supplies are equipped with both chlorinators and filters, whereas properly protected wells or spring catchments are supplied with only a chlorinator.

The design of the filter and the chlorinator has been standardised and tabled, in a way that a treatment set, including quantities and costs can be immediately selected for every water supply, according to the capacity of the storage tank.

4.4 Waste Disposal

Standard design for a pit latrine including quantities and cost has been prepared by the project. From a standardised table in the design, number of units, quantities of materials and costs of installing pit latrines in the market and the school of the location, can easily be found according to the size of the community served by the proposed water supplies.

5. TRAINING

5.1 Aims: The training of the Health Inspectors staff in the standard design of rural water supplies, has had two aims:

(a) To co-operate the staff in the performance of the development programme.

(b) To prepare the staff for taking over and continuing the development of rural water supplies in the country.

5.2 Seminars: The training of the health inspectors has been performed in seminars specially planned for this purpose. The stress in these seminars was laid on the technical training in the standard design of rural water supplies. In planning the syllabus, the background training of the health inspectors in the School of Hygiene had been considered, where they had studied basic hydraulic and design criteria. Only five lectures were included in the seminars which lasted a whole week each, whereas the rest of the time was allocated to practical design, on special forms, with the aid of the table-set.

The design included four different types of water supplies:

(a) Pumped supplies operated by means of mechanical pumps from rivers, springs, lakes or catchments.

(b) Pumped supplies operated by means of hydraulic rams.

(c) Gravity supplies.

(d) Well supplies operated by means of hand-pumps, or mechanical wellhead pumps.

5.3 Tables: A set of hydraulic and costs tables has been prepared by the project to assist the health inspectors in performing the standard design. The set included the following 14 tables.

Table 1: Loss of head in galvanised iron pipes of different diameters.

Table 2: Specifications for Climax wellhead pumps, complete with engine and casing.

Table 3: Specifications for Blake double-acting pumps.

Table 4: Specifications for Deming pumps used for very high lifts.

Table 5: Combustion reduction in engines due to altitude and temperature. Due to the high altitudes existing in Kenya, adjustment in the engine's horse-power output must be inserted, since engine characteristics fit sea-level conditions. An average temperature of 80°F has been fixed in the standard design.

Table 6: Specifications for Lister diesel engines.

Table 7: Specifications for Blake hydrams.

Table 8: Water storage tanks, showing dimensions capacities and costs of various tanks made of galvanized iron sheets, stone or concrete. The table indicates also the required quantities of cement, reinforcement, weld-mesh, and aluminium sheets.

Table 9: Gravity flow discharge for galvanized iron pipes.

Table 10: Weights of galvanized iron piping (ton/1,000 ft).

Table 11: Costs of railing one ton of piping from Mombasa to 13 various railway stations in Kenya.

Tables 10 and 11 are to be used for calculating costs of transporting supplies from Mombasa to various scheme sites.

Table 12: Mean annual rainfall in the districts of Kenya. To be used for the design of roof or rock-catchments in areas where detailed meteorological data is not available.

Table 13: Price list of water supply materials.

All tables include coordinates to facilitate the checking of the design, columns were lettered: a, b, c, etc, and rows numbered: 1, 2, 3, etc. Every figure quoted from the tables had to be referred to Table's number and the adequate coordinates. A set of these cyclostyled tables has been given to every health inspector attending the seminars. With the aid of these tables and the available general data regarding the scheme, the standard design can be performed in the standard form.

5.4 Form: The standard form consists of four parts: Part I: the area which contains data as per place, population, source, flow, distance, head, and altitude, as well as institutions to be served such as schools, markets, dispensaries or missions.

Part II: The design, which includes the consumption (based on a standard figure of 10 gallons per day) and storage capacity, and the loss of head for the calculation of the piping. The next step in the design is the calculation of the pump. The form includes tabled data for four different pumps used in the designs: a double-acting Blake pump, Deming pump, a Hydram, and Clima-x well-head pump. No pump of course is necessary in case of a gravity scheme, in which case all four sections of the table's data are left blank. The third step in Part II is the calculation of the engine, according to the formula given in the form. A standard rate of 40% efficiency is allowed for the engine and is incorporated in the formula as well as an altitude adjustment to determine the final horse-power output.

Part III: Cost list. This list includes the quantities and costs of the necessary materials required for the construction of the water supply scheme according to the previous design. The list is divided into two separate totaling columns referring one to UNICEF contribution and the other to the local matching aid. All prices are given in local East African currency. The UNICEF contribution includes almost all materials that have to be imported from abroad, which are the piping* pumps, engines, reinforcement bars, valves, meters etc. The local matching aid includes mainly the labour, the inland transportation of materials, the construction of storage-tanks and the necessary fitting.

*Recently, UNICEF has agreed to purchase locally produced plastic piping for the assisted schemes.

Part IV. Sketch. The sketch shows the general layout of the scheme. The details that have to be indicated in the sketch are: The existing pipe (length and diameter), the new pipe (length and diameter); the source of supply (river, spring etc.) and the direction of its flow; the intake point and its elevation; the storage tank and its capacity and elevation; the institutions served (school, dispensary, market etc.); the near main road and its direction and distant from the nearest town; the North direction. Most of the above information is symbolised in the legend of the sketch.

The standard forms have been printed by the project and distributed among the Health Offices according to a rate of four copies for each scheme. The four copies are to be distributed as follows: one to be sent to the Ministry of Health headquarters in Nairobi, one for the County Council, one for the Provincial Health Office, and one to be filed locally in the District Health Office.

6. COOPERATION

6.1 Responsibility: The WHO/UNICEF assisted rural water supply development programme has been established mainly to promote community health. This programme has been operating within the Ministry of Health. However, this Ministry is not the authority for water supply in the country. It only assumes responsibility for the quality of water supplies, whereas the responsible body for rural and urban water supplies is the Water Development Department in the Ministry of Agriculture. The programme has therefore been developing during the years upon close connections and cooperation with this Department. Such cooperation must be considered essential, since any rural water supply development has to be performed within a common country-wide planning, while avoiding costly overlapping.

6.2 Local Staff: The proposal of new water supply schemes to be developed by the project, is usually being done by the District Health Inspectors operating in the 34 District Health units in Kenya. These Health Inspectors being local officers, are thoroughly acquainted with all other development projects planned in their areas, and have been accordingly advised by the Ministry of Health to cooperate with all bodies involved in community development, such as the Water Development Department, the Ministry of Economic Planning and Development, the Ministry of Local Government and of course, the local authorities which are directly connected to all development works that take place in their areas of jurisdiction.

6.3 Bilateral agencies: Apart from the WHO/UNICEF Programme and the Water Development Department, there are few other bodies engaged here with rural water supply development. These are mainly United States Agency for International Development and other bilateral agencies operating under the auspices of developed countries (Sweden, West Germany etc.). The project has been maintaining close connections and cooperation with all bodies involved in the development of rural water supplies in Kenya.

7. MAINTENANCE

7.1 Rating: The maintenance of small rural water supply schemes is not an easy task, due to lack of operating funds, and possibilities of collecting such. Rating creates a problem due to lack of private connections and meters. No funds can be hence available for systematic maintenance of repairs of major break-downs. It has been thoroughly investigated and the following conclusions were drawn:

7.2 Conclusions

(a) Rating of water in rural areas can not be introduced without arranging for a proper background, based on a long term health education period. Normally this period will last two to three years, during which a gradually imposed rating system based on fixed charges per family or house is introduced together with encouragement to install metered private connections. Only when the people are fully aware of their responsibility for the water supply, then rating, and through it, proper maintenance, can be successfully practiced.

(b) In order to avoid, as far as possible, during the two to three years of "adjustment period" the need for major repairs which can not be financed, it is recommended to include in the design, pumps and engines of somewhat higher strengths and capacities than needed. The increase in the cost of the machinery due to this increase is very small, and has almost no effect on the cost of the scheme. The machinery will hence operate upon longer intervals, and be less worn out during the said period. However, this arrangement will answer also for longer future needs of the community.

(c) The same kind and make of machinery should be used as far as possible for all assisted schemes. A diversity of pumps and engines from various products complicates the handling and maintenance of the machinery especially with respect to spare parts.

The project has been using, since its commencement in 1960, mostly Blake pumps and Lister engines in hundreds of rural water schemes. This kind of machinery has been chosen because the producers have been maintaining a large agency in Kenya, equipped with proper workshops and stores of spare-parts distributed in the country.

(d) In order to reach safe long periods of non-stop operation of the water supply systems, the project has planned an insurance scheme, to cover the pumping machinery operating within these schemes, major breakdown repairs. According to this insurance scheme which was possible due to the use of the same make of machinery in the programme, every rural water supply will pay through the County Council where the supply is located an annual premium to the machinery agency. This premium will secure regular servicing by a mechanic of the agency that will be travelling along a planned route, so that every scheme will be visited once in two to three months according to the size of the scheme. The insurance will also cover the cost of repairs of major breakdowns (such as cracked casings or splitted pistons), as from a minimum basic amount and up.

8. FUTURE FORECASTS

8.1 Assessments: It is quite clear that the WHO/UNICEF assistance in the development of rural water supplies in Kenya can not last forever. As mentioned before, the main purpose of the programme has been to demonstrate to the people and to local authorities the urgent need and the benefit of having piped and safe water supplies. The project itself as well as UNICEF have performed surveys and studies aiming to show how much progress was made towards achieving this purpose. It can be assumed from a close watch of the programme and its effect on the country and the Government, that it has been successful in demonstrating the rural water supply needs, and in stimulating individuals, and Government authorities, to search for more efficient ways and means leading to the solution to this urgent problem

8.2 National Plan: The new Five Year National Development Plan for Kenya (1969-73) has been concentrating on rural development, and in particular on the development of rural water supplies. Accordingly, the Environmental Sanitation Department in the Ministry of Health has prepared estimates for the Development Plan, where a sum of £400,000 has been requested for rural environmental health purposes and in particular for dvelopment of rural water supplies for dispensaries, markets etc.

The Water Development Department with the aid of bilateral and Government assistance, has also launched an ambitious plan incorporated in the National Plan, involving expenditure of millions of pounds for rural water supply development.

The WHO/UNICEF Programme has been hence performing an important act in the field of rural water supply development in Kenya, and a considerable part of the recent rural development trend in the country can be attributed to the demonstration effect of this Programme.

COMMUNITY DEVELOPMENT TRUST FUND OF TANZANIA

VILLAGE WATER WELLS PROGRAMME

by Marion, Lady Chesham

The Community Development Trust Fund of Tanzania was founded in May 1962 five months after Independence. Its main objective is to assist the Self-help Projects in the rural villages of Tanzania by supplying the people of the villages with the materials such as cement, C.I. roofing, nails etc., the buying of which is beyond their resources.

We have assisted and continue to assist the building of village teachers quarters, village school classrooms, dispensaries, maternity clinics and community centres. But we very soon found that the priority help needed by practically every village is a conveniently placed, clean water supply. In some areas we have been able to pipe water from above the village by gravity to water taps. But in most villages a concrete lined, concrete topped well with a hand-pump answers the problem.

The first reason for helping the people to install these wells was to relieve the women from the slavery of spending a large part of their days walking to and from a water hole, carrying a debe of water on their heads, or two on their shoulders. There are cases where the walk is as long as ten miles each way, the average is three to five miles, frequently up and down a hill. In the dry season the water often has to be dug for in the dried up bed of a river and then only a trickle of water is found. By relieving the women from this back breaking work we give them time to take better care of their homes, their children and their husbands. Also they are able to attend adult education classes and womens training centres.

Secondly, the improvement in health by providing a clean supply of water. We are now receiving reports from villages we have helped to have water wells that the incidence of typhoid and dysentery has dropped dramatically and in some places no <u>new</u> cases of bilharzia have been reported. This alone makes our water well project worthwhile.

Our method of working is as follows:

We always consult the people and seek their co-operation. We have always received this co-operation from the village people because the well is theirs, they want it, they work on it and install it. It is not imposed on them.

<u>Location of water wells:</u> We have received invaluable help and co-operation from Water Development and Irrigation Division (WD&ID) who frequently send their survey teams to locate the best place with the best supply of water for us. But WD&ID is overworked in the Regions and cannot assist us in every case.

The nearest Christian Mission is always ready to assist us in everyway. They know every inch of their areas and where the water is. In other cases it turns out to be that the Mzee of the village knows where the water is and in many cases has shown us a very old abandoned water-hole which only needs cleaning out and rebuilding.

Materials: The wells must be lined and covered. The lining of the well depends on local conditions: Some wells can be lined with burnt brick and cement; some wells with dressed stone and cement. But in most cases the answer is concrete rings made on the spot by the people from cement and weldmesh. This has its drawbacks as many Regions and Districts are short of the moulds needed to make the rings. In all cases the well must have a concrete cover to keep it from pollution.

Pumps: All rural village wells should have a hand-operated pump. It is quite impossible for a remote village to keep a mechanically run pump in order; added to which no remote village has electricity and no village has enough cash in hand to buy petrol or diesel oil.

We have experimented and observed many different varieties of pumps and have now settled on two types. The first type is a pitcher-spout type which has been used on many farms in Europe and the United States for many generations. This will pump water from a depth of 20 to 25 feet, This pump has been tested at WD&ID Ubungo and pronounced satisfactory. The second type of pump is known as the Uganda pump and will bring water up from a depth of 50 feet. I cannot name the other pumps which we discarded because of frequent breakdowns as I might be sued for libel if I did.

On both the pitcher spout pump and the Uganda pump we found it necessary to install a foot-pedal for priming as otherwise the pump was primed with dirty water and in one case with oil. This of course nullified one of the main reasons for installing wells. Both these pumps can be operated by children if properly installed at not too great a height, and with perfect safety as the well is concrete covered and the child cannot fall in.

If we find that the water is at too great a depth for our simple installation to be effective, or if we run into a deep rock formation we hand this problem over to WD&ID and move on to a village where we can help. Also when we know that WD&ID has, or will soon have a big irrigation or dam project under way to give plentiful water to a District we move on. In fact we concentrate our well programme in the remote and more backward Districts where we know it will be a long time before big development plans can reach them due to lack of money.

Supervision: The organising of the voluntary teams for digging is done by the Chairman of the Vill ge Development Committee. More expert supervision is given by the nearest Rural Development Officer who can call on the local WD&ID officer for advice. In many, many cases the project is supervised by the nearest Mission father who is always very ready to help. Our own field officer is constantly on safari checking up on projects, supervising, and helping, very often installing the pump himself.

To sum up: There are at least 17,000 villages and many hamlets in Tanzania all needing water. A great many of these are in the Government Five Year Development Plan and WD&ID is continually working on big water projects for them. But there is still plenty of room for other organisations to help if they set about it in the right way.

It seems to me that there is an imperative need to co-ordinate all those who are working on water well projects for villages. We need a clearing house.

1. Water Development and Irrigation Division should be consulted as to what they are doing and plan to do during the Five Year Development Plan and these Districts should be left to them.

2. All organisations ready and prepared to assist the water well programme should submit to a clearing house the Region, District and name of the village in which they propose to install a well. It may be that some other organisation has already done this or started to do it. The clearing house could inform them of this fact and tell them where nothing is being done and needs to be done. In this way a great deal of time, wasted effort and money could be saved.

Since 1962 when it started in a very small way the Community Development Trust Fund has helped with the installation of 745 water wells in rural villages. At this date many other organisations are now interested in this problem and I feel strongly that some machinery needs to be set up so that the best use is made of all this good will and financial help. I hope very much that this Workshop will work out some such plan and will submit it to WD&ID and to a meeting of the voluntary organisations for their approval and co-operation.

WATER SUPPLIES OF KIBAHA VILLAGES OF COAST REGION TANZANIA

by H. A. Mbelwa

The Kibaha area is mostly undulating land. Some parts have clay soil covering a great part of it as in much of the eastern side of Kibaha. The rest is mainly sandy soil where there are several water sumps and intermittent streams during rainy seasons.

The Dar es Salaam (Ruvu) water supply main pipe passes through this area but Nordic Tanganyika Project (NTP) is the only privileged settlement with piped water. The rest of Kibaha gets it water from the following sources:

(a) intermittent small water courses mainly when it rains.
(b) storm water accumulating in ditches.
(c) Scraped shallow open water holes at dry stream beds.
(d) water sumps heavily infested with Bilharzia causing organisms, etc.

All the above sources are grossly polluted and as a result water borne diseases prevail endemically. The most prominent ones are Bilharzia, Diarrhoeas, Dysenteries, and Enteric fevers. Though the latter is not actually noted to occur, they are most likely to spread easily if introduced.

Water drawing points are mostly far from homes and getting water from the sources is by the traditional means of a water pot or four gallon tin on heads. The main problem is not lack of water but protected water supply sources.

Although there was no actual well organised survey carried out initially, it was found naturally that a help to implement measures against the health problems prevailing in the area, would be very ideal. This among many improvements of Kibaha village water supplies was and is still one of the first priorities, including the provision of latrines, housing improvements and health education in general. Kibaha Health Centre (KHC) of the Nordic Tanganyika Project initiated a campaign of rural water improvements three years ago. The Kibaha Health Centre has been working hand in hand with Community Development workers there to make the campaign successful.

The area which needs such help is too large to cover successfully within a short time. It was therefore decided that all health extension activities be first concentrated at defined workable areas where the population is fairly concentrated and within easy reach by road or motor tracks, and where the villagers responded. The villagers around the Nordic Tanganyika Project are mainly crop farmers and individual families tend to live separately from other families at their own small scattered crop farms. So Kibaha Health Centre decided to concentrate mostly on the area within a 10 mile radius in the Kibaha catchment area. As it is well known that big water programmes require much money, tools and highly qualified personnel on water supplies, large projects seemed out of reach. Because the large population is spread out over such a large area, one or two very highly constructed water schemes would not help the thousand of villagers of a population in the area of 45,000 to 50,000. Such a scheme would benefit only a few. In order to extend a hand to the majority of people, simple but effective ways of protecting water using the protected shallow wells at reasonable distances were decided upon at various places. Hand dug wells and the small bored lined wells were the choice. The Kibaha Health Centre catchment area has so far 38 big dug wells and 100 small bored hole wells, and there are 8 dug wells being constructed now.

The Construction of the Wells

The Dug Wells

These are usually constructed of concrete rings, each ring being four feet diameter by four feet high and two inches thick. Five rings may be sunk if it is found desirable.

It is essential to select a suitable site where one is sure that there will be an ample yield of water particularly during the dry seasons. It has been found by experience that the local people where the well is to be constructed, usually know where water is obtained even in the very dry seasons. Sites near swamps, at an existing water hole, at and near to water stream beds, etc. are good sites for wells.

When a good well site is uncertain it has been found very helpful to bore a deep hole first with an earth auger such as one sixteen inches in diameter. This not only determines the source of water but also it tells the condition of the water stratum as to whether there is a nearby impermeable rock or the soil is too sandy for boring.

After the site has been determined. The site is well cleared of grass and other vegetation and leveled off. It is essential that the site be level, otherwise the rings may not fall vertically.

When digging, one of the rings is placed on the prepared site and digging begins inside the ring by one person at a time, and as the process continues the ring sinks into the hole. Care is always taken to see that the ring falls vertically so that the process of digging continues till the top of the ring is at ground level.

When the top of the ring is level with the surrounding ground, another ring is put into place immediately on top of the first ring. Digging continues as usual until four rings are in place. The top ring is left two feet to two and a half feet above ground level as a coping. The rest is now 13½ feet to 14 feet according to the height of the coping left. When digging is complete the space between the rings and the sides of the hole should be filled with puddled clay, hard rammed, and a concrete apron at a later date is constructed to draw away waste dirty water and rain water from the pump.

The ground has to be left to settle for sometime, usually for four months, before the concrete apron is made, otherwise the surrounding ground would crack and sink down through ground settling and cause damage to the apron. Instead the ground is covered with clay soil and sloped away from the well and then a precast concrete slab of one and a half feet by two feet is placed on the ground below the direction of the pump delivery pipe to direct away waste water. Sand and water is for practical purposes removed by buckets tied with strong ropes, but it has been found advisable if equipment can be obtained, to have a standby pump to remove water while digging as much water retards digging and sinking progress. At Kibaha the subsoil water table is very high and without a standby motor or hand pump digging has not always been possible. After construction is over all joints between the rings are sealed with cement mortar to be water tight.

Bored Hole Wells

They are bored with an earth auger and the best size found useful at Kibaha is the 16 inch diameter one of very strong construction. The boring is done after the site has been leveled as for the big well. In this case it is essential to ensure that the site is level because the hole must be vertical otherwise, because of its small diameter, the lining pipes will not drop. A guide board to assist in keeping the auger vertical must also be available.

A hole of about 18 feet diameter and 18 inches to 24 inches deep is now dug by hand. It is necessary that the sides of the hole are truly vertical as it is used to start the auger. The boring starts and as soon as the auger is full of earth it must be withdrawn and emptied. Boring then continues. It is absolutely essential that great care is taken especially in the initial stages to see that the hole is truly vertical. Any deviation will make it very difficult and in most cases impossible to drop in the lining concrete pipes later on.

When boring continues, extra lengths of shafting are added as required until a depth of about 15 to 16 feet has been reached. In suitable ground this can be completed in about four to five hours. Four men are required for rotating the auger, but at least ten men are needed for removing the auger when all three shafts are in place and it is full of earth.

The auger can only be used in certain types of soil. It should be reasonably firm, permeable soil, free from large stones. If a large stone cannot be removed by the auger then the hole must be filled in, and a fresh start is made elsewhere. In sandy soil the sides may collapse, but if the layer of sand is not too deep, an empty tar of petrol drum can be inserted to strengthen the top of the boring. When the hole has reached the required depth, say of 15 feet depth, boring is stopped, then there remains lining the bored hole.

The lining of the bored hole is made by using 12 inch internal diameter concrete culvert pipes each 6 feet long. These pipes are lowered into the well one at a time, one on top of the other. The top one will be two and a half feet to three feet above the groundlevel as coping. As with the dug well there will probably be a small space between the pipes and the sides of the hole. This should be filled with hard rammed clay, and once this has settled a concrete surrounding can be built exactly as for the big well. Cement mortar is used to seal the joints by placing it in the female side of the pipe when the next one is lowered.

Covers of Wells

For the big dug wells, wooden covers are made and lined with white galvanised metal sheeting, or alluminium sheeting. If this is not done the timber warps and shrinks in the sun allowing dust, dirt, dirty water, birds droppings etc. to enter into the well. Then a pump and piping are fixed. A semirotary water pump No. 1 and No. 2 run well and have been found very useful.

Covering a Bored Well

The simplest way of fixing the pump is to use a plug of concrete made for this purpose with a central pipe opening and two dexion uprights to which the pump is belted. The plug is cast in a plastic bucket which must be tappered towards the base, and the base must be less than 12 inches to the top. Several inches of sand must be placed in the bottom of the bucket and the sides greased above the sand. The dexion frame is now fixed in the bucket centrally, then concrete of 1:2:4 mix is poured into the bucket and left to harden. The bucket must not be disturbed otherwise it will loose shape. This plug acts as a stopper in the top of the bored well.

The cost of a bored well to construct is Shs 230/- excluding labour. It takes only a day when ten people work on it. The cost of a big dug well is approximately Shs 800 to 900 with labour included. Distribution of wells in the catchment area is aimed at approximately at least one mile distance from one to another, and to serve 200 people.

Kibaha Villagers' Participation in the Well Digging Programme

All well rings, pipes, covers and pumps are given free of charge by the Nordic Tanganyika Project to the villagers. The villagers' part is to offer free labour and when the well is completed it is owned by the villagers themselves. Equipment such as one hoe, a pair of matocks, two metal buckets, a strong rope of 20 feet length, one shovel, and a standby pump are lent for use at the well site. But before that there needs to be an awareness of the villagers that they have a water problem in their village and that they must work hard collectively to combat the problem. This is done through health education of all adults including village leaders.

The Community Development Officer and the Health Officer stationed at Kibaha usually make informal visits and surveys in the area in question and thereafter they usually have friendly discussions with the villagers they meet such as village leaders (10 house chairman), local TANU leaders, U.W.T., Assistant Division Executive Officers, and other department officials. The problem is presented at the village development committee meeting by one village leader for discussion and when it is approved, it is forwarded to the W.D.C. Thereafter the request is sent to Kibaha Health Centre for consideration. If it is found reasonable and there is time to do so, then the Community Development worker makes the necessary arrangements at the village. Well digging equipment is then delivered to the well site by the Kibaha Health Centre field extension staff to start the well.

Problems Faced by the Field Extension Staff

Villagers always start with very good spirit for digging on the first day of digging. But it has been found at several occasions that people do not continue attending for the digging regularly, and so they have to be followed up again and again - a waste of time, transport and technicians labour, but eventually they complete the digging.

The writer remembers a big dug well which took more than eight months to complete and another which took only four days to complete. All this depends on the enthusiasm and initiative of the people concerned.

There is another problem which hinders digging progress - sand and water. As the digging progresses deeper, sand may become saturated with water and sometimes the sides of the well collapse while digging. This consumes time and energy which always discourages villagers from digging anymore. Some of the well sites show very good signs of water when boring or consulting with the villagers. But after completion of the well, the water yield tends to decrease and sometimes there is too little for any use. This is in most cases caused by soils with a mixture of clay soil which hardens at dry seasons and so prevents surround water from getting into the well. In this case water filter catchement trenches have to be made. These are simply of aggregate and sand and then covered on top with clay soil to prevent direct drainage from above into the trenches.

Another difficulty met with some of the bored wells is that they fill with sand silt coming up with the water from below, thus reducing considerably the effective depth of the well. Two such wells filled with silt to the top. A smaller earth auger of about ten inches diameter was used to empty the silt with the aid of a small bucket to remove muddy water. With the big dug wells it is easy to pump out water and to have someone get into the well and remove the sand or mud with buckets.

Equipment and Tools

1. A four foot diameter well ring can be obtained from local dealers in Dar es Salaam for about Shs 170/- each but transporting them is very expensive. Kibaha Health Centre moulds its own rings there and transports them to the well sites. Once a metal ring was borrowed from Kisarawe District Council and it was very useful. Later on Kibaha Health Centre bought its own two ring moulds from Dar es Salaam for Shs 2600/- each and they have been very useful. Cement concrete of 1:3:6 mix and the ring reinforced with two inch by two inch galvanised weld mesh all around, makes a very stong ring.

2. Concrete culvert pipes of 12 inches internal diameter and six feet long cost Shs 30/- to Shs 32/- each in Dar es Salaam. Three are needed for a well.

3. One 16 inch earth auger costs Shs 750/- completed in Dar es Salaam.

4. Foot valves are also obtained locally from supplies of pumps at a cost of about Shs 15/- each.

5. Slotted Angle Irons are also obtained locally at Shs 200/- per ten by ten foot packing or Shs 2/- per foot.

6. Weld mesh second quality sheets are obtainable from most hardware stores at Shs 240/- per 10 bundles. Each ring needs two.

7. Three pumps (motor pumps of two inch hose pipe size) cost in the area of Shs 1800/- to 2,000/- with complete delivery hose pipe and suction pipe. There is one hand operated suction pump costing about Shs 500/-. These prices are those in Dar es Salaam and they are all approximate costs.

The Ndoleleji Water Development Scheme.

by Franz van de Laak

1. Description of the Project

Origin: The Ndoleleji Water Development Scheme (NWDS) originates from the Ndoleleji Rural Community Centre (NRCC) and the Ndoleleji Agricultural Scheme (NAS), which provide assistance in the Kishapu area of the Shinyanga District, in the technical and the agricultural field respectively.

Aim: Its aim is to bring contact between the people of the area and the NRCC/NAS through group forming, as groups can easier be brought into contact with the offered assistance than is possible with individuals.

Clean and sufficient water, easily obtainable, is a recognised need in the area by the population, as most suffer from the lack of it. Therefore water supplies were chosen as an incentive for action. Self-help is used as a means because it is based on common effort for a common purpose.

Way of Work: Via the Village Development Committee (VDC) and their respective ten house cell leaders the possibility of obtaining a water supply is explained to the people. This campaign is assisted by distributing Swahili booklets to all ten house cell leaders in the area. People are urged to find neighbours who are equally interested in such a supply and are told in a meeting about the different ways to achieve this. The main emphasis is laid on the lack of ready cash and the potential of obtaining this cash by cultivating a common field, the proceeds of which will pay for the material costs, whilst work is done on a self help basis.

If a meeting is successful a water scheme is started to which anyone interested can become a member. A target amount for each member is fixed depending on the cost estimate and the number of members, which usually amounts to Shs 300/- per member approximately. People become members by paying a free amount cash and by promising publicly to cultivate one acre of cotton in a common field until the required amount is reached. If the proceeds per acre of the common field exceed the amount needed for a member, this excessive amount is returned to the member. If the needed amount is not reached the member binds himself to pay the rest of the cash from the proceeds of his own field or by cultivating another one acre field in the common field the next season. Besides the promise to pay his share in the undertaking each member binds himself to work at the project without pay. A schedule of work and a duty list is made up in agreement and an elected committee takes care of the necessary organisation.

With the cash collected at the beginning of the project a start on the work can be made, usually the construction of the well. Depending on the amount available the work proceeds until the scheme runs out of cash, and the proceeds of the common field are awaited to finish it.

Type of Water Supplies: As the known places where water can be drawn are very limited and are mainly three rivers in the area, a water source usually has to be of a reasonable capacity to serve quite a number of families. A well is sunk in the deepest part of the river bed with an eight foot diameter concrete ring and reaches till the clay bottom of the river bed. The cover is made at the water level in the dry season leaving it submerged for two or more feet in the sand. The average height of a well thus built is four to five feet and the capacity in the dry season usually exceeds 1000 gallons per hour when pumped continuously.

From the well a pipe is laid over the bottom of the river, fixed on concrete blocks, towards a suitable site on the shore. Depending on the wishes of the community either a handpump or a windmill operated pump is installed. Normally the handpump is installed first and when money is obtained for sufficient piping to finish the project, the windmill is installed together with the necessary reservoir to take care of wind irregularities. The material costs of a windmill operated scheme are around Shs 15,000/- average.

All services provided by the Ndoleleji Water Development Scheme except the actual building of the windmill, are provided free. Financial support for the scheme is provided by Misereor in West Germany and the Diocese of Shinyanga.

2. Evaluation of the Development Impact of the Project upon the Rural Areas.

History: The scheme started operating as a separate unit in the second half of 1968. Before a windmill operated supply was installed in Ndoleleji itself with the people of Ndoleleji doing all work free. Another windmill operated water supply was installed on an individual farm in Masanga. This windmill was built in Ndoleleji and was this year modified. This mill is used for experimentation on construction and pumps with the consent of the owner.

By the end of 1968 one project was underway in Buzinza, Bulekela, where people collected Shs 1,330/- from Shs 35/- contributions per family. The reason for the project was an underground reservoir tapped by the people who dig holes (some fifty) in the ground reaching a depth of fifteen feet. The water is then drawn by means of bucket and rope. No linings or covers are used causing the holes to fill in during the rainy season when the area there is flooded.

By December 1968 a concrete lined well was sunk 19 feet deep from which 350 gallons of water could be drawn per hour. The work was done with paid labour, according to a decision of the water meeting. The work was stopped that year because of flooding of the area, after the well was raised above the flood level of the area.

In 1969 efforts were made to restart the scheme but this failed on the fact that contributions were made on taxpayers basis, some of whom did not draw water at the wells where others, belonging to a different sub-division drew water but did not pay.

It was at that time that the need for organised action through the various VDC's was also felt and the Swahili booklet was issued to the Viongozi. As a result of this a project was started in Shagihilu, three miles from Ndoleleji, with the intent of drawing water from the nearby river Mangu and pumping it up to the village by means of a windmill. The estimated material costs were Shs 22,000/- of which Shs 4,500/- was cash collected from 45 families. The project is based entirely on self-help and presently the well, the piping to the bank of the river, and the foundation of the windmill are ready. The windmill is under construction though a handpump will be installed first. Shs 1,500/- is remaining, cash for buying piping, etc. The cultivation of a 35 acre plot has started on a communal basis.

Using the smooth operation of the Shagihilu project as an example the organisation of the project in Buzinza was changed along similar lines and the work at the well was finished. The well is now 26 feet deep with 12 feet of water at rest in the dry season. Over 500 gallons per hour can be pumped continuously. If necessary the well can still be deepened as the bottom of the water containing area is not yet reached. A cover was made and a handpump was installed. The water available is very clear and practically tasteless. The intention is to install a central drawing point outside the swamped area, with a possibility of starting an Ujamaa Village there. The thought of providing the village of Buzinza with a piped water supply is abandoned for the time being as the costs of such a pipe are high. The village is three miles away from the water source.

The total amount collected this year was Shs 820/- and the cultivation of 40 acres in the communal farm has been started, the proceeds of which probably will finish the estimated Shs 11,000/- project.

<u>Evaluation</u>: The supply in Ndoleleji has resulted in close co-operation between the members of the village. A water committee takes care of smoothing out difficulties in the supply, collects the dues of each member of Shs 1/- per month for repair purposes, and obtains help when repairs have to be done. The supply has a maximum capacity to pump 800 gallons per hour and has a reservoir of 7000 gallons spread out to seven individual tanks where people can draw water.

Besides the water supply, a co-operative duka for members only has been started at the beginning of the year and many members of the village have joined the Kijiji cha Ujamaa Ndoleleji, that was started a few months ago. The village was 26 family members.

The results so far of Shagihilu and Buzinza have raised the interest of a large sector of the population as well as of Government officials. Each of the projects can be multiplied along the banks of the rivers Mangu, Tungu and Sanga. Once a community has decided to obtain water it will go to great lengths to finish this, especially if an early start can be made with even a relative small amount of cash. The sense of ownership and pride in the collective achievement is great and competition between projects increases this.

Due to the relative high costs of materials in a project, especially of the piping, a community can be easily urged to choose a central place for drawing water. The need to raise most of the money through cultivation, as well as working on the project on a self help basis, brings them close together in common activities and in contact with modern methods of cultivation, which otherwise is very difficult to achieve. The step to start an Ujamaa Village at the central water drawing place is then not so large anymore as most people know each otherand the undesirable characters (lazy, etc.) are already selected out. Every one wants to draw his water close by home and piping to their houses is too great a cost. The money for building houses in the village can be obtained in the same way as the money for the water supply was obtained.

The main experience gained in the projects so far is that people are very reluctant to part with cash. Money is obtained once a year at harvest time. With money things can be bought to advance personal life and standing: bicycles, radios, mabati for houses, cows, beer, etc. It buys the pleasure of drinking beer in the social atmosphere of the kilabu where they meet friends easily in a time that there is no work to be done anyway. In a sense it replaces the old ways of beer parties for social purposes at their own and the neighbour's houses. Showing off at the kilabu with money partly replaces also the counting of head of cattle one owns. Money is further needed to buy food as many people depend mainly on their cotton crops.

Work, especially cultivating a common field, is an old tradition. A bit more or less work does not really matter. Provided that the work and the cultivation is organised in such a way that no other social relations are seriously harmed, it will be easily consented to.

Summarising, one could say that the scheme, if the system is reproduced several times over, could provide a large part of the population with clean water supplies. Further it is an instructional way to show the benefits of modern cultivating, and helps people to put the first steps on the road to Ujamaa living with all its possibilities for further progress. It can be a gentle way of changing established patterns of life.

3. A Critique of the Weaknesses and Shortcoming of the Project.

Communications: Especially in the early stages, when people needed to be contacted and to be told of the possibilities and the subject discussed, the system the scheme employs presently is weak. This system accepts that government has a communications network capable of doing work down to grass-root level via the Village Development Committee and ten cell leaders. The scheme thought it undesirable to partly duplicate this system, firstly because it would confuse people with such a private set-up parallel to the existing one, secondly because the scheme would therewith separate itself from the government effort which has very much the same aims, and become a private effort that nevertheless would need all the time offical public pronouncements of approval, thirdly because of the obvious need of help from the various governmental departments such as agriculture and maendeleo, which are often involved.

Thus, though government on regional and district level has been more than helpful and approve officially of the project, communications have failed this year on the local level. That is the reason that after one and a half years actual operation and more than one year preparation only two projects have come off the ground.

Some of the causes of this breakdown in communication are:

(a) Changes in the government personnel, though sometimes advantageous, delay agreements on a plan of action.

(b) Changes in the organisation of divisional level authority delayed or put off action that could have been taken.

(c) Insufficient communication with the VDC, due to slack attendance in its meetings and failure of communication among the viongozi who attend with their respective ten house cells, causes scheduled meetings to be postponed time and again as the people have not been told.

(d) There seems to be a lack of detailed plans for the area and a lack of adequate records resulting in the fact that action on the part of local officials depends very much on their own initiative with only general instructions from above. Replacement of an official therefore delays progress of the scheme until he has been completely briefed by the scheme and a new agreement is reached on the system of work.

Availability of Water Sources: Presently only one place in the area is known to have a sub-surface water source: Buzinza, Bulekela. There are indications that more places could be found, apart from deep well installations. The rivers are obviously fed by underground streams of clear water coming in from the plains where this water is collected from the rains and soaks into the ground. Most dams built away from the river dry out two months or so before the beginning of the rains, forcing people to travel often eight miles and more towards the rivers to obtain water. It is rather absurd to urge these people to go and live near the rivers and have them travel this distance to their fields. Progress in this productive and fertile land could be speeded up very much if water sources could be found nearer to the concentrations of people existing away from the rivers.

There seem to be rather accurate methods of finding water underground. I have read descriptions of the use of radar installations placed in a four wheel drive vehicle, methods using echos and photography. No doubt all these methods need skilled personnel and expensive installations.

However, if the correct information could be obtained the scheme would try to find the funds and the personnel to obtain these installations and operators, even when only the personnel would be temporary and local personnel would be trained. It is obvious that a much larger area than just the Kishapu Division could benefit from this research.

Enforcement of Decisions: Water supplies built through self-help, communal farming and Ujamaa Villages are all concerned with people setting themselves apart in a traditional surrounding for purposes of progress. Often the fear of clashes with neighbours prevent otherwise progressive minded people to join these schemes. The enforcement machinery at present employed does not do much to allay these fears.

A group of people deciding to build a water supply find themselves confronted with people who do not, by any means, want to join the effort, but who want to get the water or who want to obstruct the progress.

When cultivating common fields land is set aside by the VDC for such a purpose. Nothing is further heard until cultivating time when one or several farmers turn up, claim the land as theirs and start cultivating. A meeting with such people usually reaches agreement or the people concerned are warned. The next morning the situation is as it was. Cultivating by the people of the common plot is delayed or put off because of these quarrels. The next year things start all over again. A few examples like this and nobody wants to join these modern projects where people only quarrel, sometimes with panga fights involved.

As said already, decisions on plot allotments are made in the VDC. One of our VDCs has 265 viongozi, some living twenty miles away from the place of meeting. No wonder meeting attendance reaches only between twenty and sixty people. The information therefore does not reach all over the area. A subsequent meeting called in the area where the block farm, communal plot or Ujamaa village was allotted land is usually not attended sufficiently either, causing many people to obtain their information from rumours. When the fact finally comes through and cultivation time is reached the quarrels start. Cultivation time is pretty limited in the area. A delay of two or three weeks in planting can mean the partial failure of the crop. In Buzinza it set the start of the block farm back for a full year and still this year there are troubles.

Often the case turns out to be the communications problem. But even if people are informed and the appropriate steps have been taken the failure to enforce the decisions when the difficulties come to a head at the time of actual cultivating undoes all former preparations again. Thus a water supply project can be delayed to obtain its finances several years.

Ndoleleji, 26th November, 1969

by Anthony O. Ellman

The importance of having a clean and easily accessible water supply for development of rural areas - both from the point of view of health and of releasing labour for other productive purposes - has been stressed by other contributors to this conference. In Tanzania the strategy which has been adopted for rural development is the establishment of ujamaa villages, in which a group of farmers lives together and works together for the benefit of all. It is perhaps necessary to elaborate a little on the meaning of this strategy, and to show how it is integrated with the provision of rural water supplies.

In many parts of Tanzania at the moment people live in small isolated holdings, to which it is impossible to bring cheaply any of the services necessary for development (water, health facilities, agricultural education, modern technology, etc.) A major element of the ujamaa village policy is therefore to encourage people to move together in nucleated settlements, to which Government can cheaply provide the services listed above. At the same time, through proper economic planning, work organisation and good leadership, the farmers can make more rapid economic progress by working together, than they could as individuals. This results from economies of scale easier access to credit for effecting technical improvements, and the psychological openness to innovations that is found in many ujamaa villages. These potential advantages are not of course limited to newly established villages: by introducing co-operative organisation and economic planning to existing villages also, progress can be accelerated in the same way. The ujamaa village policy applies equally to areas where people live in scattered holdings, and to wher people live traditionally in villages: only the steps to achieving full co-operation, and the method of social organisation adopted, will vary according to the local social and economic conditions.

What is the significance of this strategy for the installation of rural water supplies? In the first place it is clearly an essential prerequisite for provision of water, that people should live together in villages. Not even in the most developed countries is the Government able to provide water to every isolated homestead. In the Second Five Year Plan priority in provision of rural water supply has wisely been given to people who have moved in to ujamaa villages. It is perhaps necessary to sound a slight note of caution in this respect: namely that the siting of the village must be carefully planned with a view to ensuring economic return on the investment, and also that the idea should not become accepted that every ujamaa village is sure to be given a water supply. This latter is a general problem, to ensure that farmers join ujamaa villages for the opportunity it gives them to help themselves, rather than out of hope of getting assistance which it may be beyond the capacity of Government to provide. Both these aspects are being stressed at the seminars on ujamaa villages which are currently being held around the country.

The second point is that self-help labour for digging the trench or the well for the water supply is easy to supply in an ujamaa village. The problem with self-help labour in the past has often been that it is slow and inefficient, difficult to get at the right time, and therefore expensive water engineers are kept waiting and scarce resources are wasted. In ujamaa villages with a structured community, centralised leadership, and the possibility of specialisation of labour, this problem is easy to overcome. Another side of the matter is that in some areas labour cost is a relatively small item in the provision of water: to minimize this problem priority is given to low-cost water projects, and siting of new ujamaa villages is wherever possible made with this in mind (though agricultural potential is of course the major deciding factor in the choice of site, and this may not always tally with a cheaply developed source of water.)

In the Second Five Year Plan period (1969-74) a total capital investment of shs. 100 million will be made in rural water supplies (80% of this provided through Swedish Aid.) In addition, experience over the last two years has shown that some 40% of the Regional Development Fund resource (40% of shs. 17 million per year) is likely to be used on village water supplies. Several hundred shallow wells and water pumps will be provided through voluntary agencies such as the Community Development Trust Fund, Missions, etc.; and as the economic status of ujamaa villages improves many will be encouraged to put in their own water supply using their own resources. Wherever possible the labour of the people who benefit from the water supply will be used in its installation, and costs will always be kept to the minimum possible.

Through the medium of the ujamaa villages which are spreading rapidly through the Tanzanian countryside, clean and reliable water supplies will be brought close to the homes of a far greater number of farming families than has been possible in the past.

RURAL WATER SUPPLY IN KENYA — ITS ROLE IN DEVELOPMENT

by Andries Klasse Bos

This article must be seen as complementary to the article written by Mr. P. J. Shah of the Water Development Division. His article deals with the historical development of rural water policy and the main technical aspects of the new enlarged Government programme of supplying rural water all over the country. This article is concerned with the benefits of the rural water schemes under the new policy and with the financial aspects. The main outstanding problems are mentioned at the end.

I. Water Development in Kenya

Adequate water supplies have so far been made available predominantly to residents of urban areas. About 90% of the population live in rural areas. Less than 11% of the people who live in villages and rural communities are served by piped water supplies.

In the past there has been an unbalanced development in investment in water supplies between urban and rural centres. The level of investments by Central Government and County Councils combined in the rural areas and small urban centres has averaged less than £ 100,000 a year and in recent years has been decreasing.

However, recently the Kenya Government has become aware that the provision of rural water was lagging far behind other development activities and was hampering rural progress. In the arid and semi-arid areas water is considered now to be the key factor to promote progress of the people. The next five year Development Plan proposes that investment in rural water supplies should increase from £ 0.5 million in 1969 to £ 1.9 million in 1974, thus changing completely the investment pattern between urban and rural supplies. The main purpose of this increasing investment is not only to relieve people of the arduous task of fetching water, but also to improve production and health conditions.

II. Impact of Rural Water Supplies

Although the benefits from an improved water supply at near distance are often obvious they have not been proven empirically up to now. This is because there are very few existing rural water supplies and no evaluation has been done. For the same reason the schemes now being planned and under construction deserve the name "pilot projects." They have to prove the hypothesis that water is in many places a key factor for development.

The expected benefits are:

a) Direct economic benefit

This should arise in major livestock producing areas. A permanent water source near or on the farm will permit an increase in cattle (especially in grade cattle) and improve the production of milk and beef from the existing herd.

This will include the time released from water carrying of the farmer and his family. The actual benefit will depend on the farm size, the type of crops and the availability of labour to carry out essential tasks especially at peak labour requirement periods. Other important benefits may include better animal husbandry practices such as early planting and better weed control. In certain areas there will be a saving in money paid out for famine relief.

c) Health benefit

The new supplies will be more reliable and free from health hazards. A better health standard may increase the work capacity of people and hence production and income.

d) Social benefits

There are a number of benefits varying from the personal relief from the heavy job of water carrying to the collective benefits out of decreased urbanization, political stability, more balanced development of rural and urban areas. All these benefits are very difficult to assess scientifically. However, any research programme into the impact of rural water supplies has to take these into account too.

Apart from this superficial consideration there is very little empirical information in Kenya except for the Zaina Water Scheme. This scheme in Nyeri District in Central Province has been well documented and studied both on a longitudinal (a survey in 1961 before installation of the reticulation scheme and after, in 1965) and horizontal basis (comparisons with a control area not having a piped water scheme). The conclusions on health and economic benefits strongly support the thesis that water is a key factor in such an area. This area which is on the lower slopes of the Aberdares has many small streams and an agricultural pattern dominated by crops. It is not typical of those parts of Kenya where water benefits are expected to be highest. The latter are expected to be the range areas where water is needed for people and cattle which now walk long distances for water. For these areas no data on the impact of water exists and in the coming years this must be given due attention under the intended research programme on rural water schemes.

III. New Policy on Rural Water Supply

Since Government has launched the enlarged rural water programme it is a pre-requisite that a coherent and consistent policy be developed. This is the duty of the Inter Ministerial Committee on Rural Water Supplies, which was formed in February 1969. The old policy was on of delegating the responsibility to the County Councils. Without going into causes it can be stated that these were not in a position to construct, operate and manage the schemes satisfactorily, technically and financially. That is why the rural water programme has become the responsibility of the Central Government, under the Ministry of Agriculture. The Water Development Division is made responsibile for the planning and implementation; it will be also the Water Undertaker so that the operation, management and revenue collection will be its responsibilities.

following:

1. Communal points

The objective is the provision of basic communal water supplies within a 20-year period to all parts of Kenya and the provision of individual connections during the subsequent 10 years. Only in cases where a large number of farmers in a scheme apply for individual connections, and are prepared to pay in advance for the full cost of this extension of the scheme, will the Government consider individual connections earlier. But that means that other schemes have to be postponed as long as the technical capacity for construction is a bottle neck and this postponement conflicts with the objective of the programme.

2. Water rates

No water will be supplied free; the user has to pay right from the beginning. Past experience indicates that this may be a problem. In some cases the water has been supplied free after an initial payment for construction. This is the case with the WHO/UNICEF schemes (small schemes intended to have a demonstration effect.) The donor supplies the pumps and piping, people supply labour and additional cash, but are not expected to pay regularly for operation and maintenance. Some larger schmes were constructed by County Councils with assistance from ALDEV. These are financed in hard loan money, making the debt service (loan charges) the main part of the yearly expenditures of the scheme (sometimes up to 80% or 90% of the total yearly expenditures is only for interest and loan repayment). This resulted in high annual rates for the farmers (Zaina Shs.40/00, later Shs. 60/00; Kabara Shs 60/00, later Shs 80/00). In such schemes revenue collection lagged far behind the target. In the settlement schemes where, with foreign capital assistance, about 50 water schemes have recently been constructed, the rates are high and the years after a two year moratorium has expired will show how they will work out.

Because of no or bad payments for water in most existing schemes there is a general attitude that water is free. This resistance to payment is a problem which has been faced by the Inter Ministerial Committee and it has been seriously studied as to how this can be reconciled with the policy of Government that the user has to pay for the water. The problem is more difficult to solve where people are supplied by communal points. In these cases it is difficult to identify and enforce individual responsibilities.

Trying to be realistic in assessing water rates and suggesting methods of collection the Committee has developed guidelines for both, but leaving enough flexibility in adapting the measurements for collection to the particular circumstances of each area. These accepted guidelines are:

a) Rates will be assessed on the expected or realized benefits for the scheme area; not based on the (full) cost of each scheme. This will result in some schemes subsidizing the others. It means that a revenue-expenditure approach has schemes of a certain phase of the programme), not on a scheme basis. From a financing point it has to be decided which part of the cost of the programme has to be covered by revenue collection. Surely in the initial phase Government has to subsidize the scheme as it is accepted that:

b) In the initial period (two years) the rate will be low, in order to encourage use of the schemes and to prevent an early failure of the collection method. A sound economic reason is that the economic results out of water will only materialize - and with a time lag - if other inputs are developed together, e.g. introduction of grade cattle. For these inputs money is necessary and in charging for water use one might hamper the introduction of these imputs. This low rate assessing has been accepted by the Treasury.

3. Collection Methods

The chosen method for each scheme should be the most acceptable to the people. While retaining this flexibility a preference is expressed for a system by which the responsibility for rate collection is delegated to the people concerned. It will be applied in 1970 to the first scheme of the rural programme now under construction. The essential point in it is, that it relies on the community spirit by defining groups of farmers, each group being served by and responsible for one communal point(designed for some 20 farmers). The farmers of each registered water user grou will elect a leader to whom they will entrust the tasks of reporting breakdowns and of collecting their contributions of the group's monthly water bill, which is due for payment at the Chief's Centre. Differentiation in rates between members within a group is entirely the concern of the people of that group.

Some minor questions have not been solved including:

a.) Monthly rate or periodically (after crop sales).
b.) Flat rate without metering each point or charging on the basis of quantity of water used.
c.) Should the group chairman be paid for his task?

Items not yet studied satisfactorily but stated explicitly in the terms of reference of the Committee are:

4. Finance Policy

Government will revise the existing financial policy that is favouring schemes for which people's contribution has been shown, but which do not need to be the areas where water investment is most beneficial; one might expect even the contrary. This rigid £ for £ policy has to be changed by making it more flexible and widely applicable.

5. Scheme Selection Criteria

Well define criteria for the selection of water schemes do not exist. At present the schemes are brought forward by District Development Committees, with indistinct selection methods at different stages.

IV. Unsolved Questions

In policy making and in planning together with implementation of the rural water programme we envisage a number of important questions that have to be answered by continuous research during the first phase of the programme. These questions are:

1. What benefits have been realized in each of the main aspects? It is important to differentiate between certain types of areas like:

   Cropping areas

   Dairy and livestock areas

   Range management areas

   Another determinant for the benefit might be the state of development and relative welfare position of the people.

   Assessment of benefits has high relevance to:

   a. What priority should investment in rural water supplies have in comparison with other fields of Government investment?

   b. Selection of schemes as far as special criteria are concerned.

   c. Assessing water rates. Now the benefit criterion has been accepted to be the basis for that.

2. If a potential benefit of a scheme has not been realized or is jeopardized what are the causes and what is the solution.

   For integration with other activities it is important that the special Rural Development Programme starts soon. This Programme includes a comprehensive approach to all factors influencing development. Water supply is one of the factors with varying relative importance. During the evaluation of this Programme one will be in a better position to assess the overall contribution of water than in areas where water supply is treated in isolation.

3. What comes out of an evaluation of the agreed policy in stages starting with basic communal supplies followed by individual connections after some 20 years?

   a. Appreciation by the users themselves.

   b. National economic return on investment. What are the differences in return between investment in a higher number of schemes with only communal points compared with a smaller number of schemes, with individual connections.

c. Revenue Collection. It is envisaged that collection of water rates will be more difficult to realize from schemes using communal points then from schemes with individual connections.

d. What are methods of revenue collection that are sociologically, economically, and administratively most appropriate, and what are the constraints?

4. Consideration of the self help (Harambee) principles. In the past the self help contribution was the decisive factor for realizing a scheme (under £ for £ rule), so many poor areas which are unable to contribute suffered from getting no Government assistance. The Government continues to encourage self help contributions, so this might be made one of the selection criteria for new schemes.

In insisting on self help we must avoid the development of a free water attitude on the part of the people. A once and for all payment is not sufficient to maintain a water supply. It might be advisable to use the self help contribution only for part of the construction costs, the remainder could be used for working capital for recurrent costs during the first period when people would find it difficult to pay prior to benefits of the scheme accruing.

15th November, 1969

by Pravinchandra J. Shah

General

Since time immemorial women in Kenya, as elsewhere in Africa have been burdened with the task of fetching water for the domestic needs of a rural household. It is not uncommon to walk up to seven or eight miles to the source of water. This consumes a lot of energy and moreover such water is usually polluted and hence unhygienic.

Some 90 percent of the population of Kenya live in rural areas with less than 11 percent having piped water. Thus the majority of the rural population are exposed to the risk of disease and are prevented from realising their potential productivity by daily time consuming and arduous water carrying. A clean and easily accessible water supply is a pre-requisite to social and economic emancipation of the rural population.

History

Early water development was mainly concentrated in urban communities and Government out stations and Missions.

In the year 1946 the African Land Development Board (commonly know as ALDEV) was formed for the "Reconditioning of African Areas and African Settlement" under the Kenya Ten Year Development Programme 1946-1955, and, later in the period, for general development in the African Districts as part of the country's normal development activity between 1955 and 1964. From the very first years of the inception of ALDEV it became evident that the provision of an adequate water supply was a prerequisite to the initiation of any programme of land usage improvement. This paved the way for the first planned programme of providing water to rural areas. Most of the development was carried out in co-operation with the Local Councils; capital expenditure was borne by ALDEV while the responsibility for operation and maintenance was taken over by the Councils. During its 18 year life ALDEV carried out many water installations of all types in all areas of the country. New innovations like sub-surface dams and rock catchment tanks were successfully tried and developed.

During the year 1964, after Independence, ALDEV was closed down; its Administrative Division taken over by the Central Agricultural Board and its Technical Division integrated with Hydraulic Branch to form the Water Development Department under the Ministry of Natural Resources.

Until 1963 the Local Councils discharged their responsibility for operating and maintaining water supplies adequately but subsequently with great changes, after Independence Local Councils ran into financial and technical difficulties which caused reductions in expenditure with priorities given to items such as Education and Health at the expense of water. Until recently there was very little, if any, planned direction and input of capital from the Central Government.

A Government Policy Regarding the Financing of Rural Water Schemes was laid down in 1966. The Policy stated in part:

(a) Government will continue to provide assistance within the limitations imposed by finance and this assistance will take the following forms:

(i) Providing free technical service and advice.

(ii) Providing limited 100 percent grants for water supplies in poor areas for small schemes.

(iii) Providing partial grants (½ for ½) for small basic supplies in areas of low and medium potential.

(iv) Providing loans to County Councils for larger schemes through the Local Government Loans Authority.

(v) Providing subsidies for dam construction under the Dam Subsidy Scheme.

(vi) Providing a form of partial insurance against failure of boreholes drilled for agricultural purposes under the Borehole Subsidy Scheme.

(b) The sum available for partial grants (not exceeding ½ for ½) may be used by districts of low and medium potential for approved schemes as a supplement to funds raised internally from:

(i) Self-help groups.

(ii) Area and County Council contributions.

(iii) Assistance from WHO/UNICEF through the Ministry of Health

(iv) Missions, and

(v) Other sources, such as the Department of Community Development.

(c) In no case will the amount of Government grant exceed the sum raised by a self-help group and/or the council concerned.

(d) Loans are generally granted on the basis of repayment in 20 years at 6½ percent per annum, and are available to Area and County Councils as well as to co-operatives.

(e) It must always be emphasised to the people that any water provided for their use, by whatever means, must be paid for regularly by the user, and because it is a commodity which is required daily and in perpetuity, the payment must be on the same basis.

(f) People must not be allowed to think that because they have made a single contribution, either in cash or in kind, towards a water supply scheme, the water will be available to them free of charge in the future.

Unfortunately, much of the grant and loan money available was not taken up by the councils or self-Help groups due to inability to raise the matching finance or lack of technical personnel first to construct and then to operate and maintain the supplies. However some rural water schemes did come into being due to either the initiative of Local County Councils, UNICEF/WHO through Ministry of Health or Local Self-Help Harambee Groups. Most of the development was haphazard.

Impetus

An impetus to Rural Water Development activity resulted with the transfer of the Water Development Department from the Ministry of Natural Resources to the Ministry of Agriculture during the year 1968.

During February, 1969, after widespread expression of dissatisfaction over the prevailing state of affairs a Cabinet decision on Rural Water Development was taken which resulted in setting up of an Interministerial Committee on Rural Water Development. This Committee is charged to review all matters pertaining to rural water development and to recommend a course of action. This includes recommendation for a possible revision of the Policy Statement of 1966 on Financing of Rural Water Schemes.

New Objectives

The Government of Kenya has realised that the pace of Water Development is painfully slow in rural areas compared with development of other services like Education, Health, Communication and Agriculture. In fact the lack of developed water has the effect of inhibiting further advances in the general growth of the country.

This is especially the case in the agricultural sector where the ready availability of water supplies is essential to the development of small holdings, large-scale farms and ranches. The many trading centres in the rural areas which are expanding rapidly as a result of the rise in agricultural production also pose problems in water supply which must be resolved both for reasons of health as well as for the improvement in the living standards of the inhabitants.

The Government of Kenya through the Water Development Department has initiated a policy of providing communal water supplies throughout the country within twenty years. This programme requires an average annual investment of K£ 2 million. In the subsequent ten years (up to the year 2000) the effort will be directed towards bringing water to every individual farm and household.

In order to cope with the enlarged programme of rural water development a reorganisation of Water Development Department has been effected and a new Planning Section has been set up. The function of the Planning Section is to carry out development studies for proposed schemes, to plan activity and to prepare a master plan for the 30-year programme of water development.

Priorities for schemes are based on recommendations from District and Provincial Development Committees.

Present Programme

The present two year programme of water development about to be commenced comprises the construction of some 82 different schemes throughout the country at an estimated cost of K£1.13 million. It is considered to be a pilot exercise dealing with all types of water installations in different parts of the country. Different organisational procedures, designs, methods of construction, techniques of operation and maintenance and methods of charging water and rate collection will be tried out.

The programme will also test the ability of people in different localities to pay for water. The Economic Planning Division of the Ministry of Agriculture will work out water rates basing their calculation on the benefits resulting from the input of a water supply in a particular locality.

The formulation of the two year programme brought out various problems.

Problems

1. Finance

As in all underdeveloped countries there is a shortage of capital for development. This inhibits development activity which in turn prevents the growth of the economy which could provide the capital.

Development can be effected as a result of:

(a) internal capital raising effort. This may result in the gradual growth in development.

(b) injection of capital from international sources to be repaid over a long period from the growth in income thus made possible.

If method (a) is adopted then there is a danger that the water development may lag behind development of the other services like education, health, communication and agriculture which have a higher political priority; as is the case at the moment.

The shortage of the capital has resulted in an overall policy (though flexible) of distributing the available capital evenly throughout the country to avoid any accusations of favouritism.

2. Scheme Selection

The selection criteria for a scheme is based on two factors.

(a) Social necessity

(b) Economic feasibility

This criteria is then related to recommendations from District and Provincial Development Committees. Schemes based on purely a "Social necessity" factor with very little or no direct economic return are not given sympathetic consideration at the moment though the attitude may change at the deliberations of the Inter-Ministerial Committee.

3. Technical Staff

The enlarged rural programme requires substantial skilled manpower to carry it through. The shortage of technical staff is felt at all levels.

While engineers needed for planning, design or construction can be recruited from overseas or supplemented by volunteers it is quite difficult to get personnel of Inspector or Foreman levels who are needed in the field first to construct and then to operate and maintain the schemes.

The Consultants/Contractors can be engaged for the larger schemes. However, it is estimated that the cost of these schemes will jump up by as much as 25 percent.

It is unfortunately found that the local engineers do not remain steady in their jobs but move out to the Local Councils or the private sector where the salary scales are higher than those of the Government.

4. <u>Design Criteria</u>

a. <u>Consumption</u>

No simple rule has yet been evolved for rural consumption habits though it is considered that the consumption will be much higher for a gravity supply compared with a pumped installation. This is because the water charge for a pumped scheme will invariably be higher than for a gravity scheme due to very high operating and maintenance cost.

However, if the water charge is based on benefits only resulting from the input of a water supply then the consumption may remain the same for all types of water installations.

This, therefore, establishes a case for the water charges to be related to both benefits and consumption.

Consumption figures used for the design purposes at present are based on the ALDEV experience. These are:

(i) 100 gallons per day (g.p.d.) per farm (10-15 acres) for a gravity scheme in high potential areas.

(ii) 30 g.p.d. per family for a pumped scheme.

(iii) 10 g.p.d. per family in dry areas.

(iv) 5 g.p.d. per person is used for an average scheme.

(v) 5 g.p.d. per native cattle.

(vi) 15 g.p.d. per grade dairy cattle.

(vii) 1 g.p.d. per small stock.

b. <u>Communal Water Points</u>

The spacing of communal water points has to be such that it encourages the rural population to obtain piped water rather than fall back on the traditional source. Consumption will vary with the distance of a communal water point. There is likelihood of increased consumption if a communal water point is near.

The spacing of communal water points also depends on the population density.

The points, as a rule, are kept at a distance of:

(i) ½ to 1 mile in high potential areas

(ii) 1 to 3 miles in medium potential areas

(iii) 5 to 10 miles in low potential areas

c. Design

Every scheme has to be designed on its own merits but generally

(i) a gravity pipeline scheme is based on 24-hour average consumption

(ii) rising main for a pumped scheme is based on the hours of pumping (usually 15 hours).

The storage has to be provided for at least 24-hour consumption on every scheme. In addition 1000-gallon storage is to be provided at every communal water point.

The cost of providing storage on a scheme can be quite considerable and hence careful consideration must be given to ensure adequate storage at the minimum cost.

d. Treatment

Elaborate treatment is expensive and hence increased capital investment is called for which in turn increases the cost of water to the consumers. Operation and maintenance costs also go up.

However, if piped water is similar in quality to what can be found in rivers or streams it becomes difficult to convince people to pay for water which can be obtained free only a few miles away.

A simple treatment like sedimentation only at a minimum cost can improve the quality of water considerably.

Conclusion

Subsequently when the schemes become operative an overall appraisal will be made to evaluate the best methods of attacking the various problems involved in a rural water supply development in Kenya. It is hoped that the experience gained will facilitate a quicker and surer implementation of the Master Plan.

Mr. A. Klesse-Bos of the Economic Planning Division of the Ministry of Agriculture will describe in his paper the role of a water supply in the development of the rural areas.

My thanks are due to Mr. G. A. Classen, Assistant Director (Water Supplies) and Mr. [illegible]. E. Farrant, Assistant Director (Planning) of the Water Development Division for their kind assistance in the preparation of this paper.

"The provision of adequate water supplies to rural areas is of high priority on both economic and social grounds". (Tanzania Second Five Year Plan)

"The provision of fresh water for human consumption and for livestock is a fundamental requisite to any development programme" (KANU Manifesto - November, 1969)

These statements must surely rank as a declaration of faith rather than fact for at present very little is known about either the economic or social benefits of improved water supplies. On the cost side much more is known because we are dealing with visible structures. In recent times there have been a few empirical studies of the impact of water supply, notably those by Warner (1969) and by White and Bradley (1970?). However, at present, only preliminary results are available and we must await definitive conclusions.

It is extremely surprising how far faith can be used to promote programmes for rural water. In Tanzania water development and irrigation are scheduled in the Second Five Year Plan to absorb Sh.187 million, 6.8 per cent of development expenditure in a higher proportion than all divisions except for investment in roads and aerodromes, another area where faith plays its part. According to the KANU election manifesto Kenya will spend Sh.164 million on the rural water programme during the next five years. Rural water clearly has some special appeal to investment decision makers. The full reasons are difficult to establish. It could be esthetic objections to visions of dirty water, it could be anticipated avoidance of disease or it could be effective engineering pressure groups.

Another possibility is that it is a visible project with wide public appeal and hence considerable political capital is likely to accrue. The apparent favour of these programmes with aid-donors would suggest that this latter explanation is a correct one.

Water is considered by many to be uniquely important as without it all life is impossible but an economist accepts no such arguments. Even if water is elevated to 'merit want' status economists have the task of finding the costs of such elevation for inevitably resources are diverted from alternative programmes. In this paper explicit questions are raised in order to draw upon the experience of participants.

It is difficult to judge how planners were able to allocate substantial sums to rural water programmes, with any confidence, if the data availability is considered. In many respects the research that has been cited is just a beginning. In a sense existing surveys of impact or benefits are pilot surveys testing broad concepts. As a result of these surveys we are now in a position to consider their evidence and formulate reasoned hypothesis for subsequent empirical testing. One useful function of this workshop would be to examine such studies as exist and derive hypothesis that require further investigation.

Data is required to aid decision making. We need to answer questions of whether or not to invest - yes or no, how big, when, where and how. In order to meet these requirements we need to know more precisely the criteria that have to be satisfied. For instance in relation to 'how' do we require communal points, metered or not, supervised or unsupervised. Thus each major question stimulates a number of sub-questions. These sub-questions are not related solely to one point such as location or timing. There is considerable overlap and interdependence which makes a paper such as this difficult to structure. However this topic has been tackled because we realise the importance of informed judgement transport, salaries etc., and indirect (foregone opportunities for skilled personnel).

It might be thought by advocates of rural water investment that further investigation is unnecessary because substantial sums are already being allocated to the programme. However we must dispute this stance for it is possible that a misallocation of resources has occurred. It could be that the total investment in the programme is greater than or less than optimum. In addition the investment may be chanelled into the wrong form of water supply - say, communal points rather than individual connections.

Analysts of spending patterns of Government, when compared to budget allocations, will note that planned expenditure is seldom being achieved. This is partly because of shortage of materials, delayed delivery dates and inadequate staff. But this is not the whole story for part of the slow spending is because many decision makers are as yet unconvinced of the efficacy of improved water. In particular the traditionally conservative controlling Treasury may show its unease by delaying sanction to use budget allocations. It is therefore important that advocates of rural water investment demonstrate the real value of their programme. They must show costs and benefits so they can be compared to alternative investment opportunities. They must also show that technical and administrative and legal machinery is adequate for the proposed programme. Also they must indicate useful social effects and the political priority as indicated by relevant interest groups. Financial prospects have to be specified and be realistic in relation to resources available. A proposed method of rating and collection must follow the principles of taxation - it must be acceptable to the recipients, there must be some certainty of collection, collection must be enforceable and costs of collection should not exceed revenue.

Sampling Problems

Data has to be collected in order to derive criteria or rules that are applied to a decision-making problem. The area of data collection should be related to the importance or ranking of the criterion, the variability within the population being examined, the likelihood of measurement error and cost of and resources available for collecting the data. If for instance it is anticipated that a particular water source may not be used, even when low-cost clean water is available, sociological investigations should receive priority. If it is known that poor repayment prospects are likely to put the whole programme in jeopardy then methods of assessing costs and physically collecting revenue should be tackled.

Having decided upon the priority areas it is then necessary *to determine the data requirements. What size of sample should* be chosen for investigating a particular problem. For instance if it is necessary to know water consumption per head throughout a particular region, what size sample must be drawn. From general knowledge it is possible to stratify into sub-areas: cash crop zone, subsistence crop zone, mixed cultivation and livestock zone and livestock grazing zone. In the survey two types of error can be anticipated. First sampling error and secondly measurement error. Unfortunately there is generally an inverse functional relationship between these errors. With a given budget a small sample minimises measurement error as the interview or survey can be long and thorough. On the other hand a large sample minimises sampling error but increases measurement error.

Sampling should be related to known variability from pilot studies. To equate sampling error within sub-areas large samples should be chosen where the standard deviation of observed phenomena is high. With regard to measurement error emphasis depends mainly upon the possibility of improving accuracy with additional questions.

Two surveys were conducted this summer by the Ministry of Agriculture in Kenya. In the first study the objective was to discoverthe standard of maintenance and it was considered that this is best assessed by a large sample of schemes. However to estimate benefits a small survey in depth was chosen of two areas, with and without piped water. In the event the survey indepth failed to achieve its objective because the control area proved to be less typical of the region with regard to water development in that 26 self help groups were found to be operating in one location (20 square miles). This was because of vigorous promotion by the local chief.

Another dilemma illustrated by this second survey was that it was not possible to ascertain precisely the relative position of the study areas before water was introduced. It is important to have 'before' and 'after' information for project areas and control areas but it is unusual for such foresight to occur.

Even where it does occur it is normal for an increase in complementary resources to occur in project areas. Both physical inputs - credit, grade cattle, fertilizers, etc, and advisers- health workers and agricultural extension workers are more concentrated in these areas. It could be that there is a complementary response between water and other improvements but it is important to ascertain whether improved water is in fact essential, or, whether the other resources alone or improved water alone are sufficient in themselves to promote development.

Often decision makers have to obtain data quickly and therefore at present have to rely upon 'horizontal' studies taken at a point in time. Here the basic assumption is that project and control areas differ only in regard to water supply. This is an heroic assumption for it may be that an improved water supply is a symptom rather than a cause of development. High incomes may lead to an awareness and effective demand for improved water supplies. Where schemes have been super-imposed in a region by government it is more likely that a control area could be found that will give a useful "horizontal" base.

Practical Problems

In the Kenya Ministry surveys the following problems occurred. These were not unusual for a survey in rural areas but it may be somewhat unusual to acknowledge their existence. The main problems were as follows:

(i) questions not fully understood in translation;

(ii) no answers to questions relating to embarrasing subjects e.g. diarrhoea;

(iii) answers given by farmers to please questioner; e.g.'water is boiled in this house to kill disease'.

(iv) lies given for various reasons;

(v) inaccurate approximations given or quick answer to get rid of questioner;

(vi) concept of time and distance sometimes difficult for farmers;

(vii) quantities harvested, area of crops unknown;

(viii) fear of questions e.g. increased water rates, taxation, etc.;

(ix) women at farm don't know, fear questions or refuse to answer e.g. questions relating to money and cattle.

In this discussion emphasis is given to issues in economic and financial appraisal which though important do not necessarily rank higher than other aspects. Recent studies have enabled us to identify key assumptions behind our programmes.

Let us consider the statement that benefits from improved water supplies can be identified as economic, health and social benefits. These are not exclusive categories but inter-related. What is an improved water supply? Is it safe water, accessible water or both? Is stream water or spring water 'safe' or must it be chlorinated and filtered? Is accessible water essential to ensure ample supplies are used? Is the proposition of Professor White valid that water is only used in large quantities if it is present in the household working area. This has important implications for design (and also research as it means data on this need not be collected). If it is essential to have large quantities of water to obtain benefits and if carrying any distance precludes this then individual connections are necessary. However costs of individual connections are roughly three times private connections therefore for a given budget only one third of the families can be served. If small quantities of safe water are 'good' are large quantities much better? In other words are there increasing, constant or declining marginal returns to water? Are large quantities of moderate quality water better than small quantities of safe water (the dilution theory)?

Economic benefits can be identified <u>a priori</u> as possibly resulting from:

- (i) release of labour from carrying and from sickness for productive use;
- (ii) facilitating zero grazing or paddock rearing of grade dairy cattle;
- (iii) improvements in household and dairy hygiene;
- (iv) small scale irrigation or seed bed maintenance;
- (v) improved spraying with clean water.

Health benefits might accrue because of a reduction in incidence of communicable intestinal diseases, typhoid, intestinal parasites, infantile diarrhoea and trachoma. These might result in savings in health expenditure, increases in daily labour productivity and reduction in infant mortality and a longer working life. These benefits require further investigation before it is possible to quantify or even put confidence in their relative importance. It could be that funds for preventive medicine are limited. Are returns to alternative forms of preventive medicine higher. e.g. mass polio, tetanus BCG or '3 in 1' vaccination. Simply subsidising rubber boots might improve general health levels more in some areas, for a given outlay, than improved water supply. Again we wish to know whether improved water is sufficient to achieve health benefits. Is a programme of disposal of waste just as important?

<u>Recognition and measurement of benefits</u>

It is necessary to consider whether recognition and measurements are necessary to evaluate the benefits of rural water investment. Measurement implies quantification normally in terms of money equivalent. It is impossible to put a value upon a health benefit that results in a man feeling well and fit. Nevertheless these types of benefit are real. However they do not necessarily stimulate development. Should we be prepared to forgo current welfare effects for the delayed welfare effects and presumably larger benefits that emphasis upon development inputs implies.

It is difficult but not impossible to calculate benefit-cost ratios for rural water investment once we have data for reasonable estimation and forecasts. We also have to solve the usual problem of the form of the calculation, discount rate, lifetime, rate of growth, etc. We should not avoid the real problems involved in attempting appraisal for it is a powerful tool to aid decision-making. In the transport field good progress has been made in tackling similar problems.

Finance

As already indicated practically all Governments will be influenced by the response of the beneficiaries to improved water. One important measure of the value placed by beneficiaries is the amount paid for the service. This is not an absolute measure for in a poor community benefits could be high but payments poor. In a rich community it is possible for the same situation or the reverse to occur. Collection measures may be defective resulting in low collection and generating a tradition of non-payment that is difficult to break.

It is important to determine a sound pricing system. In principle rates should be related to the marginal cost of supplying the service. With water supplies overhead charges are high in relation to total costs and therefore only a proportion of the total cost of supply can be directly allocated to a particular unit of output. It is difficult therefore, to determine exactly what is the actual marginal cost. It is possible to regard the investment costs as sunk costs and to optimise the use of the capacity, price could be set equal to the short-run marginal costs which are virtually zero in gravity schemes. However this would lead to a growing deficit on the capital account. Therefore a more pragmatic approach is generally adopted and long run marginal costs or some arbitary proportion of total costs charged.

In any event there arelikely to be practical problems in relation to finance. If charges were effectively imposed, and especially if rating was on a volume basis, facilities could be under utilised. In the case of communal points it might be difficult to identify beneficiaries. In cases of pollution it might be fairer to charge the polluters for downstream works made necessary because of their activities. In the early years of a project it might be necessary to adopt promotional pricing in order to encourage farmers in its use. However with discounting procedures low revenue in early years carries great weight and low rates of return result. In addition it may be difficult, for political reasons, to raise rates later once subsidised rates are the norm. There are also all the usual problems of collecting revenue from agriculturalists who suffer from widely fluctuating production and price conditions. Finally there is the problem of equity. The repayment capacity of rich areas or unproductive users (e.g. bars) may be high but small-scale farmers who stand to benefit personally might have low or even zero capacity.

It is the contention of the writer that successful finance is a key area if the rural water programmes are to continue at their present high level and that to date insufficient emphasis has been placed upon methods of assessment and rate collection. It is impossible to theorise in this area and therefore experiments of a variety of methods must be undertaken and the results carefully analysed.