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SOCIOLOGICAL ASPECTS OF IMPROVED WATER SUPPLY IN THE COAST REGION

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Introduction:

1. The Sociology of Human Water Supply

As a result of the rapid expansion of the world's population the pressure on water resources has become more and more a cause of concern. Small and scattered populations could in the past subsist even in areas where water was scarce without disturbing the ecological balance. Nowadays such populations have increased manyfold and may find themselves in overcrowded urban areas without adequate water supplies, or encroaching on marginal areas where intensive land-use sets off the process of erosion and degradation of the land.

Because of this development human watersupply is no longer a self-evident matter, but a problem that demands adequate technical solutions. At the same time, however, there has been increasing awareness of the fact that the problem of water is not merely a technical problem, but also very much a human problem. It is not just a matter of feeding the required amount of water into a certain population. Many human variables intervene both at the supplying side (design and construction, economic feasibility, political priorities) and at the consuming side (factors determining the pattern of water use, effects of shortages, impact of improvements, settlement, population growth, etc.).

In recent years a number of sociologists and public health experts have occupied themselves with the social aspects of human water supply. Much of this work has been done in East Africa (White, Bradley, White 1972; Saunders and Warford 1976; Feachem, McGarry, Mara 1977; Feachem et al 1978). Although a considerable amount of insight and data have been obtained, many of the major questions have not yet been answered conclusively. What are the factors determining the patterns of water consumption and what is their relative importance? What are the benefits of improved supply systems? Will people use more water, be more productive, be more healthy? To these and many similar questions only partial answers can be given at present.

Sociological study has mainly concentrated on the water consumption aspect, i.e. looked at things from the point of view of

the user. This has resulted in studies of patterns of water consumption, and of the impact of improved water supply systems. There is a wide range of topics involved here, such as the impact of poor water supply on health, standards of living, and productivity, the parameters influencing the amount of water used in the home, and the benefits that result from improved water supply. Our study of water consumption in Mbezi village contributes to the still scanty data on water consumption (Bantje, forthcoming).

The present paper concentrates on the benefits from improved water supply schemes in the Coast Region of Tanzania. It discusses the presumed benefits from water development and argues that their realisation does not only depend on the existence of improved schemes, but on their functionning in relation to the population that depends on them. Problems in contruction, operation and maintenance are discussed and possible improvements examined. Particular attention has been given to the potential role of popular participation in attempts to ensure a better functioning of water supply systems.

Data on piped water supply systems in the Coast Region were initially collected during a BRALUP survey in 1976, conducted by Gerhard Tshannerl and Mark Mujwahuzi. These were supplemented with data from a village survey in 1977 by CBA engineering Ltd. in the context of their Water Master Plan study. This paper presents some of the findings of these surveys. It is a slightly modified version of a chapter of the sociological input in the Water Master Plan for Coast Region.

2. Benefits from Improved Water Supply: Some hypotheses.

If large amounts of money are invested in the construction of rural water supply systems one naturally wants to know what benefits the people derive from these investments. Such benefits may be of various kinds: health (reduced incidence of parasitic diseases); social (less time spent by women on drawing water and therefore more time available for domestic activities) or economic (released labour and improved health contributing to increased production).

Two fears are often expressed in this context. The first is that people will not accept the new water supply and continue to use old sources. This fear is based on the presumed inability of people

to understand the value of a good water supply. From the literature (BRALUP 1970) there appears to be little ground for such fear. If people do continue to use old sources there are good reasons for it. Either the new supply is inadequate, resulting in queueing at the water points, or the quality of the water is perceived as inferior to that of the old sources (usually in terms of taste and colour).

The other fear (which is in direct contradiction to the previous one) is that the new water supply will attract people from a wide area and thus will become inadequate very soon. This phenomenon may occur in arid areas, and particularly in the case of nomadic pastoralists. In the Coast Region an increase in size of the larger settlements has made many of the supply systems inadequate. However, this increase was not due to spontaneous movement towards better water supplies. When people were resettled during the villagisation, the presence of improved water supply systems in some places has been a reason to direct them there rather than elsewhere.

The whole problem of measurable benefits from improved water supply systems is still unresolved. Not because it is doubtful that there are such benefits, but because it is so difficult to measure them. For example, the improvement of water usually goes hand in hand with other changes and the importance of the different parameters is hard to assess. Released labour is absorbed in the pattern of daily life in a diffuse way and time spent on various activities is difficult to measure. A poor water supply is only one of the factors endangering health, and the removal of this factor without improvement of the others may not result in any measurable changes in the health status.

More and more evidence accumulates to show that the benefits from improved water supply are easily overestimated. While water supply is a limiting factor, other, equally limiting factors will have to be changed also to realise the full benefits from water development.

In 1970 a summary report by BRALUP (Water development - Tanzania, research paper n. 12) listed 14 hypotheses that are commonly brought forward in connection with the benefits derived from improved water supply. They can be divided into 3 categories:

improvements in water use; social and health benefits; and economic benefits. We briefly discuss these hypothesis in the light of the evidence obtained from the Coast Region.

A. Improvements in Water Use

1. The quality of the water supply improves

Already in 1970 some concern was expressed that the quality of improved supplies is not always as good as one would expect. Analyses of the bacteriological quality of water sources by CBA engineering showed that the quality depends on the type of source. When the source is a borehole (4 cases) or a properly located lined well (11 cases) faecal coliforms were absent or very rare, and total coliform counts were lower than in other types of sources. However, when the source is a lake, reservoir, river, or inadequately protected well, faecal coliforms ranged from 4 - 2,000 per 100 ml. and total coliform counts from 32 - 4,000 per ml. Therefore, 33 of the 48 piped schemes in the Coast Region take their water from sources of poor bacteriological quality.

The chemical quality is good to acceptable in most of the region, but poor in the NW part of Bagamoyo district. In one village near the boundary of Kisarawe and Rufiji people stated that they use water from the piped scheme for all purposes except for drinking, because they find the taste too salty.

2. The amount of water used increases

There is still insufficient evidence to substantiate this assumption. In some cases an increase has been found, but in others not (Warner 1969). Our own research in a village only 10 km. from Dar es Salaam, and with a reasonably good piped water supply, has shown a low rate of consumption (Bantje, forthcoming). Water availability is only one factor influencing the rate of consumption and considerable differences must be expected to occur between areas and between households. One of the main findings in the Coast Region has been that the number of outlets of a piped scheme is often the limiting factor on increased water use.

3. Improved supplies are more reliable

Traditionally people's dispersed habitat was mainly determined by the presence of reliable water supplies. Although unsatisfactory from other points of view these were not subject to breakdowns, pipe damage, seasonal shortage and the like. Under the present settlement pattern people have to depend to a large extent on the improved schemes, and are therefore subject to the vulnerability of their technology. As will be pointed out, the majority of people depending on improved supplies still have to go back to unimproved sources from time to time.

B. Social and Health Benefits

1. The distance travelled to obtain water is reduced.

This is always true forthe dry season, but often not for the wet season when water may be found very close to the home. This point also has to be seen in connection with changes in the settlement pattern. As will be pointed out later on, in many cases the improved supplies in the new villages are inadequate and too far away from the homes, so that the reduced distance benefit does not occur.

2. Less time and energy are spent on fetching water.

When walking distances decrease obviously less time and energy are required. However, in some cases this gain is obliterated by the time lost in queueing up at the tap. The effects of saving time and energy are hard to measure, except in extreme cases.

3. The time and energy saved by using improved supplies will be put to productive use.

This is the kind of naive assumption about rural water supply which completely overlooks the complexities of village life. Different types of (e.g. agricultural) activities have their own labour requirements, and these are often seasonally determined. There is no linear relationship between one and the other so that time saved on one activity is transferred to one other activity. Rather, time and energy saved will be absorbed in a diffuse way in various (e.g. domestic) activities. This is not to say there are no benefits. More time spent on food preparation or child care may be very beneficial.

But it is practically impossible to demonstrate such benefits. At the peak of the agricultural season the labour released from fetching water may be transformed into agricultural labour, but again this is almost impossible to demonstrate.

4. Improved water supply will result in better health

A number of the common parasitic diseases are water related and the assumption that better water means betterhealth has therefore often been made. Some skepticism about this has been expressed long ago (e.g. Warner 1970 : 12) and in any case such health benefits would be extremely difficult to evaluate. In the Coast Region for example, the quality of existing medical statistics is insufficient to make any detailed comparisons possible.

Recently more detailed research (Feachem 1976 : 175-178) has added new evidence to the view that the health impact of improved water supply is probably less than has been commonly assumed. It also points to the overall hygiene of the village environment under hot and moist conditions as a serious disturbing factor, as well as the fact that in East Africa the period of food shortage (just before the harvest) often coincides with the period when climatological conditions are most favourable to the survival of parasites. Inadequate food hygiene in hot weather is another possible disturbing factor. These explanations why water improvement does not automatically bring about health improvement still have to be verified, but they point to the overall conclusion that water supply improvements cannot be discussed without taking the overall village environment into consideration.

C. Economic Benefits

1. Improved water supply will stimulate activities like animal husbandry, fish breeding and vegetable growing.

Again this is a typical text-book benefit for which virtually no evidence can be found. For one thing the capacity of most schemes in the Coast Region is so small that excess water is simply not available. The irrigation of gardens on any scale requires vast amounts of water. Only in 3 villages in Rufiji district some attempts with irrigation from the water scheme have been reported.

Some fishing is done in the reservoirs created for water supply purposes. But their small size and seasonality make them rather insignificant in this respect.

The relationship between water supply and animal husbandry is complex. In Bagamoyo district the facilities for watering cattle from the water schemes are very inadequate and as a result cattle are watered in the reservoirs, where they pollute the human water supply (e.g. Miono, Lugoba). Water for livestock should be seen in direct connection with grazing. So as to avoid overgrazing of the land near the waterpoint, a circuit of dispersed water-points is needed which should allow the heard to make optimal use of the available grazing areas. The fact that officials without a pastoral background often misunderstand these principles of the pastoral mode of production has put much pressure on the Baraguyu pastoralists in Bagamoyo district and hampered their economic development. Besides water, veterinary services and the freedom to maintain a semi-nomadic way of life are just as necessary (Ndagala 1974).

2. Water development will stimulate secondary economic activities and overall rural development.

This is another hypothesis for which there is no clear evidence. In as far as water supply is a limiting factor to development its improvement will be beneficial. But it is hard to see how water development alone will stimulate economic activity if no incentives are created.

The conclusion of this review must be that while some of the hypotheses have been found to be true at least in some cases, some others are likely to be found untrue or almost impossible to verify. The reason is that most of the hypotheses have been developed by isolating water supply from the total context of factors that make up the social and physical environment. Doing so leads to overestimating the generative power of a proper water supply, and therefore expecting too much benefit from relatively minor improvements. Whereas a bad water supply is demonstrably dangerous, a safe water supply does not eliminate all the other environmental hazards. Because in Tanzania the political decision has been made to provide the rural population with improved water supply the energy of scholars should be spent perhaps less on evaluating the benefits of

these improved supplies, and more on analysing the circumstances that compromise such potential benefits. We shall show in this report that for various reasons a number of the water supply schemes are not functioning as well as they should. Whatever benefits could be derived from them are therefore not fully realised. There are indications that the Coast Region presents a rather favourable picture in comparison with other regions. Applied research to improve the operation and maintenance of water schemes is as much needed as the construction of new schemes.

3. Problems in Achieving the Target of Universal Improved Water Supply

Under the traditional pattern of dispersed settlement the unimproved water sources in many cases left much to be desired. The improvement of water supply has therefore been propagated by public health experts for a long time. However, as the population concentrations were usually small the capacity of the water sources could also be small, and the risks of the spread of communicable diseases was limited.

With the concentration of people in villages a whole new dimension has been added to the problem of rural water supply. First of all the promise of good water supply has been used as an incentive for the resettlement. The construction of improved rural water supply has therefore become a political necessity. Under the Third Five Year Development Plan considerable sums of money will again be spent on this. Secondly, large population concentrations need water sources with a sufficiently large capacity. The traditional water holes rarely have such a large capacity and the construction of larger mechanized schemes becomes a necessity. Unfortunately the construction of water supply schemes has lagged far behind the villagisation and in many cases serious water problems have been created by the concentration of people in villages. Thirdly, the hazards to health become very much greater if a large number of people share the same unimproved water source. The danger of faecal contamination increases and once it occurs large number of people may be infected in a short period. The recent cholera epidemic should be taken as a warning that the danger of such infections is very real.

The whole emphasis in the matter of rural water supply has therefore been shifted from the desirability of improved supply to the imperative need of providing any water at all to those settlements who now experience great shortages of water. The government is trying to establish its priorities accordingly.

It should be pointed out here, perhaps, that there appears to be a widespread confusion between the existence of water supply systems and the availability of water. All too easily is it assumed that once a water supply system has been constructed all problems are solved and little or no further action is required. As we shall point out in the following paragraphs the reality is quite different. There are at least three fields of problems that need to be examined in this context.

First there is the problem of water availability and design. In many cases water supply systems have been constructed in such a way that they function properly in the wet season, but inadequately or not at all in the dry season. Occasionally a supply system is found that does not even function properly in the wet season. Reasons for this may be an inadequate assessment of the water availability, or mistakes in the design and the construction. As these are all technical matters we shall not elaborate on this point.

Secondly there is the problem of operation and maintenance. This affects particularly the pumps. Regular maintenance visits are paid to few of the pumping units and the system of reporting breakdowns and getting them repaired is cumbersome and slow. As a result pumps may be out of order and the supply system inactive for long periods. Data will be presented on this below, and also on the activities of the pump operators. All the same, it was found that the situation in the Coast Region in regard to the condition of water supply systems was favourable in comparison with that in other regions.

The third field of problems is that of population concentration and growth. In the process of villagization many settlements have become so large that previously installed water supply systems are no longer adequate, for they have to serve up to four times the population they were designed for. Expansion of these schemes is not always possible because of the limited capacity of the water source.

After a brief description of the existing piped water schemes we shall go deeper into the fields of problems that thave been outlined above.

4. An Inventory of Piped Water Schemes

In June 1976 BRALUP did a survey of the 48 piped water schemes in the Coast Region. This section is based on data collexted during that survey, supplemented with some data from the village survey conducted by CBA engineering Ltd. in 1977.

The purpose of the BRALUP survey was to analyse some of the problems that occur with the piped schemes, and to see how these could be improved upon. Technical descriptions of the schemes have been given in the Water Master Plan report by CBA engineering, and are therefore kept to a minimum here.

The main elements of each scheme are the watersource, the intake structure, the pump, the storage tank, and the supply system. Each of these may give rise to certain problems. We shall discuss these in the next pages.

Table 1

Distribution of Schemes.

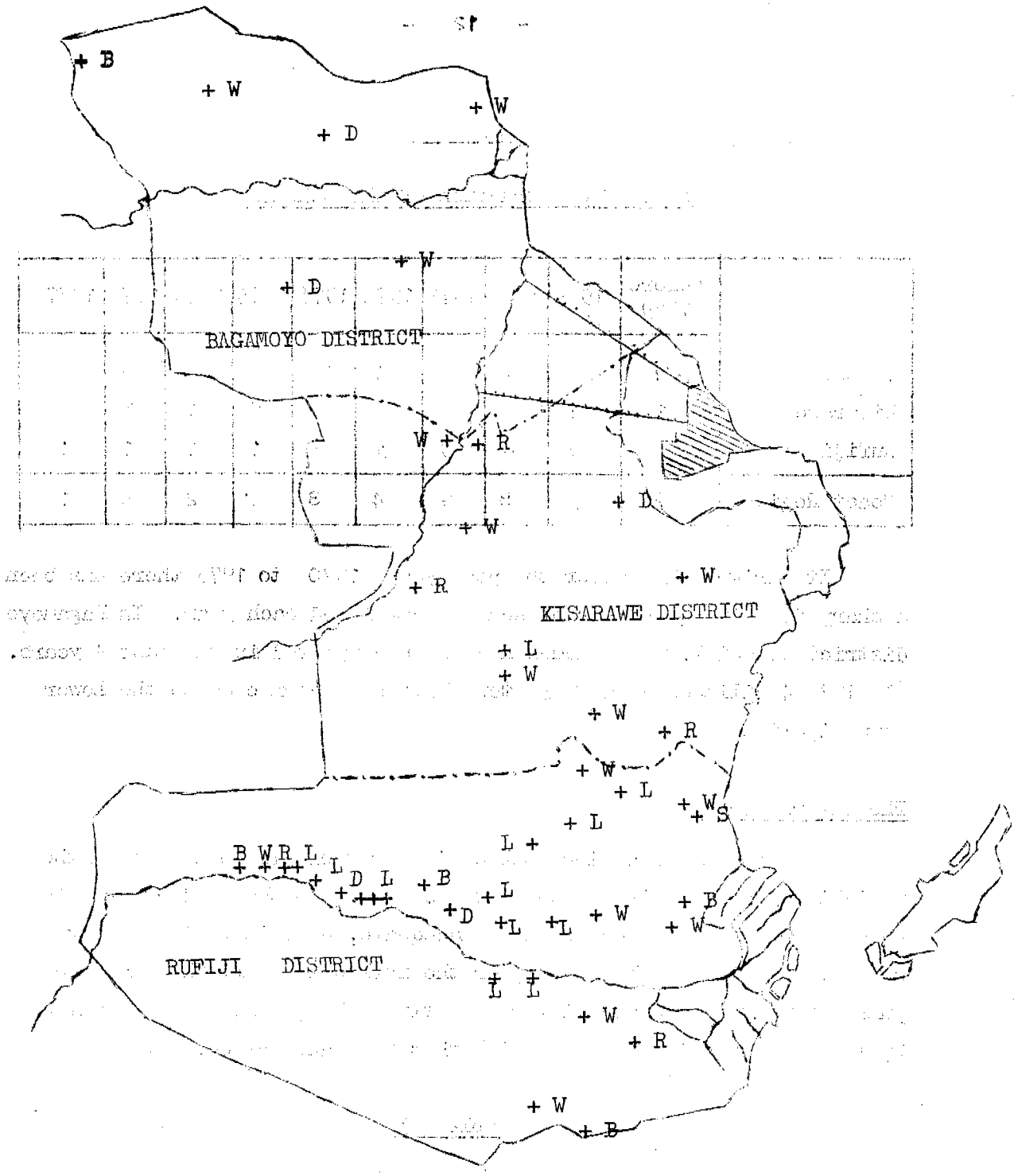
The distribution of the piped schemes over the Coast Region is shown on the map. We find the following distribution:

Bagamoyo District	6
Kibaha/Kisarawe Districts	13*
Rufiji District	29
REGION	48

*3 of these are also connected with the Upper Ruvu Pipeline.

In addition 19 villages are provided with water directly from the Upper Ruvu pipeline (8 in Kibaha, 4 in Dar es Salaam), while 4 villages and Bagamoyo Town are served directly from the Lower Ruvu pipeline. These villages are normally assured of a continuous water supply, although the inadequate size of the supply system is a real problem in some cases (e.g. Mlandizi).

Kilindoni on Mafia Island also has a piped water scheme, but this was not included in the BRALUP survey.



LOCATION OF PIPED WATER SUPPLY SYSTEMS IN THE COAST REGION 1978

S = Spring
B = Borehole
W = Lined-well
D = Reservoir
R = River
L = Lake

= Ruvu pipelines

Table 2

Year of Construction of the Schemes

	Before 1969	1969	1970	1971	1972	1973	1974	1975	1976	1977
Bagamoyo	1		2		1	1				
Kisarawe	1	1				2	5	1	3	
Rufiji		2	6	9	3	5	1	1	1	1
Coast Region	2	3	8	9	4	8	6	2	4	1

It strikes that after the peak years 1970 to 1973 there has been a sharp drop in the number of schemes completed each year. In Bagamoyo district especially no schemes have been completed in the last 4 years. (In 1978 4 villages + Bagamoyo Town have been connected to the Lower Ruvu Pipeline)

The watersources

The success of a piped scheme is first of all dependent on the reliability and quality of the water source. In the project area the watersources of many schemes are inadequate, especially in the dry season. Dams and wells dry up, or the inflow is so little that the pump can only be operated intermittently. The problem is aggravated by the concentration of population that has taken place.

Table 3

Type of Source Used

	Well	Lake	River	Borehole	Spring	Reservoir	Total
Bagamoyo	3	-	-	1	-	2	6
Kisarawe	4	3	2		-	1	10
Rufiji	8	16	1	3	1	-	29
Coast Region	15	19	3	4	1	3	45

Intake structure

Two schemes have their intake directly from the river, and two directly from a lake. In the other cases where water is taken from a river or lake the intake is in the form of a lined (but not closed) well. In two cases the pump has to be moved down to the water in the dry season.

Pumps

The breakdown of pumps is probably the most frequent single cause of the failure of water supplies. Only two schemes (Kisarawe and Kilindoni) have electric pumps, all the others have diesel pumps. Sixty five percent of the schemes have more than one pump, but frequently one pump is permanently out of order so that temporary breakdowns of the main pump cannot be dealt with.

Storage

All schemes have storage tanks and usually in good condition, However, in cases where the supply of water is inadequate no water reaches in the tank at all. All tanks are relatively small, designed to bridge periods of peak demand, but not days of pump failure.

Size of the supply systems

The number of people that can be served by a supply system depends on the number of outlets. The size of the supply systems is therefore measured by the number of outlets. Only public taps have been counted. In some places there is a small number of private outlets, which are disregarded here.

Table 4

Size of Supply Systems

	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	Average
Bagamoyo	2	1		2		1				12
Kisarawe	1	3	4	4	1					15
Rufiji	-	5	12	6	3	-	1	-	2	19
Region	4	9	16	13	4	1	1	-	2	

Treatment

Whereas the water in the main Ruvu pipeline is treated at the source, the water in most of the other schemes is not treated. Only the schemes in Kibiti, Utete and Kimbuga have provisions for sand filtration. Details on water quality have been given elsewhere.

Facilities for washing and bathing

In none of the schemes special facilities for washing and bathing have been constructed.

Provisions for livestock

Out of the 7 villages where cattle are present only 2 have a sufficient number of troughs so that cattle can be watered without polluting the human water supply. Three other villages have some (but inadequate) provisions, whereas two have no provisions at all.

In the villages where there are only goats no provisions have been made at all.

Irrigation

Three villages in Rufiji have reported small scale irrigation with water from the scheme: Hanga, Mtunda and Mkongo.

5. Operation and Maintenance:

All schemes have been constructed and are supposedly maintained by the Ministry of Water, Energy and Minerals ("Maji"), with the exception of the scheme in Kingupira (Rufiji), which belongs to the Ministry of Natural Resources and Tourism.

All independent schemes (i.e. not including those branching off from the main Ruvu pipelines) have one or two resident operators or pump attendants. Three schemes were found to be without at the time of the survey. 34 schemes had one operator and 8 schemes had two. Thus in total 50 pump attendants were employed at an average salary of 400/= per month, sothat the cost of pump attendants alone in the Coast Region Tz.Shs.270,000 per year.

The activities of the operators are generally limited to switching the pumps on and off and keeping an overall check on the

system. Their role in the actual maintenance is very minor. In 24 out of 41 cases (56%) some simple tools (no more than a few spanners) were available to the operator to effectuate minor repairs. But only three schemes reported the presence of some simple spare parts, ? in Bagamoyo and 1 in Kisarawe.

The operators have to report all defects to MAJI and to wait for a technician to come and do the repairs. This can take up to several months.

In view of the fact that so many of the defects are minor (like leaking or broken taps) there is certainly much scope for improvement in this situation. Moreover many of the operators expressed their disappointment at the fact that they did not receive more training from MAJI, so that they would be able to repair the pumps themselves.

Absence of operators

It has been found that in most cases the operators have to travel to the district capital once a month to collect their salaries. Often this involves an absence of several days from the scheme. In the many cases where there is only one operator this means that the scheme comes to a standstill, because there is inadequate storage to bridge several days.

Breakdowns of pumps

Breakdowns of pumps occur rather frequently, causing schemes to go out of operation. This problem is partly circumvented by the presence of several pumps at 65% of the schemes (although in several cases the second pump is old and permanently out of order). So, at least half of the schemes are very vulnerable. The information on the actual halting of the water supply because of pump failure is incomplete, but the following table gives an impression of the frequency of breakdowns. As can be seen more or less frequent breakdowns are reported from at least one third of the schemes.

Table 5

Frequency of Breakdown of Pumps

	Very frequent breakdown 1x/month or more	Frequent breakdown 2-4 x/yr	Rare breakdown 1x / yr of less	Unknown
Bagamoyo	5	-	1	-
Kisarawe	2	2	8	1
Rufiji	4	3	10	12
Region	11 (23%)	5 (10%)	19 (40%)	13 (27%)

Routine inspection

Routine maintenance visits would obviously help to reduce the number of breakdowns, but the capacity of MAJI to make such visits is apparently too limited. Only 29% of the schemes reported regular maintenance visits, whereas 45% reported that no such visits were made. (No information available on remaining 26%)

Availability of fuel

It is of interest to note that lack of fuel, which is a notorious cause of the breakdown of schemes in certain other regions, was nowhere in the Coast Region mentioned as a common cause for the stoppage of the water supply. No doubt the relatively better and shorter lines of communication are the cause of this.

MAJI and the villagers in construction and maintenance

The view is oten brought forward that a greater involvement of the population would lead to a more efficient use of water schemes, less neglect, less use of alternative water sources, and greater preassure on the operators to keep the schemes in working order. However, few attempts have been made to ascertain if these assumptions are true and whether the problems that occur could really be solved by people's participation (Tshannerl + Mujwahuzi 1975; Mujwahuzi 1977).

Whether lack of involvement really leads to the neglect of schemes and even intentional damage has not been ascertained. But rumours suggest that it happens from time to time. Some of these cases may have deeper political motives, as in the conflicts between cultivators and pastoralists reported by Ndagala. In other cases individuals may damage pipes to satisfy their own immediate need of water. When plastic pipes are laid close to the surface there is a serious danger of accidental or intentional damage.

The common technical defects such as leaking taps and broken pipes cannot be helped by participation as such, but by a more careful organisation of the maintenance section. Whenever a MAJI vehicle stops in a village people are likely to come and report various defects. But somewhere along the line these reports get caught in breaucratic delays, so that action may be postponed indefinitely. If the pump attendants were given a greater responsibility for the repair of small defects (and many have expressed willingness in this respect) the situation might improve.

Of course there are also obvious difficulties involved in such an approach: tools and spareparts may disappear and there is a danger of insufficiently trained people tampering with pumps. But here a village committee might play a supervising role. Such committees are said to exist in Kisarawe and Ikwiriri, although no details are available on their activities. The present level of village organisation should make it easy to install such committees.

Rather than suggest people's participation in a diffuse way, as a good thing in itself, it should be pointed out in detail what form such participation should take and how it should be organised. The main types of participation are participation in construction, in decision making and in maintenance.

Participation in <u>construction</u> by contributing free unskilled labour is what is commonly meant by the term self help. The activities of the villagers usually consist of trench digging, bush clearing and breaking stones. It is not difficult to see why people would prefer to be paid for the labour they contribute, and this is in fact what usually happens. Only in five schemes in the Coast Region (4 in Kisarawe and 1 in Rufiji) self help has played some part. In all the others unskilled labour has been employed.

Contributions to the construction of schemes may also be in the form of money. For example, substantial contributions have been made by the Baraguyu pastoralists towards the construction of water supply in the Lugoba area, and at present they are doing so again in the context of the livestock development project initiated by the Jipemoyo group of the Ministry of Culture. Once can easily see that such contributions install a sense of propriety which is absent when the whole scheme is financed by the government, and which may induce a stronger feeling of responsibility in the community.

Participation in decision making is a much more difficult matter. It is true that schemes are often undertaken on the request of villages. If such requests are taken up by the political authorities there is usually a formal consultation between Maji, the politicians and the villagers in the form of a public meeting during which people are allowed to bring forward their ideas. But from then on all decisions are made by MAJI.

In the case of the larger schemes it is difficult to see how villagers without technical know how could make meaningful contributions. But in the case of smaller schemes there are also instances where mistakes in the location of water sources and supply sustems could have been avoided if the opinion of the villagers had been listened too. It is not know if there are examples of this in the Coast Region.

A number of researchers (Tschannerl 1975, Mujwahuzi 1977) have pointed out that the bureaucratic organization of MAJI results in an emphasis on technical achievements and design standards which militates against a closer cooperation between the technicians and the villagers. While some of the reasons not to involve the local people in the design of schemes may be quite valid as such, this approach reinforces the prevalent opinion that the government has the obligation to provide water for the rural people, and that water projects are not the villagers' responsibility. These ideas have also been reinforced by using water supply as a political tool in the implementation of the resettlement policy (Mujwahuzi 1977).

The basic problem seems to be the lack of communication between the technical worldview of the MAJI technicians and the down-to-earth viewpoint of the villagers. On the one hand technical standards must be safeguarded, but on the other hand people's sense of involvement needs to be maintained. Perhaps their actual contribution to the schemes at any stage is less important than the feeling of being involved which is brought about by frequent communication. A step forward would be if people could be explained the how and why of each phase in the construction of a scheme.

The element of communication is also vital in the villagers' contribution to maintenance. People are generally interested in the condition of their water supply and are eager to report defects and breakdowns. But there do not seem to be proper channels for these reports to reach the appropriate office within the ministry. When action on such reports is delayed indefinitely people finally lose interest.

Apart from this problem of communication there is no doubt that the maintenance section does not have the capacity to keep all schemes in optimum condition. One can see three approaches to this problem of maintenance:

a. Pump attendants could be given a greater responsibility for the regular inspection of the schemes. They might be given some further training (many have expressed their interest in this possibility) and be given simple tools and spare parts so as to carry out simple repairs. Their activities may be checked by a village water committee.

b. MAJI should encourage the establishment of village committees, consisting of the pump attendant, the village secretary and a few villagers, and appoint somebody within the maintenance section with the special duty to keep up a regular communication with these committees. He should collect their reports and make sure that action is taken on them.

c. A strengthening of the maintenance section itself is very necessary and this will be even more true when more and more schemes are going to be built. As we have pointed out in the preceding paragraphs it happens frequently that schemes

are not functionning as they should. Maintenance teams should be provided with sufficient transport, equipment, spareparts and petrol tocarry out their functions adequately. These teams should have a schedule of routine inspection visits to all schemes, including consultation with the village water committees.

If the water master plan is implemented, adequate provisions should be made to cover the recurrent costs of maintaining all the schemes that will then be in existence in the project area. This number will be such that it will be impractical to direct all maintenance activities from Dar es Salaam. Maintenance units will have to be based at the District or sub-district level. That will also help to reduce transport costs.

6. Water Supply System and Population:

Theoretically, in the ideal situation, one has a village population which is served by a continuously working supply system with an adequate number of taps not too far away from the home. In actual fact such a situation is found almost nowhere. Almost every supply system has certain imperfections which force the people to make adaptations in their patterns of water use. These adaptations are dictated by the size and place of residence of the population in relation to the size and location of the supply system, by the condition of the supply system, and by the water availability in and outside the piped scheme. All these factors are susceptible to change and the relationship is therefore complex and dynamic.

First we shall look at the population distribution and changes in the settlement pattern, secondly at the capacity of the supply systems. The third point to examine is people's adaptations to inadequate supply systems, and lastly we shall try to analyse the dynamic interplay between population, water availability and supply systems.

Population distribution

As can be seen from Table 12 the majority of water supply systems in the region have been constructed before the villagisation movement. During this movement more than half of the villages with improved water supply systems have expanded very much, often to several times their original size. All villages in Bagamoyo and Kisarawe with water supply systems and 40 per cent of those in Rufiji were thus affected. It should be borne in mind that the villages upstream from Mkongo in Rufiji were resettled in an earlier stage and subsequently provided with good water supply systems. These were not affected by the later villagisation, although important changes in population have taken place also in those villages.

The result of this great increase in village size was that water schemes that were sufficient for the original village population now suddenly became totally inadequate for the new population. Appropriate extensions to the schemes have not so far been made. Because of the limited capacity of sources it would in many cases not be possible to make simple extensions to the supply system. Whole new schemes would have to be constructed instead.

The water problem in many villages is therefore largely man-made. Far from improving the water supply, the concentration of population has made it worse in the first instance and it will take time and effort to reach the old level again.

In some cases the new sections of the villages are too far removed from the water supply system to make regular use of it. Yet, in the dry season there may be no convenient alternative. Then even neighbouring villages without any water supply at all may have to come in and depend on the same small water scheme. All people within walking distance from a scheme belong to the potential "population" of a scheme if there are no other water sources around.

In 17 villages out of the 48 surveyed it was found that a number of households is not served at any one time because they live too far away from the taps. They use other, unimproved sources. In the dry season the amount of water from the scheme decreases, and often the quality as well; the waiting times at the standpipes

increase. Therefore more households will turn to alternative sources as long as they are available. In 4 villages it was found that all households are served in the wet season, but that some are not served in the dry season when the capacity of the scheme is reduced.

The supply systems

How large should a supply system be to serve a given population adequately? There are two aspects to this question. (A) the number of taps to serve that population, and (B) the location of the taps in relation to the houses.

According to Dennis Warner (Design criteria for water supply systems in East Africa, BRALUP 1973) the normal standpipe discharges approximately 250 gallons per hour. It can serve 200 people (40 households) conveniently if they use their allowance of 10 gls/cap/day. In actual fact rural populations use less than that so that the number of households can be increased to about 60 per standpipe.

However, this is a theoretical approach based on the assumption that all standpipes discharge the optimum amount of water. We found in Mbezi village that the pressure in water schemes may vary greatly and with it the amount of water discharged from the standpipes. Even when the pressure was high it took about one minute to fill a 15 liter bucket, which puts the hourly discharge at 900 liters. But often it took 2-3 minutes to fill a bucket, giving a discharge of only about 300 liters per hour. Even when allowing for as low a consumption rate as 15 liters/cap/day this means that a standpipe at most can serve between 120 and 300 people (25 - 60 households), taking into consideration that most of the water is fetched either in the early morning or in he late afternoon.

The Table below shows that ratio of households to standpipes in our 48 villages. In 35 villages the ratio is lower than the theoretical maximum, but in 13 villages (27%) it is much higher, indicating that the size of the supply system is very inadequate.

Table 6

Ratio of Households/Standpipes

	Below 40	40-60	60-100	100-200	Over 200
Bagamoyo	3			1	2
Kisarawe	4	2	4		3
Rufiji	22	4		2	1
Region	29	6	4	3	6

Adaptations to stress

When supply systems are inadequate or not enough water is coming out of the taps the amount of time and energy needed to obtain a minimal quantity of water for the household becomes disproportionate. How do people solve this problem? We have distinguished five possible solutions. These are: extending the period over which water is fetched; queueing at the standpipes; buying water from professional carriers; using alternative sources; and reducing the amount of water used in the home.

Normally water is fetched between 6 and 9 in the morning and between 4 and 7 in the afternoon. During the middle of the day it is hot and most people have gone to the fields. A few people fetch the odd bucket and children fetch water in small containers. When water is difficult to obtain people find ways to organize themselves in such a way that water is fetched throughout the day. It has not been reported from the Coast Region but observed in other parts of the country, that people may also proceed to draw water at night.

Queueing is a common phenomenon. When the waiting period exceeds half an hour people leave their containers to queue up for them and leave a child behind to keep an eye on the progress. Later they come back to collect the full containers. It is not easy to obtain accurate information on waiting times, for people are apt to exaggerate so as to give expression to their discontent. In Mbezi village very little crowding was observed, although most people said it was a common thing to happen. The table below is based on statements and therefore very approximate.

Table 7

Waiting Time at Standpipes

	0 min	0-15min.	15-30min.	30-45min.	45-60min.	More	Unknown
Bagamoyo	1	-	1	3	2	-	-
Kisarawe	3	3	4	2	-	2	1
Rufiji	13	3	1	3	-		6
Region	17	6	6	8	2	2	7

In many villages one finds somebody who earns a few shillings by fetching water for other people. When water is scarce and the distance to the source far, professional water carriers become almost indispensable. They are usually boys or men, operating with a number of debes on a little cart. But in the real problem areas like Chalinze, Msata or Kiwangwa, where water is completely lacking in the dry season, local businessmen with lorries are monopolising this trade and provide water at high cost. Prices range from as little as 0/10 per debe in places where water is plentiful to as much as 4/= per debe when it has to be brought in by lorry.

The use of alternative sources is a widespread phenomenon and can be due to a variety of factors. As we have already discussed the supply system may simply be too small for the population. Or it may yield insufficient water, either seasonally or permanently. In case of a breakdown of the pump, or when the operator has gone away to collect his salary, people also have to revert to other sources. In only one village the taste of the water as such was mentioned as a reason to use water from unimproved sources, especially for drinking. In total 60 per cent of the villages reported that unimproved sources are used more or less regularly.

Not enough data are available on the patterns of domestic water use to say with any degree of confidence how people's water consumption is affected by shortages. There is no doubt that under great shortage people are forced to use less water than when it is plentiful. Yet, a plentiful supply does not necessarily imply a high rate of consumption.

Impact studies of improved water supply systems suggest that the rate of consumption usually rises a little, but not very much, when an improved scheme is installed. In any case the variation within villages always proves to be great. The reactions to stress may differ from household to household, depending on the manpower available in the home and the nature of the relationship between husband and wife. One hypothesis is that urban cultural patterns make women more sophisticated and independent, and therefore less willing to spend a great amount of energy on fetching water.

7. Conclusions

In this paper we have pointed out that the presumed benefits from improved water supply systems are often reduced, if not annihilated, by the inadequacy of such schemes as they are at present. The problems are mainly of three kinds:

1. Water availability. Many schemes yield insufficient water or run completely dry in the dry season. In Bagamoyo this problem is so serious that it prevents the construction of supply schemes based on groundwater.

2. Operation and maintenance. The level of maintenance is very inadequate and the time needed for repairs far too long.

3. Population concentration. Because people have been concentrated in large settlements the existing supply systems have become too small.

People can only benefit from a water scheme if they are actually able to use it. If abundant clear water is available from a standpipe reasonably close to the home and one does not have to wait to fill a bucket, then people are not likely to use alternative sources. If one or more of these conditions are not fulfilled the people may well use other sources. Depending on the local situation and the needs of the household there is a trade-off point beyond which people find is more advantageous to use other water sources. One must assume this to be a rational decision within the framework of the perceived needs. Expenditure of time and labour no doubt is a more important factor than water quality, and the latter is evaluated in terms of taste and appearance rather than in terms of health risks.

In the previous paragraphs the various problems that may occur have been examined one by one. Each problem by itself may seem to cause a certain amount of inconvenience without being unsurmountable. But in practice a number of these problems tend to occur together, making some of the supply systems completely useless most of the time. One does not have to dramatize to realise the very severe stress that is imposed on people when they have to spend many hours of each day to satisfy the minimum water requirements of their households.

Appendix: A Note on Priority Ranking

Problems of priority ranking:

The construction of improved water supply systems for 8,000 villages in Tanzania, or even for some 400 villages in the Coast Region, is a huge and costly task that will take many years to complete. Until now the construction of new piped schemes has barely kept up with the natural increase of the population. Moreover, the cases of piped schemes which are not functioning properly are numerous. Therefore, even though the ultimate goal is to service all villages, it would be good to establish some priorities for the construction of new schemes. The problem is: what criteria should be sued to decide on such priorities. Should those villages be served first that have the most serious water shortage? Those are often in remote and dry areas where a good water supply system will be very costly to build. For that money many more people could be provided with water in a more manageable area. Then should the first priority go to areas where the greatest number of people can be served at the lowest cost? That would be areas where water is already easily available, so that the difference between well-served and deprived areas would become greater. The same would apply if priority is given to areas with the greatest development potential. Those are also aready better off in other respects, so that the difference between privileged and under-priviled areas would become greater.

A choice of criteria:

We want to suggest an approach to the problem of priorities which is both egalitarian and efficient, because it is not based on external (political) criteria, but on criteria that emerge from the mechanism of water supply construction itself. The following factors are taken into account:

A. Economy of scale. The more people are served by a single water supply system, the cheaper it works out per head of population

B. The urgency of water supply for large population concentrations. The more people are together in one village, the more difficult it becomes to make do with unimproved watersources, and the more essential to provide safe water.

C. Health hazards. The risks of contamination of water sources, and of epidemics when such contamination takes place, becomes greater as the population concentration increases.

These three factors provide strong arguments to give the first priority to the largest population concentrations. There the greatest number of people can be served at the lowest cost, the reduction of health hazards is greatest, and the reduction of inconvenience to people is also greatest.

The large settlements:

Twenty five percent of the population of the Coast Region lives in settlements with more than 3,000 inhabitants. For Rufiji the figure is as high as 50 percent. In the whole area there are 27 settlements with more than 3,000 people. Providing water for these 27 settlements would already take care of 25 percent of the population. As some of these 27 settlements already have good water supply systems, the number to be constructed would be even smaller.

From the table it may be seen that 11 of the large settlements have an adequate watersupply, which is supplied from standpipes in 7 villages. Four villages (3 piped) have an adequate water supply only in the wet season. Four villages have enough water but inadequate supply systems. In 5 villages (3 piped) the water source is permanently inadequate.

Table 8

Water Supply Situation in Settlements With More Than 3000 Inhabitants.

Situation	PIPED		NOT PIPED		TOTAL		Percent
	vill.	people	vill.	people	vill.	people	
Adequate	7	36,799	4	16,262	11	53,061	38.8
Wet season only	3	9,250	1	5,665	4	14,915	10.9
Supply system inadequate	4	19,376	—	-	4	19,376	14.1
Source permanently inadequate	3	28,334	2	6,587	5	34,921	25.5
No information/ under construction	1	4,250	2	10,444	3	14,694	10.7
TOTAL	18	98,009 71.5%	9	38,958 28.5%	27	136,967	100

The problem areas:

But the criteria that have been proposed do not take care of the real problem areas and one feels uncomfortable about areas like the centre of Bagamoyo district where water is so scarce that it has to be bought at a high cost or carried over very long distances (up to 12 km). It is indispensable to add another criterium for priority ranking, which is: to remediate acute problem situations. This will be very much more expensive per head of population, butthe benefits in terms of hygiene and economic viability are likely to be considerable.

Resettlements:

In some cases one might wonder if it would not be easier to bring the people to the water rather than bringing the water to the people. This possibility should have been considered before the villagisation took place. In some parts of the country subsequent resettlements have been made because villages were located in the wrong places. But this is always a painful process that causes much ill-feeling with the population. In any case when such solutions are considered, attention

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