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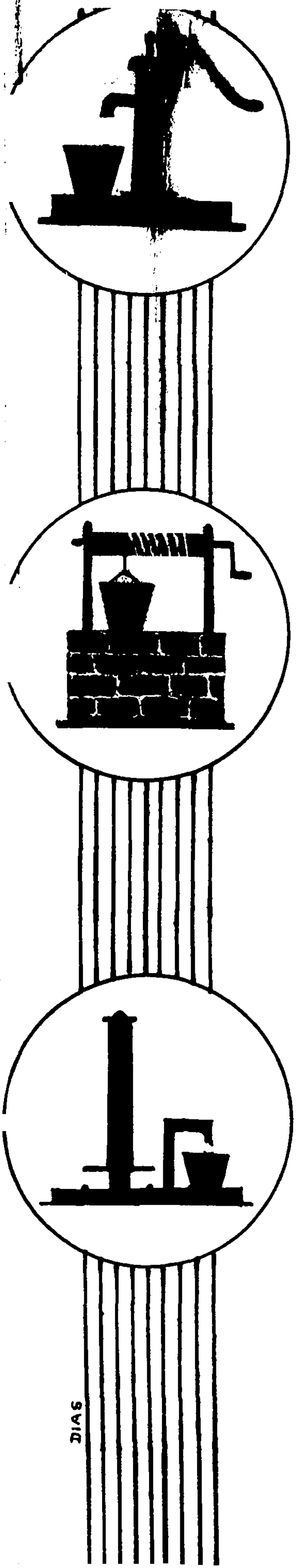

RESEARCH PAPER NO. 77

# WELLS AND HAND PUMPS IN SHINYANGA REGION, TANZANIA

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Bureau of Resource Assessment and Land Use Planning
University of Dar es Salaam

Research Paper No 77

# WELLS AND HAND PUMPS IN SHINYANGA REGION, TANZANIA

## Level of Service from Small Scale Water Supplies

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## ABSTRACT

The research paper discusses the level of service attained in the Shinyanga Shallow Wells Project, in terms of three major parameters - quality, quantity and accessibility. A fourth important aspect is added, that of reliability. The problems facing the project today, several years after the handover to the Tanzanian administration, are presented, based on a survey carried out in January 1982. Special emphasis is placed on the frequency of breakdowns of hand pumps and the inadequacy of the maintenance organization. The priority ranking of the objectives of improved water supply from the point of view of the consumer is presented and the benefits of the project are evaluated. The results of the survey indicate that a more appropriate strategy would be two seperate projects - one involving improvement of traditional groundwater sources without the use of hand pumps, and another drilled well programme for areas without sufficient shallow groundwater, utilizing hand pumps.

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## ABREVIATIONS

| | |
|---|---|
| RDD | Regional Development Director |
| RWE | Regional Water Engineer |
| DDD | District Development Director |
| DWE | District Water Engineer |
| SSWP | Shinyanga Shallow Wells Project |
| RMO | Regional Maintenance Officer |
| DMO | District Maintenance Officer |
| Div MO | Divisional Maintenance Officer |

# 1. INTRODUCTION

The attainment of the target of the International Drinking Water Supply and Sanitation Decade, that is, safe water supply and sanitation for all by 1990, will require new approaches both in national strategies as well as in international support. The magnitude of the task ahead requires a qualitative, not just a quantitative change in methods of delivery. There is a need for new approaches in technology and management. Lower standards of service, lower unit costs as well as a much expanded mobilization of the local community have to be accepted(Ahman, I. 1981).

In Tanzania there is growing awareness that there is a need for departure from the old strategy which put emphasis on piped water supplies. Apart from high investment costs such schemes rely on imported fuel and spareparts for their running. As a result the reliability is very low and the rural population has to use traditional, often polluted sources for long periods even if the village has been provided with an "improved" water supply.

In the search for new approaches the experience of earlier projects is often forgotten. Over the years there have been several more or less ambitious projects emphasising low cost technology and consumer involvement. There is a need for studies of completed projects to learn from success and failure.

One of the bigger projects in Tanzania involving alternative technologies is the Shinyanga Shallow Wells Project. This project has in many aspects developed a model which in modified form is planned or already being implemented in various regions all over the country. The Shinyanga Shallow Wells Project has features, many of them apparently contradictory, common to many other projects, for instance:

- although self-reliance and use of local resources are emphasised the dependance on foreign assistance in the form of funds, management and technology is great.
- implementation is on a large scale but the technology used is classified as small scale
- the project is, after massive external support during the implementation phase, supposed to be handed over to a local organization for operation and maintenance.
- participation of users is emphasised but the component of unskilled labour in construction is of little significance
- the consumers are supposed to appreciate and use the new supply and abandon traditional sources.
- although there is much talk about integrating water supplies with other development activities the planning is central and carried out in isolation
- improved health is the ultimate objective of the projects but little effort is made to support activities aiming at improved hygiene and sanitation.

It is felt that much can be learnt from the Shinyanga experience. The implementation phase is well documented in the handbook

"Shallow Wells" published by the consultant DHV (1978). Less is known about problems facing the project today several years after the handover to a local organization. There are many vital questions to be answered: What is the users' perception of the supply? Is it considered an improvement compared to the old form of supply? What factors influence the consumers' choice and motivate changes in the traditional water use pattern (Quality? Quantity? Accessibility? Reliability?) How is it possible to maintain a water supply system based on scattered wells and handpumps? How long can a hand pump be expected to last, given the constraints in the present Tanzania society?

Above questions, and many others, should, if not answered, at least be taken up seriously before any other large scale undertaking is considered. This study is an attempt to discuss some of the advantages and short-comings in the Shinyanga project as experienced after several years of operation.

## 1.1 Objectives of Rural Water Supply:

Since independence in 1961 the Tanzanian Government has given high priority to the development of domestic water supplies in rural areas. Realising that the acceleration of rural development was tied up with the supply of water to the villages a major policy decision was taken in 1971 instructing the government to take immediate steps to carry out:

- a rural water supply programme which will ensure that in less than 20 years every one in the rural areas will have easy access to clean and potable water (Lwegarulila, F.K. 1975)

The above objectives are normally referred to as the 1991-goal.

Ease of access is generally interpreted as a walking distance of 400m.

In 1975 another major policy decision was taken as a first step towards the 1991 goal that:

- by 1981 every village should have a source of clean potable and dependable water within a reasonable distance as a free basic service.

The list of expected benefits can be made very long but the two most important aspects are normally considered to be

- improvement of people's health
- saving of time and energy particularly among women and children due to shorter water journeys.

## 2. SCOPE

### 2.1 Outline of This Study:

This study is an attempt to follow the development of water resources in one region - Shinyanga Region. Emphasis is placed on small scale technologies like wells with hand pumps as this is considered a promising approach for future development.

The starting-point of the study (chapter 3) is an inventory of existing policies, standards, recommendations, and practices which determine the features of all water supplies in the country. Special attention is paid to the relevance of these standards to small scale technology

Chapter 4 concerns the implementation of water supplies in Shinyanga region and answers the question: What level of supply would have been achieved if all projects built over the years were qorking and people were using them?

Differences in level of supply between various areas in Shinyanga Region is discussed in Chapter 5.

The main concern for the consumers is of course not how many water schemes have been built or how many people could have been supplied, but how many are actually working and what the present level of supply in the region is. These aspects are discussed in Chapter 6.

To find reasons why so many projects are out of order a survey of wells and hand pumps has been carried out in the region. Chapter 7 contains the result of the survey and also gives some indication as to why the expected level of provision is not achieved.

In Chapter 8 benefits of improved water supply are discussed with special emphasis on wells equipped with hand pumps.

Chapter 9 deals with questions related to organization. What is done to make the water supplies work and how can this organization be improved?

To illustrate the above aspects of water development a brief case study of one village, is presented in chapter 10 to give some concrete examples of advantages and shortcomings with a water supply system based on wells and hand pumps.

Some tentative conclusions and recommendations are made in chapter 11 as basis for further discussions about the use of wells and hand pumps in Tanzania.

## 2.2 The Survey:

This study is meant to be a piece of applied research. An approach is chosen which will give practical insights. At the same time a certain degree of uncertainty has to be accepted as neither time nor funds allowed for a more extensive fieldwork.

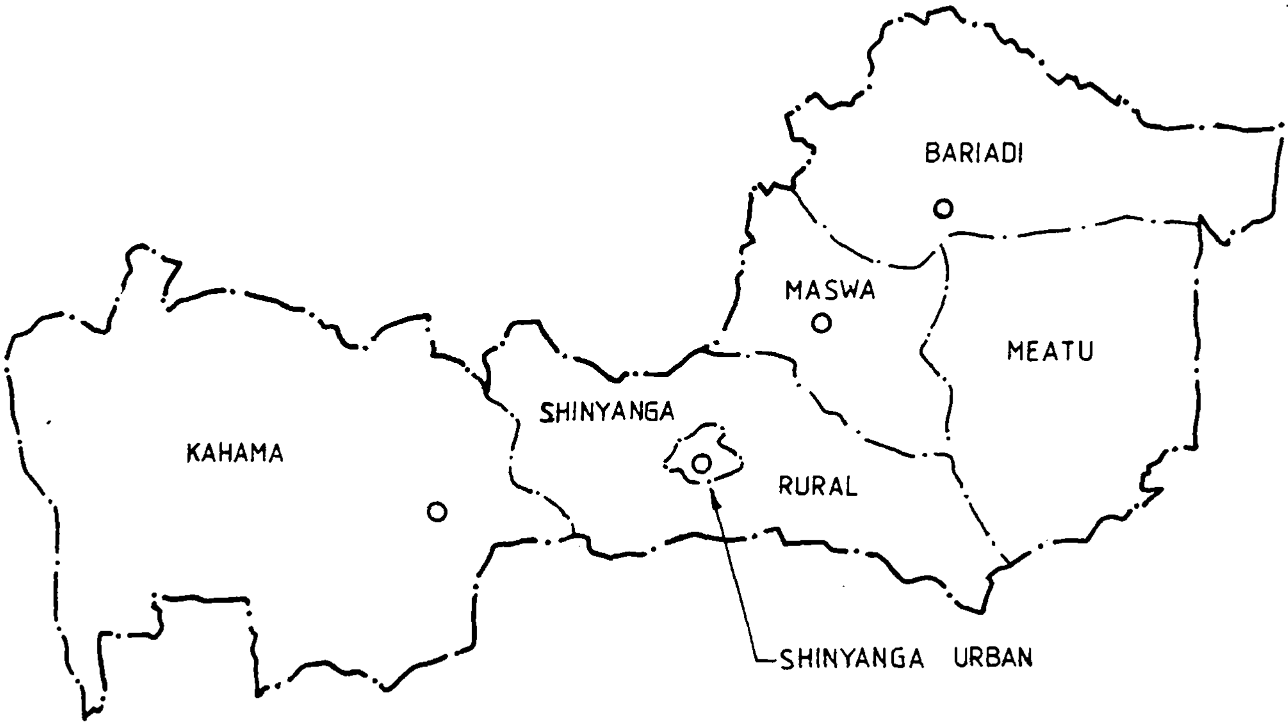
Information has been obtained by following means:

1) Inventory of literature related to water supplies. Special emphasis was placed on small scale technologies like wells with hand pumps. Publications and reports from the consultant involved in the Shinyanga Shallow Wells Projects (DHV) were very useful sources for more detailed information.

2) Inventory of all existing water supplies in Shinyanga Region. Information was obtained through interviews with engineers and maintenance officers in regions, districts and divisions.

3) On-site visits to a random sample of wells in the region. The sample was stratified in respect of the varied geographical, social and economic environment. Perfect random sampling is difficult to achieve in practice. The sample of wells was drawn from maintenance cards at Regional Water Engineer's office. The card system is however not complete. Wells built the last years are for instance not included. It is howeverfelt that the sample is fairly representative although one part of the region, Meatu subdistrict, (See Map 1) was not accessible due to rain. All other districts are represented and the sample covers all but two of the socio-economic areas defined in the regional water master plan. (NEDECO 1974). The location of villages in sample is indicated on map 2. Apart from Meatu the sparsely populated land in the northern and western parts of Kahama District is not included in the survey.

During the fieldwork 30 villages were visited and in all 57 wells and handpumps were inspected. Of these 5 were in urban areas.



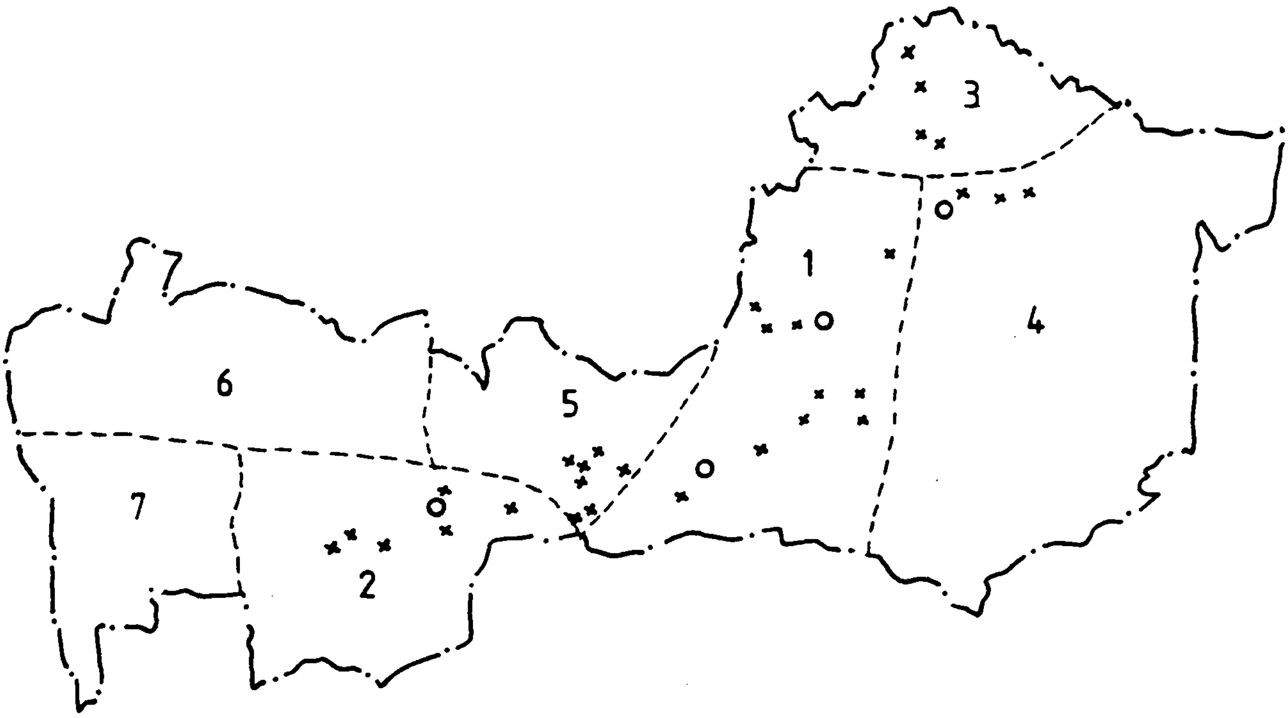

LEGEND

| | |
|---|---|
| -·—·— | Regional boundary |
| -·—·- | District boundary |
| o | District centre |

1

SHINYANGA REGION

ADMINISTRATIVE AREAS ( DISTRICTS )




LEGEND

O District centre

x Village surveyed Januari 1982

2

SHINYANGA REGION

SOCIO-ECONOMIC AREAS

( as defined in Water Master Plan )

## 3. DESIGN CRITERIA FOR SMALL SCALE RURAL WATER SUPPLIES:

The well known 1991 goal stats that all Tanzanians should, by then, have ease of access to clean water in sufficient quantities. This objective includes three major parameters in planning and design of water supplies namely, quality, quantity and accessibility. In this section we will add another important aspect: the reliability of the supply. These four planning variables will be separately discussed in following sections.

### 3.1 Quality:

The minimum quality of domestic water is partly defined by legislation. The principal Act is "The Water Utilisation (Control and Regulation) (Amendment) Act of 1981", which gives the acceptable level for physical and chemical substances. Bacteriological standards are not covered by the above acts but are specified as "Temporary Standards of Quality of Domestic Water in Tanzania" as worked out by the Rural Water Supply Health Standards Committee (1974).

The quality standards of drinking water are based on WHO recommandations and are very strict when it comes to bacteriological pollution "Drinking water should not contain any organism of faecal origin...Occurrence of E.coli (faecal coli) in consecutive samples in less than 100 ml of drinking water is an indication of faecal pollution and hence a dangerous situation needing urgent rectification" (Temporary Standards of Quality of Domestic Water in Tanzania, 1974). Current WHO recommended standards are regrettably not realist. The guidelines given are rarely met in developing countries even where supplies are filtered and chlorinated (Lloyd, B. 1982). The same applies for Tanzania. The great majority, if not all, rural water supplies will not meet the recommended standards.

To eliminate faecal pollution minimum distance between a well and potential source of contamination in the temporary standards is is given as follows:

- 50 metres for pit privies, septic tanks, sewers
- 100 metres fromborehole latrines, seeping pits, trenches and sub-surface sewage disposal fields
- 150 metres from cesspools, sanitary land field areas and graves.

Other precautions must also be observed:

- Domestic livestock should be kept away from the intake by fencing the area of a minimum radius of 50 metres from installation
- Defecation and urination around the intake should be completely prohibited, by law.

### 3.2 Quantity:

The necessary amount of water to be supplied to the consumers is much discussed and highly controversial. Numerous empirical studies both outside and inside Tanzania have shown that if people have to carry water home from a public supply point they are unlikely to carry more than 10-15 lpc (litres per capita and day) for domestic use. (See e.g. Kauzeni, A.S. 1982, Bantje, H. 1978 and Carruther, I. & Browne, D. 1977).

The present design criteria, which is primarily intended for design of piped schemes, is 30 lpc. To allow for population growth another 50% is added to this volume. A new design manual is under preparation at present. This will recommend 25 lpc for a projected population figure.

No specific design criteria exists concerning wells and hand pumps. The problem of setting an exact volume per person and day is avoided by giving an average number of people supplied per well. This figure is based on experience from earlier projects in Tanzania and varies between 200-500 persons/well. Table 1. below gives average consumers per well as experienced from various hand pump projects.

Table 1

Average Numbers of People Supplied per Hand pump and Well

| REGION | PEOPLE/WELL | SOURCE |
|---|---|---|
| *MTWARA/LINDI* | *200 (Design Figure)*<br>*250-350 (Actual figure)* | *Rantala, M. 1980* |
| *MOROGORO* | *250-400* | *Bonnier, C.J. 1980;*<br>*Van de Laak, F.H.J. 1980* |
| *SHINYANGA* | *250*<br>*300* | *DHV, 1978*<br>*Kashoro,Y.N. 1980* |
| *SINGIDA* | *300* | *Roberts, G. Personal Communication* |

From a purely technical point of view a hand pump of the Shinyanga model can meet the daily demand of 500-800 people assuming an average per capita consumption of 25 l/day and 10 hours pumping (given the well has a sufficient yield)(DHV 1978).
Other studies indicate that even more than 400 people can draw water from shallow wells. From an appropriate technology project in Arusha Region it is reported that 5 wells with hand pumps are serving about 1500 families. Assuming an uniform geographical distribution of wells and population and an average household size of 4 more than 1000 people could be supplied from one pump. (Rajeswaran, K. 1981).

Studies from other African countries give lower figures e.g. a study from Lesotho recommends at the most 150 people or about 30 households per hand pump (Feachem, R. et.al. 1978)

Considering factors like seasonality, settlement pattern and water collection habits the most quoted figure 250 persons per well seems to be relevant under Tanznaian conditions. Further studies on microlevel are however required to determine the actual level of supply. Supply based on hand pumps should however not include too generous an allowance for future growth as the system is easy to expand. One simply adds further hand pumps and wells when required.

## 3.3 Accessibility:[1]

400 metres or less is considered to be an acceptable walking distance from place of residence to water point according to the official Tanzanian policy.

When planning water supplies with a reticulation system this criteria can fairly easily be met. For shallow wells where the domestic water point is located at the source a number of physical restrictions limit the possibilities to find an optimal location in relation to settlement pattern. The accessibility of water dictates the location of the well.

In the Shinyanga Shallow Wells Project a different criteria from the official concerning what is a reasonable walking distance was applied. "The detailed hydrogeological surveys were limited to a radius of 1.5 km around the villages as the wells to be constructed should be within reasonable walking distance of villages" (DHV, 1978)
In the Morogoro Project this distance has been reduced "The site has to be within walking distance (1 km) from that part of the village for which the well is meant" (Van Lissa, R.V. 1980)
Studies from other parts of Africa recommend that most households should be within about 200 metres of a pump (Feachem ,R. et. al. 1978)

## 3.4 Reliability:

When it comes to reliability of water supply sytem there are no specific recommendations given in the official policy. It is said that the village should have a reliable sources of clean potable and dependable water.

There is a need to specify what is an acceptable level of reliability as there is no such thing as a 100 percent reliable pump, be it powered by hand, wind, gravity or diesel. Such a criteria for reliability could e.g. be that the scheme should function without any major interruptions with a duration in excess of one day and with not more than 10 interruptions a year. (SIDA, 1980) This criteria might seem strict but it is based on the condition that if the duration of a breakdown is longer than one day the consumer has to return to the traditional source with its obvious health hazards.

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1) The term "accessibility" is used in this paper to refer to spatial aspects.

There must however, be different standards for various systems. A piped water supply covering a large population must function better than a supply based on a number of shallows where one hand pump can break down without affecting the whole community.

Several studies have shown how highly unreliable most water supplies are in Tanzania today. Some sources claim that 75% of all piped supply systems are out of order at any given time (Bonnier, C.J. 1980). A BRALUP study from 1978 found that 22 out of 31 projects in Dodoma Region were out of order and that 66.5% of the population once supplied did not get any water (Mujwahuzi, M. 1978). A recent report from Kilimanjaro Region reveals that about 50% of all schemes, nearly all of them gravity supplies, do not work satisfactorily. A water master plan for the regions at Lake Victoria 1977 pointed out that the installations only produced 60% of the projected water quantities (Broconsult, 1977).

Hand pumped supplies should be more reliable than diesel powered ones for at least three reasons

- they have fewer moving parts and are simpler to maintain
- they use no fuel
- normally several hand pumps are installed in a village thus one could break down without jeopardizing the whole scheme as villagers could turn to the remaining pump(s) until it is repaired (Feachem, R. et.al., 1978)

However the question of maintenance is crucial also for small scale technology projects based on hand pumps as findings from Mwanza Region indicate. In a study made 1977 it was found that 90% of all hand pumps installed were unusable (Broconsult, 1977)

A recent BRALUP study of shallow wells and hand pumps in Morogor Region reports that 17% of the pumps were not working for variou reasons such as breakdowns or low recharge (Anderson, I. et al 1981). Other studies indicate that the highest level of servic it is feasible to anticipate in a hand pump programme is 90% (Feachem, R. et. al., 1978).

# 4. WATER SUPPLY IN SHINYANGA REGION

## 4.1 Traditional Water Supply:

The majority of the rural population in Shinyanga Region obtain their water from unimproved sources. During the wet season, the only period when the numerous streams have run-off, water is collected directly from rivers or from ponds in depressions. In the dry season, when there is no flowing water the inhabitants rely increasingly on ponds, natural springs and waterholes. Man-made wells seldom reach a depth of more than a few metres and are usually inlined. Waterholes are preferably dug into riverbeds where the water table is relatively easy to reach.

The distance between water source and place of residence varies greatly, a distance of 6 km is not uncommon. Often there is no source of water within the village boundary but the inhabitants have to rely on neighbouring villages. Time spent collecting water varies considerably between the seasons. The Mwanza/Shinyanga village sample survey conducted in 1976 found that the average time spent per household and day fetching water was 2.2 hours in the rainy season and 4.1 hours during the dry season.

The quality of the traditional sources, in particular towards the end of the dry season, is very poor. Ponds or water holes are heavily polluted by man, livestock and insects.

## 4.2 Piped Water Supplies:

All piped rural water supplies, with few exceptions, are pumped schemes, either from deep boreholes or from shallow wells in depressions or riverbeds. They all rely on diesel powered engines for their functioning.

At present there are 46 piped rural water supplies built and operated by Regional Water Engineer's Office (RWE) in Shinyanga Region. Apart from these there is a number of smaller schemes operated by the Catholic Mission.

Geographical distribution and size of piped supplies is illustrated on the next page (map 3).

Urban centres (as defined by the 1978 census) are to varying degree supplied by piped schemes. If these supplies are included in the statistics 13% of the total population in Shinyanga Region has been provided with piped water.

## 4.3 Hand Pumped Supplies:

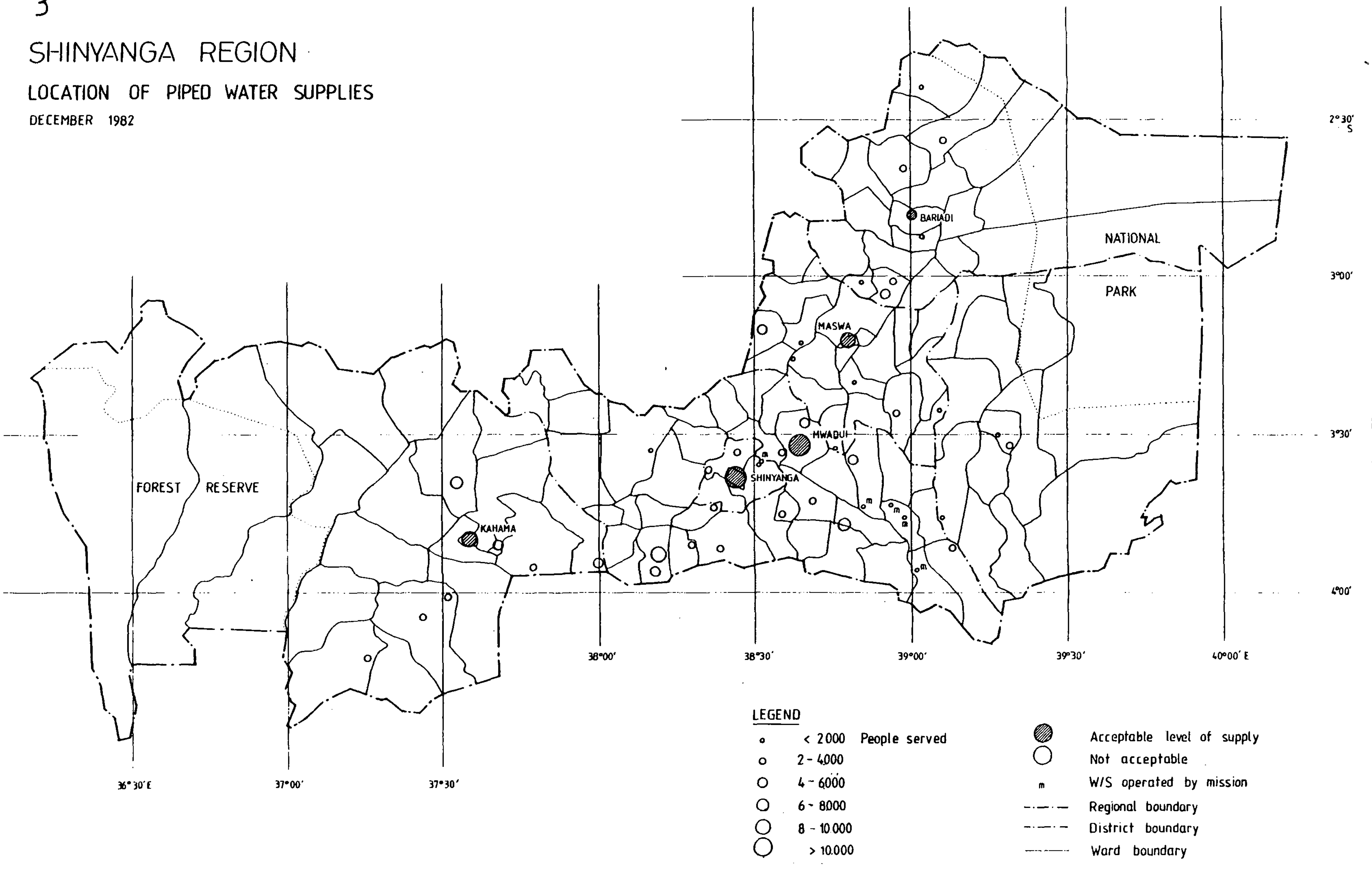
The most common form of improved water supply in Shinyanga Region is through shallow or medium depth wells equipped with hand pumps.

# 3

# SHINYANGA REGION

## LOCATION OF PIPED WATER SUPPLIES

DECEMBER 1982



The Shinyanga Shallow Wells Project ( SSWP) began in 1974 as a first step in the implementation of the regional water master plan (WMP), the first WMP carried out in Tanzania. The plans recommended the provision of water from shallow ground water wherever feasible, rather than from deep ground water or surface water. An estimated total of 2000 wells could be installed in the region using known shallow ground water resources, thereby serving over 40% of the regions rural population. (NEDECO,1974).

The reasons for this recommendation were twofold:

- provision of shallow ground water with wells and hand pumps is the least expensive technology and
- the quality of shallow ground water is generally better than deep ground water, which contains excessive salts, especially flourides, and surface water which is often bacteriologically unsafe.

The Shinyanga Shallow Wells Project which was financed by bilateral assistance from the Netherlands Government brought the number of wells and hand pumps in Shinyanga Region to about 750 by mid 1978 when the project was handed over to the Tanzanian administration.

The total number of wells and hand pumps in good condition at the hand over was 714. Based on the Consultant's (DHV) estimate an average of 250 people was supplied from each well. Thus 178,500 people or 14% of the rural population was supplied by wells and hand pumps in July 1978.

The shallow wells programme has thereafter continued under the Regional Water Engineer's management. The rate of construction has slowed down after the Dutch assistance ceased and during the last years only 50-60 wells have been built annually. During 1977, 1978, the last period of the Dutch project an average 230 wells were constructed per year

The total number of shallow wells built in Shinyanga Region by January 1982 is estimated to be between 960 and 1025. (including also wells under construction.) The figure varies depending on which source is used e.g. Kashoro, Y. (1981) gives the total by mid 80 to be 994. The lower figure 960 is based on information collected during the field work period in January 1982.

The conservative figure 960 is consequently used as a basis in the calculations throughout this study. The difference in the statistics from various sources can probably be attributed to a combination of factors e.g.

- Some wells have been included in the statistics as completed although they have only been surveyed.
- The existence and location of some wells is not known on regional and district level.
- Some wells have been washed away, others have been abandoned due to low recharge.

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960 wells provide domestic water to about 240,000 people or 18% of the rural population or 16.5% of the total population (based on 250 consumers per well). Distribution of wells between various districts is given in Table 2. The geographical distribution of wells with hand pumps can be found on map 4.

## 4.4 Level of Supply in Shinyanga Region Based on Design Figures.

About 30% of the total population in the region had access to improved water supply according to design figures as discussed in earlier sections.

Table 3 summarizes the level of supply in Shinyanga Region

Out of the total 1,446,000[1] inhabitants in the region 1981, improved water supplies have been built for an estimated 425,000 people, thus leaving about 1,021,000 to be catered for.

Figure 1 illustrates the provision of water measured in terms of numbers of consumers[2] between 1967-1981 (graph d-e). The line a-b shows the growth of rural population for the same period. Assuminga growth of 3% in rural areas the population will reach about 1.8 million by 1991 (line b-c) compared to 1.446 in 1981. The actual number of people to be supplied by then is represented by the gap b-e (present population without improved source) plus the vertical distance c-b (growth of population). To reach the target of the Tanzanian aspiration that by 1991 the whole rural population shall be provided with improved water, water supplies must be built to cover another 1,375,000 people. The required implementation rate is indicated as line e-c and has a considerably steeper inclination than the present population growth - about 140,000 people should annually be provided with improved water. In 1976-78 during the last years of the Dutch project, the production of wells covered 60,000[3] people annually. The present implementation capacity is less than 25,000 people per year.

The gap between the two graphs a-b and d-e is actually widening both in absolute and relative terms. More people today drink water from traditional sources than some two, three years ago even without considering the problems of maintaining and running the existing schemes. These aspects of operation andmaintenance will be covered in a following chapter.

---

1. Based on 1978 census and a 3% growth rate
2. Based on design figures
3. Assuming 250 users/well

4

# SHINYANGA REGION

## LOCATION OF SHALLOW WELLS

DECEMBER 1982

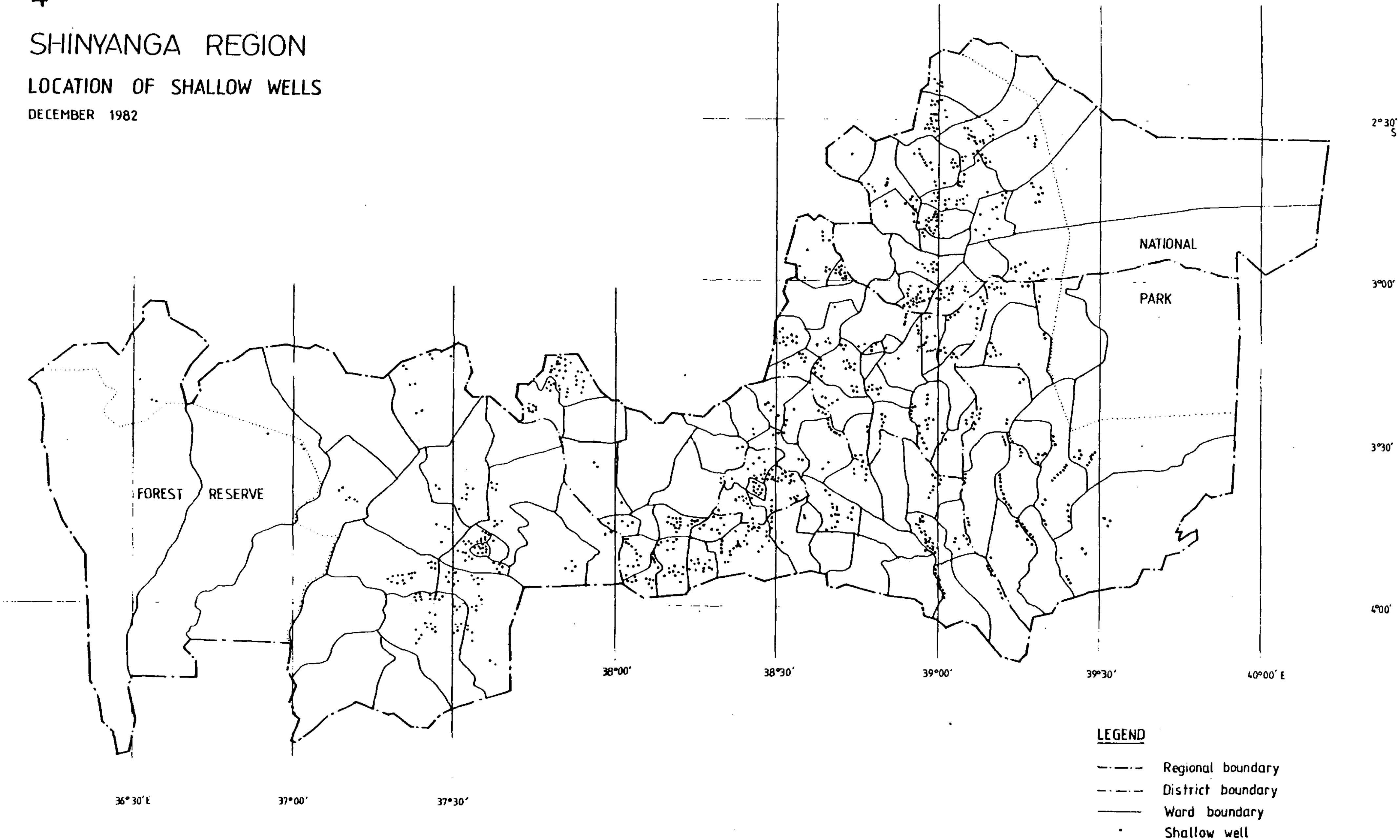


TABLE 2

SHINYANGA REGION DISTRIBUTION OF WELLS ON DISTRICT LEVEL

| DISTRICT | NUMBERS OF WELLS JAN. 1982 | NUMBERS OF VILLAGES PER DISTRICT (1978 CENSUS) | RURAL POPULATION (1978 CENSUS) (000') | AVERAGE NUMBERS OF WELLS PER VILLAGE | AVERAGE NUMBERS OF CONSUMERS PER WELL |
|---|---|---|---|---|---|
| Bariadi | 210* (230)** | 113 | 297 | 1.9 | 1415 |
| Maswa | 140 (160) | 74 | 173 | 1.9 | 1235 |
| Meatu sub dist. | 100 (115) | 53 | 131 | 1.9 | 1310 |
| Shinyanga Rural | 290 (300) | 193 | 362 | 1.5 | 1250 |
| Shinyanga Urban | 70 ( 70) | 23 | 69 | 3.0 | 985 |
| Kahama | 150 (150) | 161 | 292 | 0.9 | 1945 |
| REGION TOTAL | 960 (1025) | 617 | 1,323 | 1.6 | 1380 |

* Numbers of wells identified during field work January 1982. These figures include also wells under construction and wells where no hand pump has been fitted.

**Numbers in brackets are based on information from RWE's Office

TABLE 3

LEVEL OF SUPPLY IN SHINYANGA REGION 1981 (BASED ON DESIGN FIGURES

| TYPE OF WATER SUPPLY | POPULATION SERVED | |
|---|---|---|
| | NUMBERS (000) | % |
| Rural water supply, piped | 145 | 10 |
| Urban water supply, piped | 40 | 3 |
| Hand pumped supply, (mainly rural) | 240 | 16.5 |
| Improved water supplies | 425 | 29.5 |
| Unimproved water supply | 1021 | 70.5 |
| | 1446 | 100.0 |

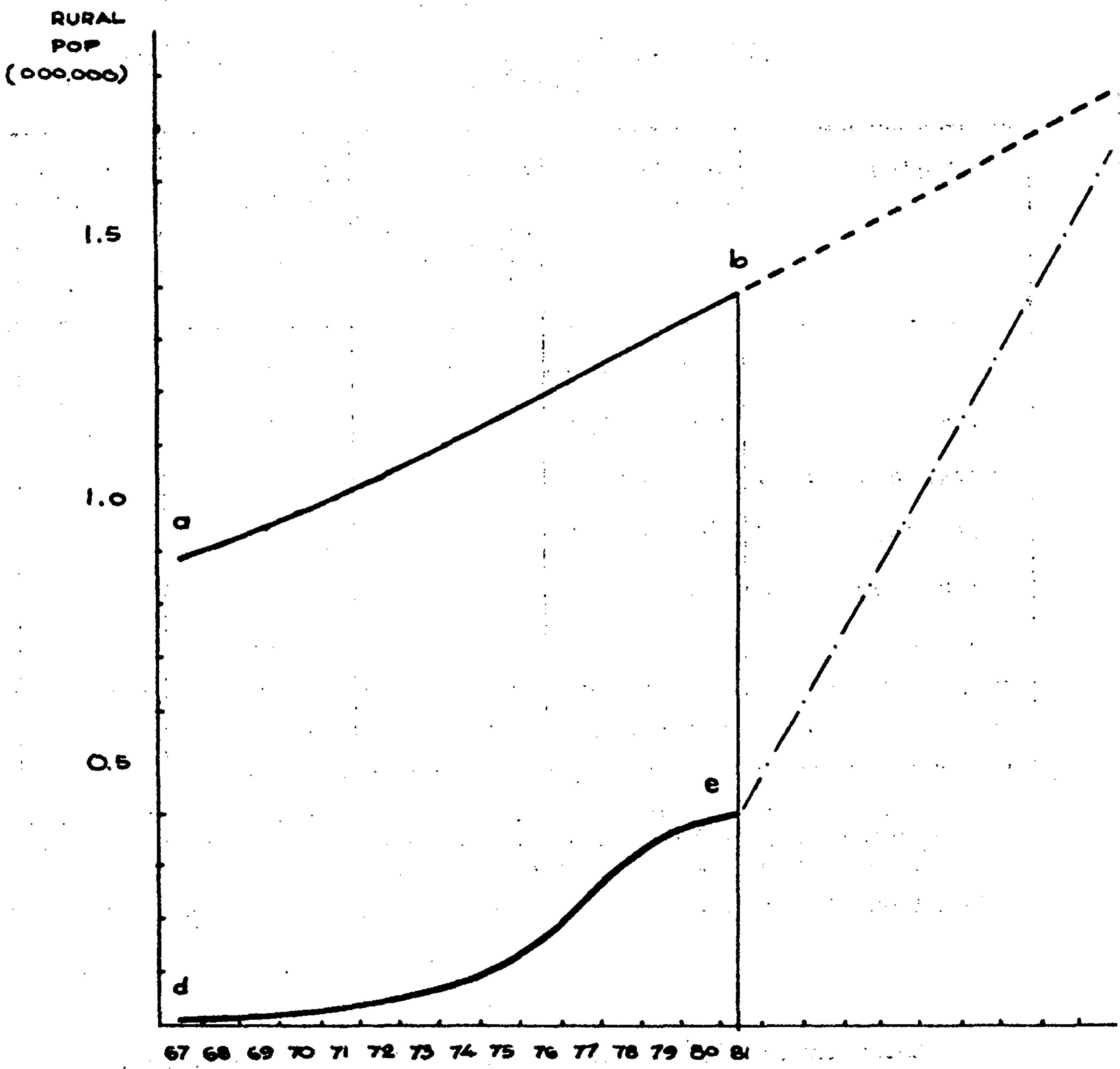



Fig 1. The rural water target
Design population projections
Shinyanga Region

## 5. SPATIAL DISTRIBUTION OF WATER SUPPLIES IN SHINYANGA REGION:

The preceding chapter discussed the development of domestic water supplies up to 1981 and projections for future development. Aggregate figures on regional level however hide a considerable variation of supply standard between different districts, wards and villages.

### 5.1 Distribution of Piped Supplies:

Map 1 gives the distribution of piped supplies in the region. Most schemes are located near major urban centres or in the near vincity of main transport routes between the district centres. The centre is favoured at the expense of the periphery. Most of the water supplies are furthermore located in Shinyanga Rural and Urban Districts. These two districts have almost 50% of all schemes in the region.

### 5.2 Distribution of Hand Pumped Supplies:

The availability of ground water depends on hydrogeological conditions. Good quality water cannot be found everywhere! Map 2 shows the distribution of wells (shallow and medium depth) with hand pumps.

Areas with highest prospects for ground water extraction have been developed while others remain neglected, like the area NW and SE of Shinyanga town. In these places the possibilities of finding sufficient amount of groundwater for domestic use is poor. In other areas the quality is unsuitable for human consumption because of the high content of fluoride and salt. In spite of these physical restrictions for ground water use, the distribution of hand pumped supplies is more uniform than that of piped supplies.

Compared to piped schemes the per capita cost for building wells with hand pumps is less than 1/4 the price of any diesel powered project. At least four times more consumers can be covered by the same investment cost.

### 5.3 Has The 1981 Goal Been Achieved?

The geographical distribution of water supplies is, however, of little value unless it is interpreted inthe context of population distribution. Today the whole rural population of Shinyanga Region is settled in villages. As stated in the goal every village was by 1981 supposed to have a source of clean, potable and dependable water within a reasonable distance as a free basic service. Wells with hand pumps fulfill these requirements of reliability and quality if properly built. Aspects of accessibility will be discussed later, at present we are satisfied if the well is within the village boundary.

By the end of 1981 290 villages had at least one well with hand pump within its boundaries, another 30 villages relied solely on piped supplies. Out of the total of 617 villages : the region 320 had some sort of improved source (52%). There still remains about 300 villages to cover. Map 5 on followi: page illustrates the spatial distribution of villages with improved source. As can be seen there are still large portic of Shinyanga Region with low coverage, especially in Kahama District and N.E. part of Shinyanga Rural.

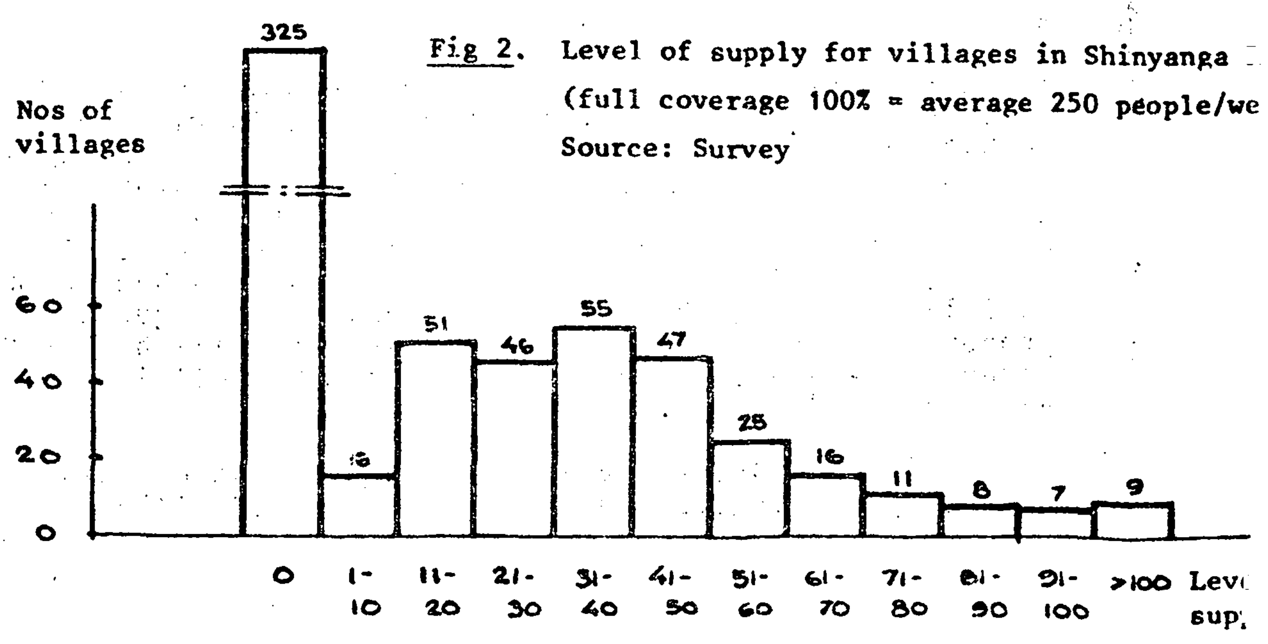
## 5.4 Level of Supply Possible With Adequate Functioning:

One supply point per village is, however, far from sufficien to cover the needs for domestic ater. A more realistic pictu of the supply level is given in map 6 where population suppli per well is calculated on ward level. As population suppliec through piped supplies is not included, map 6 does not give : complete picture of the supply level. However, as most pipe schemes in rural areas are operating at a very low level of reliability the map gives a fairly good estimate of present supply level, or more precisely the level of supply which co have been obtained if all hand pumps and wells built were working.

The level of supply is measured as numbers of people per well and when interpreting the map it should be borne in mind tha one well is supposed to supply an average of 250 people. No ward has at present reached this level of provision. Best service level is reached in Usanga Ward, Maswa District with an average of 330 potential consumers per well and hand pump. There are 113 wards in the region, of these 16 wards have no well at all within its boundaries another 28 have an average more than 2000 people per well.

If we go further down the scale and analyse the level of provision for the various villages we find very few places where the design criteria 250 people per well is met. Figur 2 gives the varying level of supply. Only 9 villages out of 617 in the region have 100% coverage (of these 6 are in Shinyanga Rural and one in Shinyanga Urban). On the other hand 325 villages have no well at all and very few of these villages benefit from a more sophisticated piped supply.

Fig 2. Level of supply for villages in Shinyanga
(full coverage 100% = average 250 people/we
Source: Survey



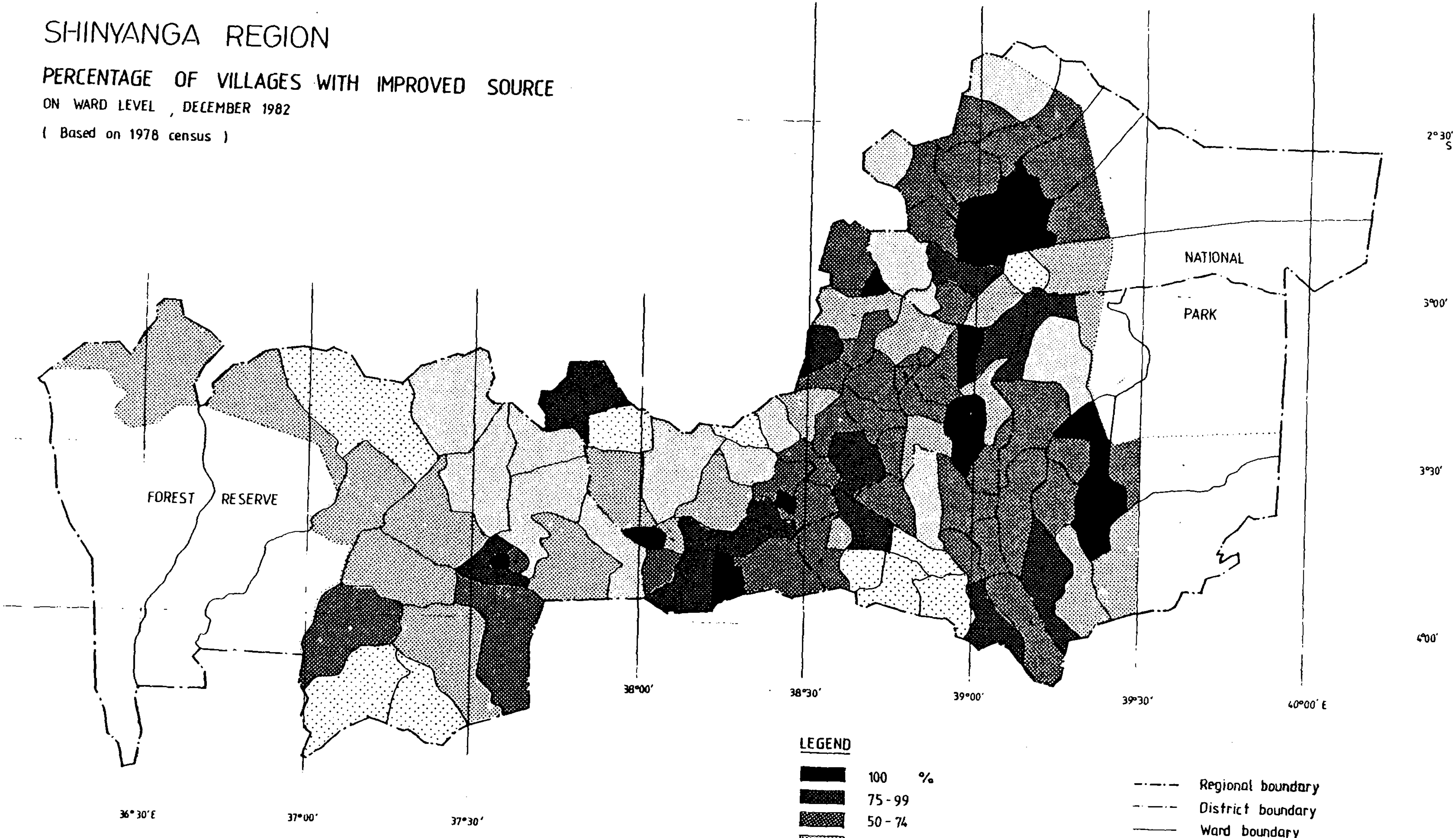
5

# SHINYANGA REGION

## PERCENTAGE OF VILLAGES WITH IMPROVED SOURCE

ON WARD LEVEL, DECEMBER 1982

( Based on 1978 census )



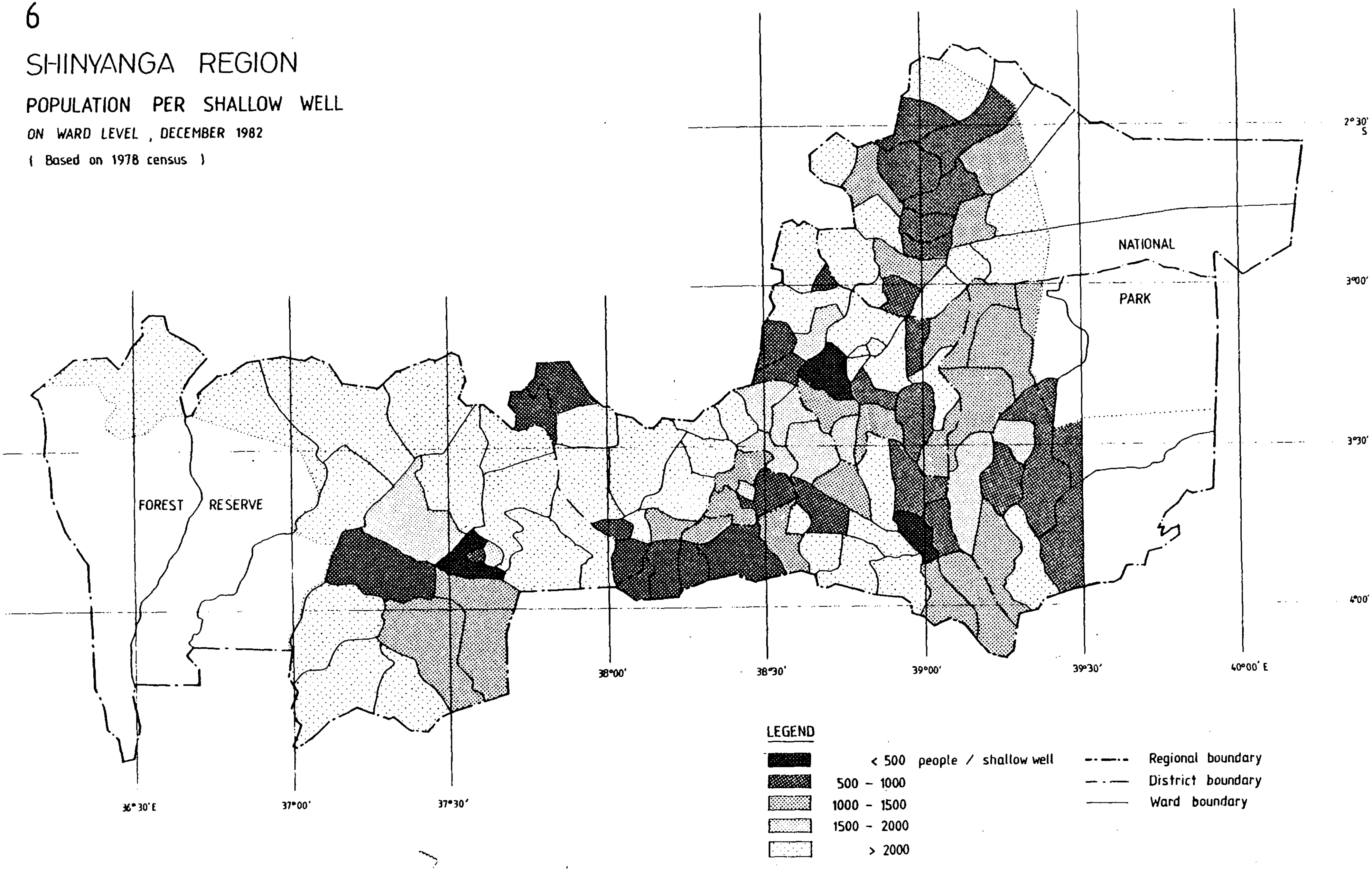
6

# SHINYANGA REGION

## POPULATION PER SHALLOW WELL

*ON WARD LEVEL , DECEMBER 1982*

( Based on 1978 census )



In all development projects there are conflicting interests between the various decision makers. In the Shinyanga case the consultants put emphasis on technical and economic efficiency and preferred to concentrate on a few areas at a time. They also proposed full coverage (1 well per 250 people) from the beginning. On the other hand the politicians and regional authorities emphasized equal distribution with the ambition to cover as many villages as possible.

Political considerations steered the decision making. Available funds were divided equally between the four districts. Instead of giving the villages 1 well per 250 people, only a few wells were built in each village. The long-term planning was that, after the hand-over to the Tanzanian organization in 1978, the villages would receive additional wells in order that each village would have a reasonable level of supply. However, due to the slow rate of implementation these intentions have never been fulfilled.

Figure 3 illustrates the variation in level of supply (not considering breakdowns) between various districts. 60% of all villages in Maswa (incl Meatu) have one well or more compared to 27% for Kahama District. 50% coverage is reached for 15-16% of the villages in Maswa and Shinyanga compared to 8% for Bariadi and Kahama Districts.

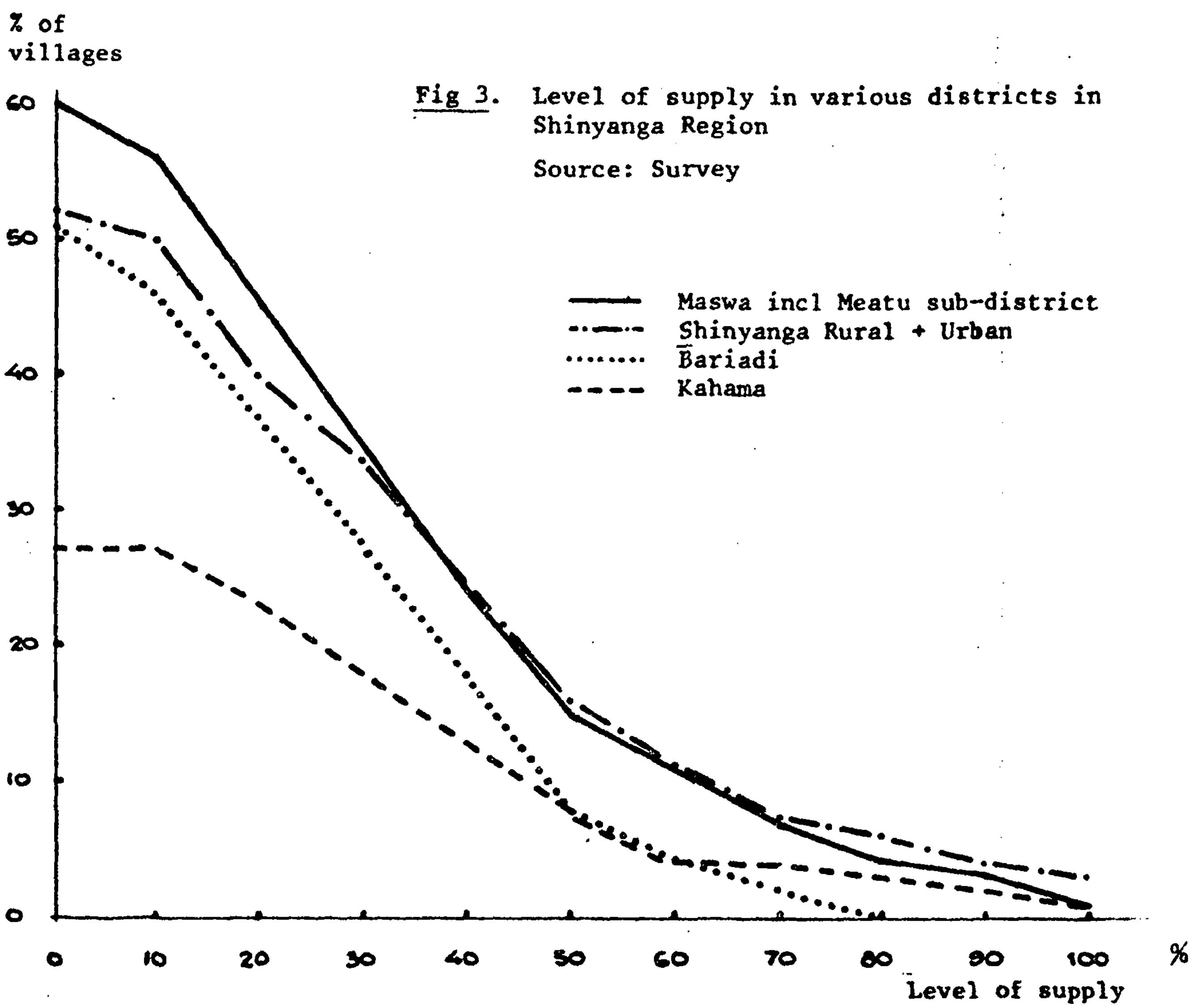



Fig 3. Level of supply in various districts in Shinyanga Region

Source: Survey

So far we have only discussed wells and hand pumps in a rural context. It should however be noted that many urban and semi-urban areas depend heavily on this simple form of water supply. Perhaps the actual impact of the shallow wells project is greater for these areas than for rural settings. In the small district Shinyanga Urban, for instance, 75% of all villages have one hand pump or more. These pumps also work with a greater degree of reliability than in other areas further away.

The densely populated fringe areas around Shinyanga and Maswa towns have only one form of supply - hand pumps. The major part of Bariadi town is also supplied in this way. The important trade centre Malampaka had, in late 1981, relied on hand pumps for domestic water for several months while the piped supply was out of order. In January 81 construction of wells took place in Kahama town at the district hospital and at the prison, indicating unreliable supply from the old piped scheme and users preferences for hand pumps instead of diesel powered pumps.

## 6. ACTUAL LEVEL OF SUPPLY:

In an earlier chapter we discussed the concept of level of supply, what present standards or practices are when it comes to quality, quantity, accessibility and reliability. References have been made to other studies to illustrate the problems involved in setting standards. The question now is. What actual service level can be expected from shallow wells with hand pumps? How big a portion of the installations deliver adequate quantities of water? Is the quality delivered of acceptable standard? etc.

The data analysed in this section was collected during fieldwork in January 1982. Two different methods were used in gathering information:

- Survey - site visits to a random sample of wells and hand pumps
- Inventory - interviews with maintenance officers on regional, district and divisional levels.

### 6.1 Piped Supplies:

Although this study concentrates on aspects of hand pumped systems some findings about the actual availability of water from piped schemes must be included to give a balanced picture of the development.

The present state of piped supplies is not different from experiences in other regions as described in Chapter 3. If strict criterias for reliability are applied (compare section 3.4) probably none of the existing rural or urban water supplies is up to standard. The schemes in main urban areas have a better performance than those in rural setting. The reason for this is not that they are in better condition - the frequency of breakdowns is indeed very high, but when the engine or pump is out of order repair is quickly carried out. A number of influential inhabitants will not accept the inconvenience caused by a broken down pump for a longer period. Furthermore skilled staff, fuel and vital spare-parts are usually always available in urban centres.

Rural schemes are unreliable even when they are new. If they are in working condition the supply of fuel is very irregular. For instance at the time of the fieldwork Busangi W/S (Kahama District built 1979) been at a standstill for 8 months due to shortage of diesel. Kigwanyhona W/S (Shinyanga Rural, built 1978) has not been operating since September 1979 for the same reason.

In Bariadi District the rural supplies are only allocated one drum every four months - one drum is expected to last one month. Remaining quantities of fuel are expected to be bought and transported by the villagers themselves. However, diesel is difficult to get hold of and if a small quantity is available priority is given to transport and maize mills.

Map 3 indicates which piped supplies can be considered fairly reliable and those not working or giving unsatisfactory supply.

## 6.2 Hand Pumped Supplies From Shallow and Medium Depth Wells:

960 wells were identified through interviews with maintenance officers on regional, district and divisional level. Location of these wells is shown on map 4. Distribution between the various districts is given in Table 2.

The result of the inventory is:

| | Nos | % |
|---|---|---|
| Wells identified January 1982 | 960 | |
| Wells with hand pumps installed | 905 | 100 |
| Hand pumps in working condition | 555 | 61 |
| Hand pumps out of order | 350 | 39 |

About 55 wells had been completed but no pumps could be installed as these were not available. In such cases the people used bucket and rope to draw water from the open well. 555 pumps were in working condition, but according to the maintenance officers, another 270 pumps which were out of order could be repaired. The remaining 80 wells and pumps were not possible to maintain for reasons such as:

- wells near river beds washed away
- not sufficient recharge
- cylinder assembly and superstructure beyond repair.

There is a considerable differance in actual level of service between the various districts. For instance in Kahama District where the oldest pumps are found only 41% of all pumps installed were working satisfactorily while the corresponding figure for Shinyanga was 90%. It should be noted however that maintenance in Kahama District has been neglected. A rehabilitation programme is about to start and all old hand pumps will be replaced. Excluding Kahama District in the calculation it seems as if the present maintenance organization is capable of keeping roughly 80% of the servicable pumps in running condition at any given time.

The level of supply as per January 1982 is indicated in figure 4. The upper graph (a-b) on figure 4 indicates the level of supply that would exist if all hand pumps were working. 47% of all villages have one or more wells within its boundaries. The remaining 53% lack this form of service. 12% of the villages have their estimated demand covered to 50% or more i.e. average 500 people per well or less.

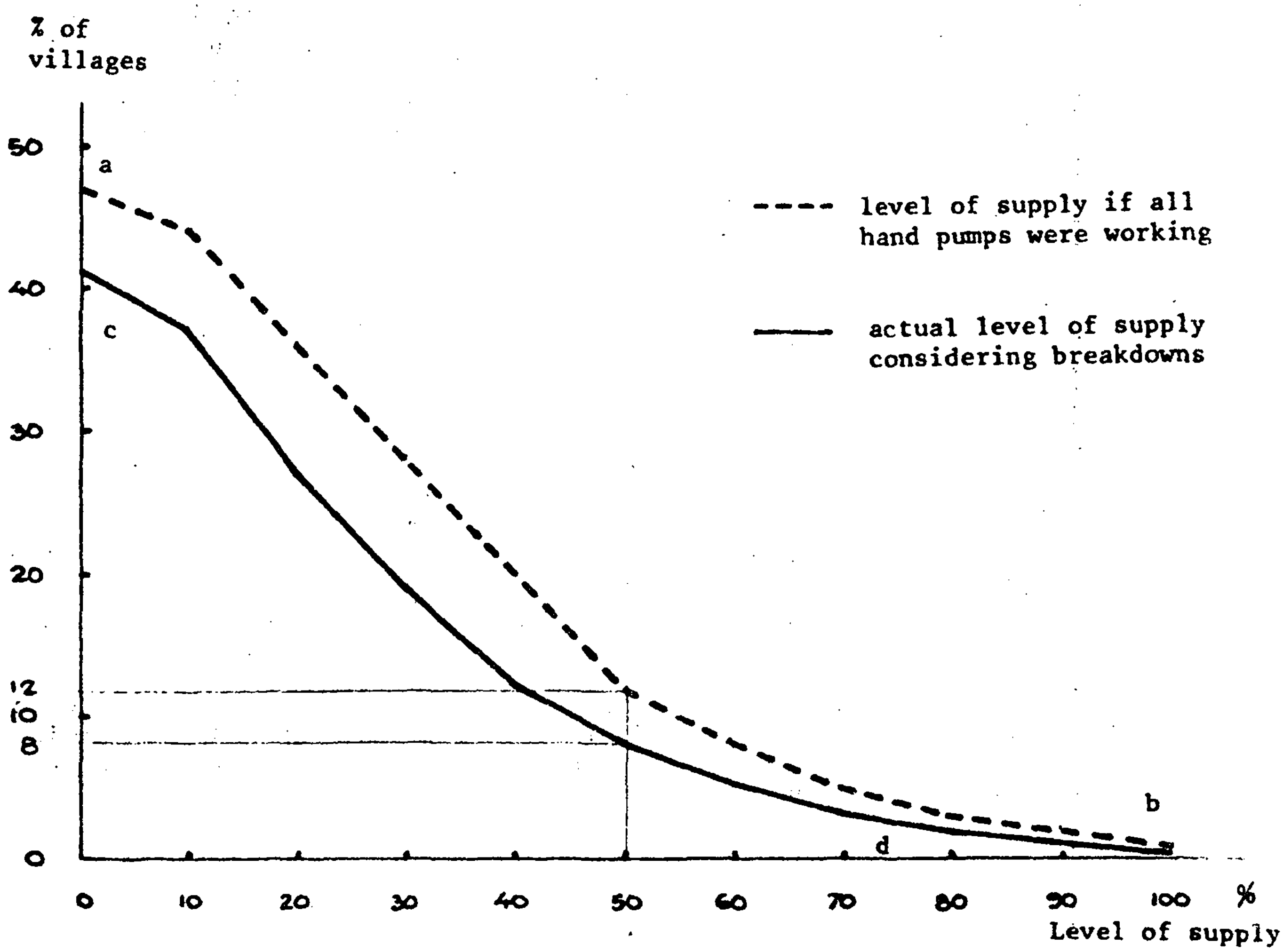



Fig 4. Actual level of supply from hand pumps in Shinyanga Region-

Source: Survey

If we consider the effect on supply level caused by breakdowns of the pumps of course the impact is smaller. The lower graph (c-d) in figure 4 illustrates the actual level of supply (based on the design figure 250 people/well) as it was in January 1982. 42% of the villages in Shinyanga Region have at least one well with hand pumps in working condition. 5% had once been provided with wells and hand pumps but none of them was working. 50% actual coverage is reached for 8% of the villages compared to 12% which could have been supplied if all pumps once installed were working.

## 6.3 Actual Level of Service in Shinyanga Region.

In section 6.1 and 6.2 we have estimated the actual availability of domestic water from improved supplies in the form of diesel-powered, piped projects and wells with hand pumps. Based on this information it is now possible to estimate the actual level of service in Shinyanga Region.

The findings from an inventory made in 1975 indicates that, by then about 108,000 rural inhabitants were supplied from piped projects. Of these 27,000 did not get any water because some schemes were out of order. (Engstrom, J.E. & Wann, J.E. 1975). Another study from 1979 indicates that at that time 50% of all piped supplies were at a stand still and about 10% of the hand pumps out of order. The design population amounted to 357,000, but in reality only 270,000 had an acceptable level of supply (Andersson, I. 1980).

The situation in rural areas today, as we have seen, is that about 60% of all hand pumps installed are functioning and 0% of the diesel powered rural schemes operate with acceptable reliability. 403,000 people have been provided with improved water supplies over the last 15 years but in terms of reliable supply the actual number has decreased to 154,000 (graph f-g, figure 5). If the distribution of fuel would improve about 50% of the piped supplies could start thus increasing the actual number of rural people with reliable supply to about 230,000 (graph f-h). The sad fact remains however that fewer people have access to improved water supply today than some years ago measured in both relative and total terms.

The ongoing rehabilitation of hand pumps will hopefully, in a short period of time improve the actual level of service but unless the present system of maintenance is considerably improved the curv will soon point down again.

There is a great need for revision of present policies if the ambitious goal to provide all rural inhabitants with improved water supply by 1991 is to be attained. The demand for clean water for the projected 1.8 million villagers in Shinyanga Region 1991 must be met through a strategy including following activities (compare figure 5).

| | | Population (000) | 1991 % |
|---|---|---|---|
| A. | Improved preventive maintenance to ensure continued supply from existing hand pumps in working condition. | 150 | 8 |
| B. | Improved fuel distribution to existing diesel powered projects. | 70 | 4 |
| C. | Rehabilitation of existing piped supplies. | 80 | 4 |
| D. | Rehabilitation of wells and hand pumps presently out of order. | 100 | 6 |
| E. | Construction of new shallow and medium depth wells. Estimated ground water potential sufficient to supply 40% of remaining population. | 560 | 31 |
| F. | Construction of new water supplies exploiting other resources than shallow ground water. | 840 | 47 |
| | | 1.800 | 100 |

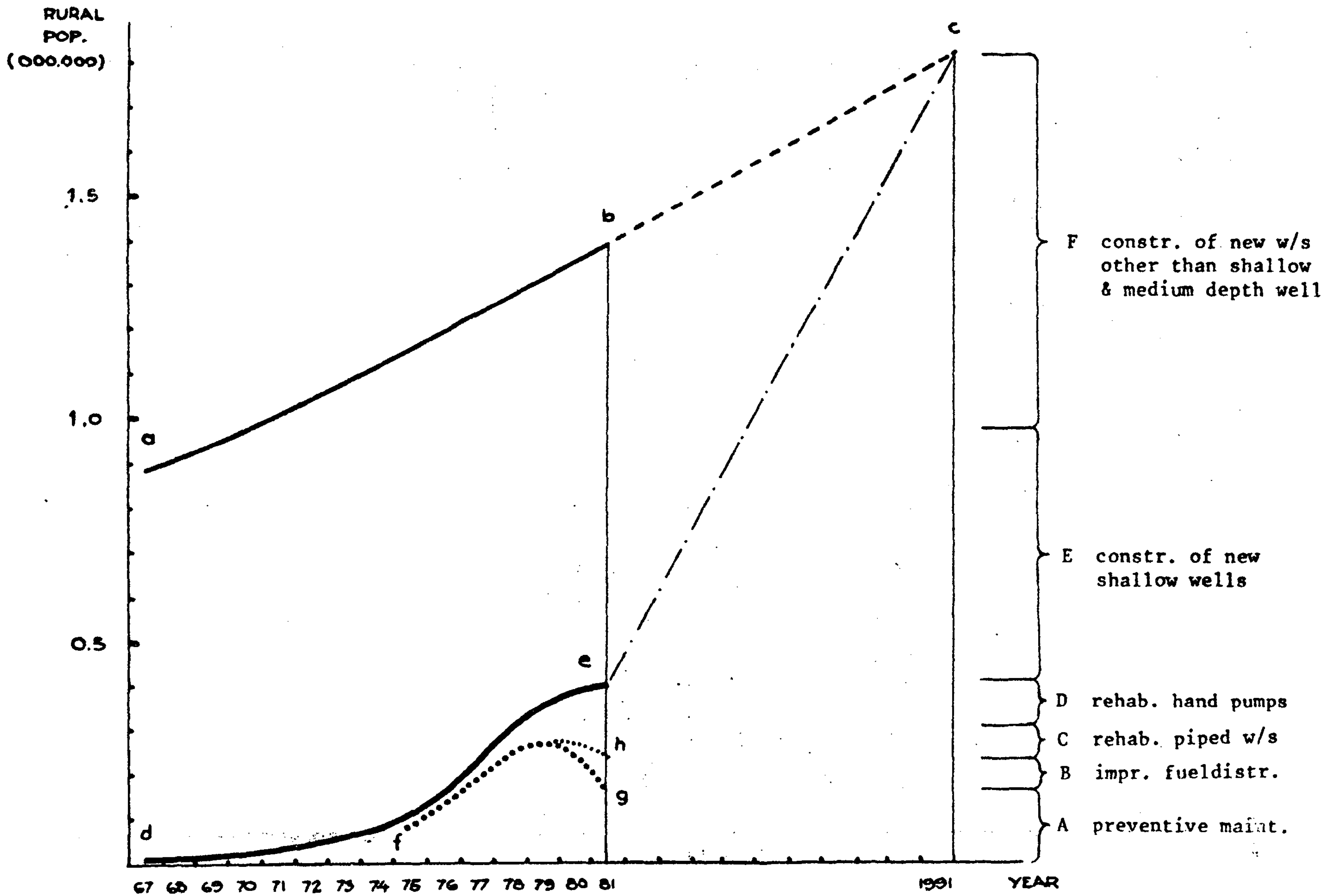



Fig 5. Actual level of supply in Shinyanga Region and the

## 7. A SURVEY OF THE HAND PUMP PROGRAMME:

So far the problems of water supply have only been discussed in the macro perspective. There is a need for more detailed studies to find out the unsatisfactory performance of existing schemes. A technical evaluation can give some answers to why the water supply does not meet expected standards. Such evaluation was carried out during two weeks in January 1982 to find out:

- extent and causes of breakdown of the supplies
- the most common technical problems
- appropriateness of the technology in relation to existing organization for operation and maintenance.

### 7.1 Reliability:

The extent of breakdown of wells and hand pumps as found in the survey is given below:

| | Numbers | % |
|---|---|---|
| Well sites visited | 57 | 100 |
| Well abandoned (washed away or low recharge) | 7 | 12 |
| Pump in working condition | 33 | 58 |
| Pump out of order | 17 | 30 |

20 hand pumps were well maintained, remaining 30 pumps (60%) were in need of maintenance (also minor defects are included in this figure for examole a missing nut). 40 pumps (80%) were considered worth maintaining. The rest (20%) were beyond repair.

In following sections the frequency of breakdowns is studied in relation to

- type of well
- type of pump
- age of pump

Causes of breakdwons are then studied in more detail e.g. which part of the pump gives most problems and what has been done to improve the performance.

7.1.1 Type of Well:

In Shinyanga Region four different well types can be distinguished

A. dug wells with constant diameter over full height

B. dug wells with reduced diameter in upper well section

C. drilled wells

D. river wells

For a detailed description of the various types see the handbook Shallow Wells (DHV 1978)

The majority (almost 60%) of all wells built are of type A. Type A and B are hand dug and together account for about 70% of all wells made. Another 20% are drilled, mainly by hand but to some extent also by motor driven rig. There was a shift in emphasis during the years from hand-dug to hand-drilled wells. The hand-drilled well is generallly deeper than the dug well but as drilling takes less time than excavation by hand and dewatering is not necessary, it turns out the cheapest alternative. The drilled well has hardly any storage capacity and has a much smaller diameter than a dug one. The narrow hole, only 15 mm in diameter makes it impossible to use buckets to draw water if the pump is out of order. Type B is equally inaccessible due to a narrow opening.

The prevalence of breakdown of hand pumps at wells of type A, B and C varied between 25-35%. The higher percentage for the wide hand-dug well (type A). The reason for this higher frequency is probably due to the fact that type A is generally older than type B and C.

River wells were introduced as a means to extract water from the sandy rive beds to a well and hand pump situated at a sufficiently high level on the river banks to avoid flooding in the rainy season. Different methods were tried. A rather sophisticated technique was used where the suction pipe of the hand pump was extended to a ring well in the middle of the river. Out of 35 wells built of this type only two are working today. Most of them have been washed away.

Another and simplier technique was developed where water from the river bed passes in a hand dug trench filled with sand or in a pipe to an ordinary well at the river side. This model proved more reliable, but a location close to an intermittent river is risky and also several of these have been washed away.

7.1.2 Type of Hand Pump:

Almost all wells visited were equipped with the so called Shinyanga Pump which was manufactured in Shinyanga during the project (see drawing following page). About 30% of this type of pump was out order in January 1982. 3 pumps of older model (Nairobi pump, Craelius pump) were included in the survey. They were all worn out.

Two wells with newer pumps, developed and manufactured in Shinyanga were also visited. The principle of the new pumps is the same as for the Shinyanga pump but steel pipes replace the wooden superstructure. The two new pumps were of recent date (made 1980), they were both working but showed considerable wear at the pin connecting the handle with the pump rod and would be out of order within a short time.

7.1.3 Age of Pump:

The sample was divided in three classes namely pumps and wells constructed 1975 or earlier, those built 76-78 and finally pumps installed 1979 or later.

The period up to 1976 includes wells built before the shallow wells project started and the first year of trial. Pumps from this period were generally in poor shape, 60% were out of order.

The result is the same for all district except Shinyanga District where 4 out of 5 pumps from this period were still working.

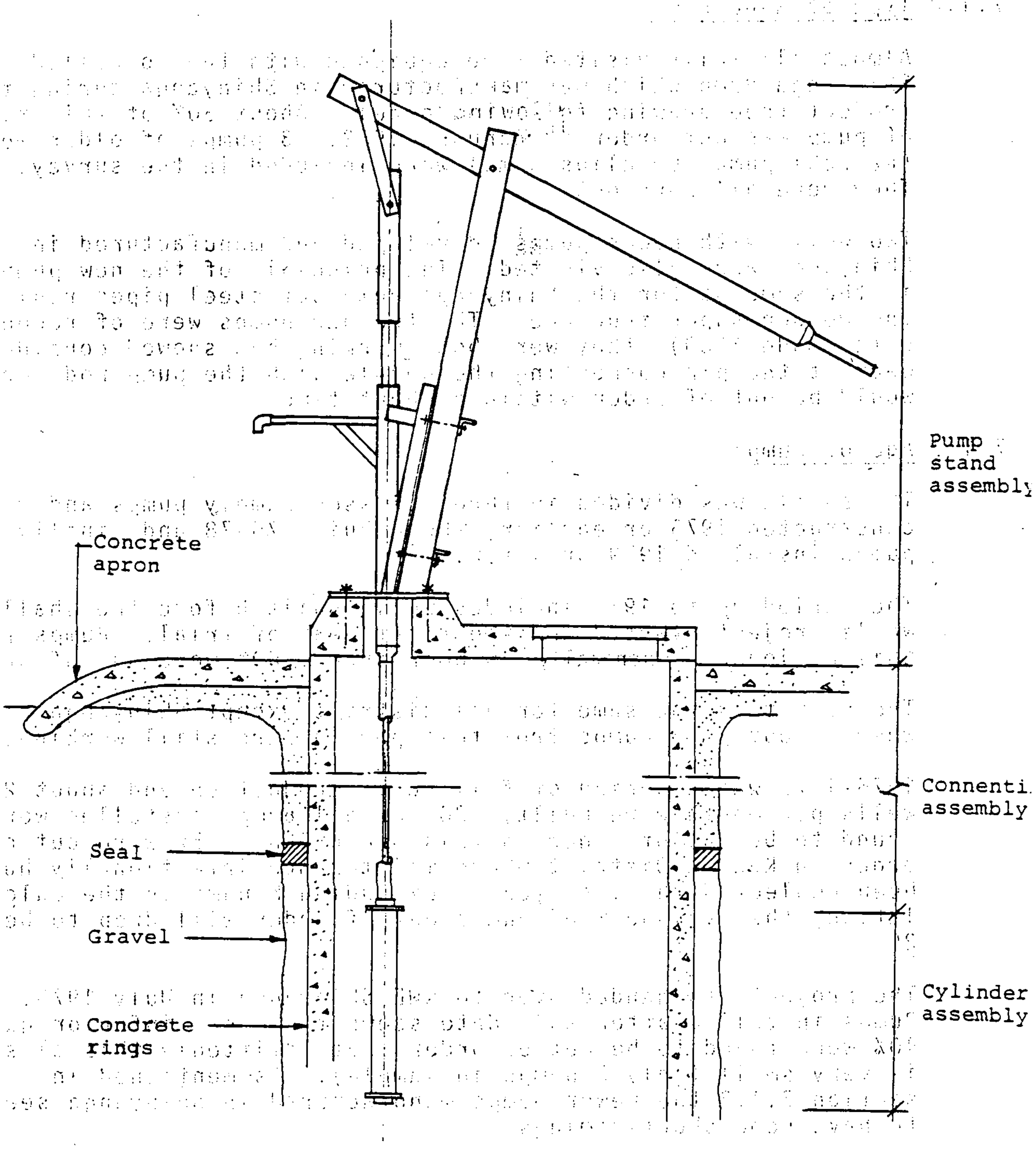
1976-1978 was a period of full scale production and about 20 wells per month were built. 30% of all pumps installed were found to be out of order in this age group. 75% were out of order in Kahama District where maintenance intentionally has been neglected the last year. Excluding Kahama in the calculation, the average % of pumps out of order will drop to below 25%

The project was handed over to RWE Shinyanga in July 1978. Pumps installed after this date seems to be of inferior quality. 40% were found to be out of order, but admittedly this class is very small (only 5 pumps in sample). As mentioned in section 7.1.2 the newer pumps manufactured in Shinyanga seem to have some short-comings.

7.1.4 Causes of Breakdowns:

The component assemblies of hand pump can be divided by function into three categories:

- the pump stand assembly atop the well
- the pump cylinder assembly in contact with water
- the connnecting assembly which joins the pump stand and the cylinder.




THE SHINYANGA HAND PUMP

For a more detailed description see Hand Pumps, IRC Technical Paper No. 10. (McJunkin, F.E. 1977)

The main reason for a shallow well not supplying water is, that the hand pump is not working. The most troublesome part is the cylinder assembly with its moving piston and valves. The pump cylinder was successively developed during the shallow well project. "The target was to construct a pump cylinder/ piston assembly with negligible maintenance requirements, which is comprised of parts which can be bought over the counter anywhere (DHV 1978).

As a result there is a variety of different cylinder assemblies used in the SSWp. Unfortunately there are no records indicating which type of cylinder is used where.

Only the pumpstand and small part of the pumprod is seen above the well cover and it gives us no hint of what cylinder is used. In spite of this an attempt to evaluate the hand pumps was made. Information was collected partly from the survey, partly from maintenance cards at R.W.E.'s Office. Unfortunately the record keeping is irregular and one finds few records of repair after 1978.

Reason for pumps not working at time of survey:

The survey indicated that the pumps were not functioning due to fault in:

- pumpstand assembly 10%
- connecting assembly 60%
- cylinder assembly 30%

Pump rod disconnected from piston was given as the major problem in the connecting assembly. A defect which can easily be repaired by a local "fundi" if he has the appropriate tools.

Major repairs according to maintenance cards:

Information gathered from the maintenance cards gave a different picture from that of the survey. It should however be noted that the cards give details about what repair has been done; they do not indicate if the pump was out of order, or still working but in need of repair at the time of visit by the maintenance team.

The maintenance cards indicated the following distribution of repairs

- pumpstand assembly 20%
- connecting assembly 10%
- cylinder assembly 70%

Least problems have been encountered with the pumpstand assembly according to both the survey and the inventory of maintenance cards. The design of the pumpstand, however, affects the other components of the pump and much time, energy and money have been spent developing a new assembly, the Kangaroo pump.

The shortcomings of the Shinyanga pump, as given by the consultants (DHV) are:

1. Many hinge points which are subject to wear and tear and need frequent greasing.

2. Several bolts and nuts which get loose and lost or are stolen and used elsewhere, e.g. in oxploughs or oxcarts.

3. The wooden parts of the pump structure are often stolen and used as firewood.

4. The heavy superstructure causes the footplate to become loose after intensive use. Continued pumping causes the cylinder and connecting assembly to sway and this leads to a broken raiser or pumprod.

5. Because of the design of the superstructure most pumping is done with short, fast strokes. This results in considerably more wear of valve and valve seat that if pumping is done in long strokes. To solve this problem the consultants chose a design based on high quality components which had to be importe The development of the kangaroo pump can also be seen as a way to solve this problem. The operation of a foot pump cannot be carried out in short strokes.

6. The main reason for abandoning the Shinyanga pump for another design is, however, given as the difficulty in obtaining the necessary components. By 1977 those components which had been read.ly available could not be obtained in sufficient quantiti and were prohibitively expensive.

The development of the Kangaroo pump and, more recently, the SWN hand pump is an engineering solution to the above shortcomings. The Kangaroo pump, which is estimated to have a maintenance-free period of 10 years (DHV, 1978), is still under development. The design has been altered several times in recent years.

The Shinyanga pump has, however, several positive characteristics.

- It was manufactured in a local workshop in Shinyanga which sti exists but which has very reduced output.

- Most components, except the cylinder, were available within the country.

- Because of the simple design of the pumpstand it was possible to observe the actual working of the pump and thus it was easier for relatively unskilled persons to learn to repair it

- From an ergonomic point of view the Shinyanga pump seems very appropriate. It can easily be handled by small children and old women. A 4-5 year old child can get water out of the pump if it is in fair condition. An adult can fill a 17 litre buc in about 30 seconds, which is actually faster than it takes to get the same volume from a tap, Vandalism:

Another reason for changing design of pumpstand assembly was given as theft of the handle and other wooden parts of the pump. Of the 57 pumps visited no handle had disappeared. The wooden handle and upright were generally very worn around the pins at pumps built before 1976. But as mentioned earlier 40% of these were still working, in some cases thanks to simple repair done by the villagers using steel wire. If theft was a problem once this seems to have been solved, perhaps due to better information and understanding of the benefits of a hand pumped supply.

A problem much discussed in the Shinyanga project is the theft of bolts and nuts from the pumpstand assembly (mainly nuts fixing the foot plate to the concrete slab). Bots, nuts and clamps seem to be attractive for alternative use in e.g. ox ploughs and and ox carts. Their disappearance is an indicating of the existing priorities in the society. Of course agricultural production with potential economic return is valued higher than "unproductive" domestic work as water collection. There are probably differing opinions between men and women as well about this priority ranking.

25% of all pumps visited missed one or more nuts at the footplate. The problem is most acute in Bariadi District where nearly 40% of pumps was affected. It should however be noted that only in few cases was more than one nut missing and thus the functioning of the pump was not immediately affected. Howevever, if one nut out of four is removed the stress increases on the remaining bolts. The problem of swaying (as explained earlier) is accentuated and causes earlier breakdown.

7.2 Quality:

No actual control of water quality was carried out during the field work but problems related to the upkeep of hygienic standard were observed and will be commented in following section.

7.2.1 Quality Control:

A well equippped with hand pump can, if properly constructed, used and maintained, supply water of high quality.

The only real obstacle in Shinyanga Region is excessive flouride and/or salt content. To find out if the water is fit for consumption a check of flouride content and conductivity is made as early as at the hydrogeological investigation. After the hand pump is installed the well is disinfected with tropical bleaching powder until a concentration of 50 mg/l available chlorine is reached. This solution is left standing in the well for at least 12 hours, then water is pumped out until the remaining available chlorine concentration is below 1 mg/l (Trietsch, R. 1978).

After some time the well is supposed to be sampled again. This time both a chemical and bacteriological sample is taken and analysed in a laboratory. Regular quality samples of water is then supposed to take place at an intervals of no longer than two months for wells serving less than 2,000 people. (Ministry of Water, Energy and Minerals, 1979).

These are the guidelines worked out by the SSWP. The organization today normally carries out the sampling at survey, but when it comes to regular monitoring, the objective is impossible to achieve.

To follow the criteria would mean that each well should be visited 6 times/year, resulting in total of at least 6x960=5760 tests to be sampled and analysed. There are no resources for this neither in form of finances, manpower or transport to meet this demand. The Shinyanga Shallow Wells Project proposed a less ambitious sampling programme checking each well at least twice per year (once in the dry and once in the wet season) and of having a bacteriological check included every time (Trietsch, R. 1978)

Today the ambitions have been further lowered. The water quality section has their own landrover, and about 10 days/month is spent in the field collecting samples. The present capacity to sample and analyze is limited to about 50 wells per month which would mean an interval of average one and half year between investigations of each separate well.

7.2.2 Prevention of Pollution:

To prevent pollution great care must be taken in choosing a well site. The rule of thumb in the Shinyanga programme was not to locate any well within 100 metres of cattle posts, latrines and other health hazards and preferably upstream of those. (DHV, 1978). These aspects concerning location of the well, although closely related to quality will be discussed in section 7.4.2.

Other measures to prevent pollution are to build the well in such a way that waste water cannot enter the well. The following measures are recommended:

1. A concrete or clay seal is used just above ground water level to block seepage water entering along the outside of the well.
2. The cover plate and concrete apron around the well is designed to form a watertight structure.
3. Spill water must be drained away from the well to a special drainage area so that muddy wet places are avoided (breeding places for insects).
4. The well should be surrounded byaa fence of special vegetation to prevent cattle from entering and polluting the well area.
5. The users should be persuaded not to throw water anywhere near the well but in the designated drainage area.

Point 2-4 can easily be observed at a survey and gives an indication of the quality of the water in the well, especially as it was observed that most users do empty their buckets near the pump after rinsing. (point 5 above).

Condition of concrete cover and apron:

37% of the wells in the sample were inadequately protected against pollution. Either the concrete slab had big cracks, was broken or manhole cover was missing (in all 27%) or no concrete apron was constructed around the well (10%), due to recent shortage of cement.

Another 25% got minor remarks like e.g smaller cracks in the slab which might lead to pollution. 38% of all wells were found to be satisfactorily protected.

Condition of the area around the well:

Of the well sites visited more than one third (36%) could be descr bed as unsatisfactory. These wells were surrounded by muddy, wet places near the pump which formed excellent breeding places for mosquitos and other insects. This problem was most common in Bariadi District where 50% of all wells had some form of wet surrounding. In the other districts between 20-30% of the wells were unsatisfactory from this point of view.

Another third of the wells surveyed got other remarks concerning the surrounding. The main reason for this being long grass in the area near the pump. Less than 30% were considered to have well drained tidy surroundings.

The main reason behind all the muddy pools was of course the fact that all water used in rinsing the containers was thrown away near the pump, in combination with inadequate drainage. In other places clothes were washed and rinsed in the immediate vincity of the well.

At the construction more work should be carried out to arrange proper drainage e.g. a stone filled pit at a sufficient distance downhill from the well from where the water could perculate. More work on drainage doesn't necessarily mean higher costs as such work could and should be carried out by the villagers on self-help basis.

Fence around well site:

Only 4 out of the 52 wells in the sample had proper fencing that reallly prevented cattle from entering the area close to the pump.

In many places there were no traces of fencing as if planting had never taken place (especially in Kahama and Shinyanga Districts). Other well sites (mostly in Maswa and Bariadi) had remains of the fence once planted.

Nowhere it was observed that domestic animals were watered from the well. In very few cases traces of animals were seen near the hand pump and if so the well was located near a dam or charco where the animals were watered.

There is definite need for a demarcation of the well area. This area should be kept dry and clean and no laundry should take place inside the fence etc.

The fence does not necessarily need to be planted. The impression was that a fence of dried branches of thorn bushes (like a traditional boma) was easier to maintain and lasted longer. What material to be used should be based on local experience.

7.3 Quantity:

In theory given a well with sufficient yield, a handpump of the Shinyanga type can meet the daily demand of 500-800 people, assuming an average per capita consumption of 250 lpc and 10 hours pumping.

In practice however the collection of water is more or less concentrated to two peak demand periods, one in the early morning and one in the afternoon. This reduces the effective well capacity, limiting the number of consumers to approximately 250 per well (DHV 1978).

A survey carried out for the Shinyanga Water Master Plan (August 1972) gave an average consumption of between 12-13 lpc from traditional sources. Larger households (5 people or over) had a lower average daily consumption (11.6 l) than smaller (16.5 l). The distance showed a significant effect on the use of water. Families living at five minutes walking distance or less from the source had a per capita average of 14.1 l while those living further away used 11.6 l a day (NEDECO 1974).

The per capita consumption from improved (piped) rural water supplies is, according to WMP, slightly higher (16%) than from traditional sources. Households in urban areas and trading centres used between 20-23 lpc if water was collected from public taps (NEDECO, 1974).

To find the actual volume used for domestic purposes detailed studies must be carried out in the households and at the water source. That is outside the scope of this study, but the survey in January 1982 does not give any indication that more water is used if collected from hand pumps than from the traditional sources. Questions were asked of women collecting water at the wells (in all 14 interviews) and a typical answer is cited below:

A family of four living 400 m from a hand pump collected water for domestic use twice (morning and late afternoon) in a bucket containing 17 l (Average consumption 8.5 lpc). This water was used for drinking, cooking and washing of utensils. Bathing and washing of clothes was done at a traditional source nearer to the home.

A study carried out in Bariadi District 1979 confirms above findings. People still use their traditional sources even if a hand pump is installed in the village, especially in the wet season when the majority finds pools much nearer to the house than the new supply point. The improved quality of the water from the well is appreciated and people prefer it to other sources when it comes to drinking but the project has not changed much of the pattern of water use. The usages are the same whether there is an improved source or not, what is to be noted is that the people are more conscious of drinking pure water (Ausi, H. 1979).

4 Accessibility:

At least three spatial criteria must be considered when it comes to location of a well (shallow or medium depth) if policies, standards and recommendations are to be followed:

1. ~~The well must be located within 1-1.5 km from~~ the main settlement cluster (section3.3)

2. The consumers should live within a 400 m radius from the supply point (=the hand pump) (section 3.3)

3. Location of well closer than 100 m to latrines etc is not acceptable due to pollution hazards (section 3.1)

Criteria 1 and 2 give different interpretations of what an acceptable level of access is. The 400 m distance (a simple conversion of earlier criteria 1/4 of a mile) was set as a criteria for piped supplies at a time when few planners thought of alternative technologies like hand pumps. However, according to the policy the level of supply is supposed to be uniform all over the country regardless of physical, social and economic conditions which in fact determines the choice of technology. The 400 m criteria must be considered valid also for hand pumped supplies at least till there is a change in the official policy.

While criteria 2 can be said to consider the consumers' interest of ease of access, criteria 1 gives the producers' point of view; ease of exploitation. The possibility of finding a reliable ground water source within an area of 400 m from the settlement is indeed small, especially as dry and fairly high locations are normally preferred as habitats. If the search for ground water can be carried out in an area of 1.5 km radius instead of 400 m the surveyor has at least a 14 times[1] better chance of finding an acceptable source.

Criteria 3 is a restriction on the two earlier points in order to eliminate the pollution hazard. Present a campaigns emphasise the need for improved sanitary conditions in villages. Every household must have its own latrine. If the latrine is supposed to be used at all times of the day it must be close to the dwelling. Thus a restriction such as criteria 3 will locate all wells and hand pumps at least 100 m from the place where most water is used, in the homes.

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1 $\dfrac{\pi \times 1.5^2}{\pi \times 0.4^2}$

7.4.1 Distance between well and nearest habitation according to survey:

To get an idea of what service level, measured as distance, a shallow well programme can achieve the distance between the wells visited and nearest house was measured.

Average distance to nearest house was found to be:

Rural areas 250-300 m (range 40-1200 m)

Urban areas 40- 60 m (range 20- 100 m)

In the rural areas about 10% of all wells were located closer to the nearest habitat than 100 m. The reason for this is twofold:

- ease of access is an important factor for individuals chosing a site for a new house. Some houses close to hand pumps were found to be of recent date.

- the surveyors have often no possibility to choose between various sources. If the only possible location of a well is near to a house and the demand for water is great, he modifies the quality criteria and accepts a distance shorter than 100 m. In the survey it was found that wells constructed after the Dutch withdrawal generally were coser to habitats than those built in the SSWP.

The average distance 250-300 m to nearest homestead implies that walking distance between the well and the main cluster of houses is even longer-in most cases more than υ00 m. This figure should be compared with the findings from the Water Master Plan (NEDECO, 1974) where the majority of consumers at traditional sources came from a distance of approximately 500-800 m.

From this two conclusions can be made:

- it is impossible for a shallow well programme to meet the national objective of supplying water within 400 m for all villagers, unless the ground water potential is very favourable.
- from the point of view of accessibility (measured in distance) wells and hand pumps cannot be perceived as a major improvement by the villagers. At least not in wet seasons when often water is found nearby.

The latter point is confirmed in another study carried out in Bariadi District 1979. It was found that, in the dry season the distance between source and home had decreased substantially from between 3-6 km to 1.5 km. after installment of hand pumps in a village.

In the wet season however information and observations implied that the majority of the traditional sources are closer to the village than the new wells with hand pumps. The author concludes that time and energy has been saved during the dry season only. (Ausi, H. 1974).

For urban areas the distance between improved wells and nearest habit^t was generally much shorter, 40-60 m compared to 250-300 m in rural settings. Construction of new houses was found to take place even closer e.g. in Bariadi town where a house was being built only 20 m from a well with hand pump.

The risk for contamination is obviously higher in a densely populated town area than in a rural village. The higher the population density the more consideration should be given to aspects of water quality including safe locations of shallow and medium depth wells.

4.2 Quality as a function of distance:

In considering the health implications of waste discharge to ground water there are two central questions: (Kalbermatten, J.H. 1980)

1. How far do the pathogens move vertically and horizontally from the point of discharge

2. For how long are they able to survive

If the contamination reaches the ground water the pathogens move considerably further than if it travels through dry soil. To minimize the contamination the pit should be constructed so as not to extend below the water table. Risk for pollution is virtually nil if the bottom of the receptacle is less than 1.5 m above the ground water table and the soil is uniform and free from cracks (Winblad,U.& Kilama, W. 1979).

Studies of bacterial movement have shown that the pathogens can cover a considerable distance e.g. 30 metres in sand and in fine soil and up to several hundred metres in gravel or fractioned rock. Viruses may travel even longer distances. It must however be noted that when moving through soils the great majority of bacteria and viruses are retained in the first metre and it is only a very small fraction that are able to travel more than 10 m. It is generally accepted practice to keep a minimum distance of 10 m between latrine and well and increase the distance up to 30 m in gravel and sand. However it is difficult to establish detailed universally valid guidelines for separation of latrines and wells (Kalbermatten, J.M. et.al. 1980).

Winblad and Kilama are of the opinion that if an uphill location of a pit latrine cannot be avoided a distance of 15 metres will prevent bacterial pollution of the well. In sandy soil a latrine may be placed as close as 7.5 metres from a properly constructed household well (Winblad, U. & Kilama, W. 1980).

Nordberg considers a distance of 30m between latrine and water source to be sufficient even when soil conditions are unfavourable (Nordberg, E. 1979)

The Final Report - Part 1 from SSWP classifies various shallow aquifies suitability for shallow well construction concerning depth, quality, pollution hazard etc. (DHV, 1978). The same report contains information on the existing aquifer types of all wells constructed up to July 1978.

Highest pollution hazards occur in laterites (outcropping and on slopes) due to the cylinder - like structure. The natural filtering capacity is very small. Moderate pollution hazards are reported for aquifer of fine clay or silty sand (on clay and sandstone). The other aquifer types indicate no or little risk for pollution.

Out of 607 wells surveyed by SSWP hydrogeologists only 51 (19%) had aquifer with the highest pollution hazard, 11% had moderate and remaining 80% had no or little risk for pollution.

A safe distance of 100 metres between latrines and wells seems highly exaggergated. If the SSWP has a more integrated approach, including sanitary aspects, other ways of solving pollution hazards could have been found for those 51 wells with risk of contamination than a general rule of thumb. There are methods to restrict the hazards at the source of pollution such as alternative latrine types e.g. composting techniques or pit latrines with sand filters.

## . BENEFITS FROM HAND PUMPED SUPPLIES AS EXPERIENCED IN SHINYANGA REGION:

There seem to be differing opinions between the consumer and the producer in priority ranking of the more immediate objectives to improve quality, quantity, reliability and accessibility of water supply.

The producer, the technician, is trained to design pipelines and treatment plants. Emphasis is placed on quality. Quantity is more or less determined by the yield of the source. Accessibility, the location of supply points, is delegated to a survey team to decide (at the best in collaboration with the village leaders). Finally, the reliability is the responsibility of an operation and maintenance organization with inadequate allocation of funds and manpower. The producer has a sort of engineering pride to make technically advanced designs. A hand pump with few moving parts gets little attention if any.

The consumer, the village woman will compare the new "improved" water supply with her earlier traditional source. Her perception of water quality is vague. The volume of water used is restricted to a minimum in an inherited pattern of domestic duties. Time and energy does not allow for more than a few daily trips to the source. What is highly appreciated, is therefore the accessibility and the reliability of the supply

### 1 Convenience:

To be accepted and used a new water supply must bring obvious advantages as percieved by the villagers. The relative reliability of hand pumps compared to diesel powered schemes is much valued by users in Shinyanga Region. The reliability compared to traditional source does not favour hand pumps as long the former has sufficient volume of water to meet users' demands.

The accessibility to hand pumps is not considered adequate in the wet season when closer but polluted sources can be found. In the dry season however when no other source is available nearby, the well and hand pump is much used.

If water quality was given high priority in the society the polluted spring would have been bypassed and abandoned. More quantitites of water would also be used if the transmission mechanism of various diseases was known. Reasons for using more and cleaner water are rather abstract concepts to the villagers and there must be a big emphasis on education about water, sanitation, health and hygiene to change the water use pattern.[1]

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1)There are indications that such change of water use has occurred in some places where the polluted source is bypassed and water for drinking and cocking collected from a more distant well and hand pump. The old source is however still used for other purposes like washing, bathing etc. (Ausi, H. 1979).

It seems as if the most important objectives to promote are reliability and accessibility with less emphasis on quality. Similar views are expressed by Carruther, I. & Browne, D, (1977). They suggest that the appropriate service for poor rural communities should be a guaranteed source within reasonable walking distance with less emphasis on quality.

It is crucial to minimize time and effort spent collecting water if expected health benefits shall be achieved. Polluted sources will only be abandoned if the improved supply point is closer to the home than other sources. Health education can perhaps convince all women to use water of good quality but the quantity will not increase much unless the new supply point is within a convenient distance. Shallow or medium depth wells will only meet this criteria in a few cases.

## 8.2 Health:

Table 4 gives the mechanism of water related disease transmission and the preventive strategies appropriate to each mechanism. A strategy based on wells and hand pumps like in Shinyanga will, if carried out in isolation, have little impact on health. The major improvement of a hand pumped supply compared to a traditional source is higher quality of water. Reliability is better in dry seasons and will shorten the water collection journey. Still the distance is too long to have any substanatial impact on the volume of water used. In the wet season alternative, but polluted sources are closer to the majority of households than the hand pump.

The following impact of a hand pump project can be expected (given the constraints as experienced in Shinyanga).

1) Water-borne mechanism:

Protected wells equipped with hand pumps normally give drinking water of good quality. This is a prerequisite to control water-borne disease but the provision of safe water is not enough as all diseases of this type can also be transmitted by contaminated food. To further restrict transmission, casual use of other unimproved sources must be prevented. The latter objective is hardly ever achieved as has been pointed out earli

2) Water washed mechanism:

The strategy to control this form of transmission is to improve domestic and personal cleanliness. To achieve this there is a need for improved water accessibility and quantity. The Shinya nga project did improve accessibility in dry season but it is doubtful if the volume of water used has increased. In the wet season people still use their traditional sources which neither improve accessibility nor quantity. A reduction of water-washe diseases is not likely to occur, if not emphasis at the same time is put on information and education about improved hygiene

3&4) Water based and insect vector mechanism:

These mechanisms can be controlled if contact with infected water is provented. Water for all purposes must be only collected from improved sources and that is not the case in Shinyanc As earlier described unimproved sources are still in use, also where wells have been dug and hand pumps installed.

**TABLE 4**

**CATEGORIES OF INFECTIOUS DISEASES RELATED TO WATER AND PREVENTATIVE STRATEGIES**

| CATEGORY | EXAMPLES | RELATIONSHIP TO WATER | PREVENTATIVE STRATEGIES |
|---|---|---|---|
| Water-borne | Cholera, typhoid, dysentery, infectious hepatitis | Water acts only as a passive vehicle for the infecting agent. These diseases also depend on poor sanitation. | Improve water quality and prevent use of other unimproved sources. Improve sanitation. |
| Water-washed | Skin and eye diseases - trachoma, scabies - and leprosy, yaws, bacillary dysentery and hoodwarm. | Lack of water and poor personal hygiene create conditions favourable to their spread. The intenstional infections also depend on poor sanitation. | Improve water quantity and water accessibility and promote better hygiene. Improve sanitation. |
| Water-based | Schistisiniasis and guinea worm | A necessary part of the life-cycle of the infecting agent takes place in an aquatic animal. Some are affected by poor sanitation. | Decrease need for water contact. Control snail populatiin and improve quality of water. Improve sanitation. |
| Water-related | Yellow fever, malaria, sleeping sickness | Infections are spread by insects that breed in water or bite near it. Unaffected by sanitation. | Improve surface water management, destroy breeding sites and decrease need to visit breeding sites. |

Source: White, Bradley and White, 1972 and Saunders and Warford, 1976.

One of the most dreaded diseases - cholera - is transmitted in water which is drunk. Late 1981 there was a serious outbreak of cholera in Shinyanga Region.

All districts apart from Kahama was affected. This is worth noting because Kahama District has the lowest coverage of wells and furthermore the frequency of breakdowns were much higher than in other districts.

In Bariadi District 55 out of total 119 villages reported cases of cholera. Statistics were also available for Shinyanga Urban and the eastern half of Shinyanga Rural District (Kishapa, Mondo, and Negezi Divisions). In this area 51 villages of 129 had cases of cholera reported. The information obtained during the field study is presented below in a two-by-two table.

*TABLE 5*

*CROSS CLASSIFICATION OF*

*CHOLERA AND WATER SUPPLY IN BARIADI AND SHINYANGA*

*BARIADI DISTRICT*

| *NUMBER OF VILLAGES* | *CHOLERA REPORTED* | *NO CASES OF CHOLERA REPORTED* | *TOTAL* |
|---|---|---|---|
| *With well and hand pump* | 25 | 29 | 54 |
| *Without improved water supply* | 30 | 35 | 65 |
| *TOTAL* | 55 | 64 | 119 |

*SHINYANGA**

| *NUMBER OF VILLAGES* | *CHOLERA REPORTED* | *NO CASES OF CHOLERA REPORTED* | *TOTAL* |
|---|---|---|---|
| *With well and hand pump* | 25 | 37 | 62 |
| *Without improved water supply* | 26 | 41 | 67 |
| *TOTAL* | 51 | 78 | 129 |

**Shinyanga Urban and parts of Shinyanga Rural District*

As can be seen from the table there are no indications of relationship between cholera and level of water supply. (The ø-coefficient forthe Bariadi observations is 0.01 and for Shinyanga even less). However as this study has shown, most people in the region still rely on unimproved water supplies (at least for part of the year) thus no health benefits can be expected except for individual cases where the shift from old to improved source has been total.

Protected wells equipped with hand pumps normally supply safe water. Only in one case was a shallow well reported to be infected by cholera. This well was lined and covered but no hand pump was installed.

One of the first recommendations to a cholera infected village is to .bandon the traditional water source (often a river bed) and dig a unlined shallow well (if physical conditions, allow). The new well must then be used by all villagers. Users own buckets are not allowed for drawing water from the well but one special container must be used. The need for hygieric conditions around the well is also emphasized. Another advantage with wells compared to most other sources is that they can easily be treated by chemicals if contaminated.

To summarize - no real impact on health from a well and hand pump project like the one in Shinyanga can be expected. The project must be coordinated with other development activities including sanitation, health and hygiene. Even then it is doubtful if the water use pattern will change to any substantial degree so that more water will be used. The problem of accessibility remains. A development strategy based on wells and hand pumps does not meet the felt need for ease of access.

## 9. ORGANIZATIONAL ASPECTS WITH EMPHASIS ON MAINTENANCE:

The set-up of the organizational structure in the construction phase of SSWP is very well documented in the handbook "Shallow Wells (DHV 1978). The hand-over to the Regional Water Engineer in 1978 did not change the organizational set-up to any substantial degree although the financial input decreased drastically. The condition of vehicles and equipment has as a result of insufficient funds deteriorated. Lack of transport was considered to be the main bottleneck in January 1982. Since then however a Dutch supported rehabilitation programme (including new pumps and vehicles) has started thus improving the over all situation.

In this section emphasis will be placed on the organization of operation and maintenance of wells and hand pumps. Operation refers to activities and resources used in making a piece of equipment do the work it is intended to do. When it comes to hand pumps, however, all labour is provided free by the consumers and the only raw material needed, water, is provided by nature (Cairncross et al 1980). Thus we can restrict the following discussion to deal with maintenance only. Maintenance includes activities like periodic inspections, replacement or repair of damaged or worn parts and lubrication. Also the work to keep well and surroundings in hygienic condition is considered as a form of maintenance.

Two types of maintenance can be distinguished

(1) Preventive maintenance to prevent or minimize breakdowns

(2) Corrective maintenance is done after a breakdown has occurred.

In order to minimize transport cost etc. a combination of these two maintenance types was chosen in SSWP. The responsibility for preventive maintenance was delegated to the village, while a central organization based on the regional and district level was incharge of corrective maintenance.

Structure of the maintenance organization today is indicated below:

| | |
|---|---|
| Regional level: | Regional Maintenance Officer (RMO) Shinyanga |
| District level: | District Maintenance Officer (DMO) Shinyanga, Kahama, Maswa, Bariadi |
| Divisional level: | Divisional Maintenance Officer (Div MO) in 7 divisions of total 27 in the region |
| Village level: | Village Pump Attendants. Two in each village (at least). |

1 Regional Organization:

The overall responsibility of maintenance of hand pumps and wells in the region rests upon the Regional Maintenance Officer. On the regional level there is also a repair team equipped with vehicle and tools to carry out major repairs. This team spends about 5 days per month in each district which is inadequate considering the present conditions of the pumps. The bulk of the maintenance work is supposed to be managed from district level.

2 District level organization:

The District Maintenance Officer's (DMO) task is to check the village maintenance, to help with bigger repairs, to see to the provision of spares and to keep records on all wells in the district. The DMO is responsible to the regional organization where he can obtain the spares required and can request help for major repairs. The maintenance officers on district level have been allocated a motor cycle on which a box can be fitted for tools and spares (DHV 1978).

However due to lack of transport and increasing numbers of breakdowns the district maintenance officer cannot cope with all requests for repair. Early 1982 all motorbikes had been out of order for more than a year. The DMO has to rely on District Water Engineer for transport which is a constraint as some districts only had one vehicle in running condition.

3 Maintenance on divisional level:

To improve the performance a further decentralized system has been developed and maintenance officers have been employed on divisional level (Div.MO) to take over some of the duties of the DMO. (Kashoro 1980). Financial constraints limit the number of Div. MO to 7 although there are 27 divisions in the region. In most cases a Div.MO rotates between two divisions as one division normally does not contain enough wells for full time employment. In case there is no Div.MO in the division the duties of maintenance is directly under the DMO.

The Div. MO travels by means of bicycle or bus (less frequently). He/she is equipped with some tools e.g. pipe wrench and spanner and is trained to carry out simple repairs like fixing a disconnected rod. The educational background for a Div.MO is standard 7 plus several years working experience in one of the shallow well projects. Additional training has been given for 2-3 months at the workshop in Shinyanga.

The target for a Div.MO is to visit at least 40 wells per month. Some of these visits are at the request of villagers to carry out repair but most visits are a part of a preventive maintenance schedule where all villages in the division are visited in time and each well site and hand pump is inspected. The Div.MO spends one or two days in the village. On arrival at the village the chairman is contacted. Inspection is normally carried out in cooperation with the village leaders. The Div.MO brings along a "visitor's book" in which records are kept about the state of the well, repair needed etc. The village manager is supposed to sign this report every time the Div.MO has visited the village.

The Div.MO can at the most visit 6 well sites in a day when in a village. Ideally the village should be revisited a few days later to check that the recommended work has been properly done. If the well or surrounding is still not well kept the maintenance officer has the authority to plug the pump as punishment. However this measure is seldom used.

## 9.4 Maintenance on village level:

"The responsibility for good maintenance lies with the village water committee, which appoints two pump attendants per village or per well. These pump attendants are trained in preventive maintenance and simple repair and receive instructions on keeping the well surroundings clean" (DHV, Final Report, Part 1, 1978)

The performance of the pump attendants is often discouraging. The appointed attendant is in most cases a young man, with some skill in technical matters. After having received additional training in maintenance of hand pumps he starts looking for better job opportunities than being a part time and unpaid pump attendant.

It would be more relevant to appoint attendants with strong ties to the village e.g. married women or settled men. The 10-cell leader on whose ground the well is dug could perhaps also be given the responsibility (as he is for the upkeep of latrines within his cell). Or a nearby peasant could be appointed pump attendant and in return be allowed to use the water for irrigation of his vegetable shamba.

An approach as outlined above would mean that most maintenance work on the pump itself must be left for the district and divisional officers, which is actually the present state of affairs. (e.g. no pump attendant in Kahama District is known to ever have made any repair on a pump). More responsibility could instead be given to the village pump attendant for upkeep of hygienic conditions of the well site.

## 9.5 The role of women in maintenance:

In the search for a working system for operation and maintenance the involvement of women should be assured. The importance of women getting involved has often been stressed but few cases are known when any action actually has taken place. One exception was found in Kahama District where a younger woman has been appointed Divisional Maintenance Officer.

The Div.MO in Kahama was interviewed and some of the positive and negative aspects as perceived by heris presented below. Her duties do not differ from those given in section9.3.

To be a Div.Mo and woman has certain advantages. For instance she finds it easy to establish contacts with the village women, When visiting the well site she tries to have informal meetings with the women discussing cleanliness of the well and personal hygiene. As an aid she brings along posters giving the message that contaminated water causes stomach illness. This promotion is however done in isolation no cooperation takes place with local health workers.

There are also shortcomings being a woman and Div.Mo. Bicycle is the only reliable means of transport but this makes travel difficult during pregnancy, and it is still uncommon to see girls on bikes. There are traditional restrictions between man and woman when it comes to communication. The village council is often dominated by older men and a young female maintenance officer has problems to make her opinion heard.

Although there are certain problems inovlving women in maintenance, further involvement should be encouraged. When it comes to extension or promotion of water and health women are well suited as these areas by tradition are their responsibility.

Only in one known case has a woman been appointed pump attendant . In this village (Buyange, Kahama District) the higher level maintenance officers were very satisfied with the upkeep of wells and surroundings. For an outsider at least, the duty as pump attendant seem very appropriate for a woman. It should be of prime concern to her to keep pump and surrounding in good condition (given she appreciates and benefits from the new water supply).

## 6 Evaluation of present maintenance activities:

To get an idea of the efficiency of the maintenance organization, prevalence and duration of break downs were studied. Frequency had to be omitted in the survey as up-to-date information covering this aspect was not available. Attention was also paid to the communication flow from user to maintenance organization.

### 6.1 Reporting system from consumer to maintenance organization:

A well functioning reporting system is essential if a broken down pump is to be repaired within a reasonable time. Today the main flow of information goes from the user via the Village Chairman to District Maintenance Officer. The survey indicated that about 70% of all pumps out of order at any given time were known by the DMO. As the Div.MO was by passed in the reporting system his knowledge about breakdown was lower.

9.6.2 Prevalence:

Prevalence refers to number of units not working at any moment of time. The technical evaluation revealed that 30% of all pumps were not working due to technical problems.

9.6.3 Duration:

Duration refers to the length of time elapsing between break-down and repair. In the survey the duration of breakdowns could only be fairly well established in 10 cases. The average duration period was 4 months. If Kahama District where maintenance was intentionally neglected is included the average time betw breakdown and repair is then reduced to 3.5 months, This is an unacceptable long period during which the villagers are forced to use other (often polluted) sources.

There seems to be a considerable difference in duration of breakdown periods between rural and urban areas, e.g. a pump in Bariadi town stayed out of order for only one week before repair was done. In and nearby the district centres the problem of transport and communication is of course smaller and therefore the maintenance staff will know of a breakdown within hours. Social and political pressure will also ensure that repair is quickly done in urban areas if spares are available.

9.6.4 Alternative sources when hand pump is out of order:

One of the strongest arguments for a hand pump project is the reliability of the system (compared to most other types of water supplies). At a break-down one villagers can use other protected wells with pumps nearby, and are not forced to use polluted water from an unimproved source. This aspect was included in the survey. At a number of wells with hand pumps out of order (26 numbers), questions were asked to people living nearby where they now collected their domestic water. Although the sample is small the result gives an indication of what alternative sources are used when the improved supply fails.

| Alternative source used at break down of hand pump | | % |
|---|---|---|
| Unimproved: | riverbed | 15 |
| | well, spring | 27 |
| | pond dam, charco | 15 |
| Improved: | Another hand pump | 12 |
| | Manhole in well with broken down pump | 27 |
| | Water vendors (urabn areas) | 4 |

The alternative sources for 57% of the sample were open and easily polluted. 27% used to draw water from the manhole of the broken down pump. Also in this case there is a big risk for pollution. Thus 84% had to rely on water supply of unsatisfactory standard in the event of break down. 12% preferred to draw water from another protected well with hand pump. In the latter cases it was found that a hand pump was the nearest and most convenient alternative. It is obvious from this result that there is a need for a fairly high density of supply points in a village, if the objective to give all people clean water on a permanent basis is to be met.

9.6.5 Frequency of repair:

A sample of maintenance cards were studied in order to get an idea of the efficiency of the maintenance organization. Unfortunately the ambitious card system introduced by the Durtch in the SSWP has been neglected after 1978. The following results are thus based on old information and do not give a picture of present maintenance situation. The findings are still of interest as it gives some indication of frequency of break downs of various pump assemblies.

The maintenance cards indicated that each well was visited on an average once every six months and that:

- intervals between major repairs of cylinder assembly was on an average every 15 months (range 6-26). The most common repair reported was change of foot valve, and second most common was repair of piston
- Major repair of pumpstand was reported in few cases. The average time elapsing between such repairs was found to be about 18 months (range 9-29 months).
- Repair of connecting assembly was omitted in the card system perhaps because if the rod is disconnected it is easily fixed during other major repair work.

9.7 Some recommendations about maintenance:

Some tentative recommendations about a maintenance set up can be made from this information, given that the present level of local participation will not improve to a substantial degree.

There is a need for preventive as well as corrective maintenance on two levels:

a) regular check-ups by a div. MO at least every sixth month with emphasis on pump stand assembly, connecting assembly, and the conditions of the surrounding. Need for major repairs should be reported at the regional level.

b) preventive maintenance and major repair by a regional team which should visit each well once per year and replace the existing cylinder with a reconditioned and then take the old one back to the central workshop for overhaul. The pump stand and connecting assembly should also be checked and if necessary repaired or replaced. At the same visit water quality could be tested. The evironment around the well would be inspected as a check of lower level maintenance.

The regional maintenance team would require independent transport with capacity to carry spareparts and tools for several days work in the field.

The above recommendations are less ambitious than those put forward by DHV in their handbook Shallow Wells (1978) but more realistic in terms of manpower and cost. The present organization could be kept but recharged with additional inputs. After all the present maintenance set-up is doing a fair job considering all logistic shortcomings.

Further decentralization of maintenance to village level is desirable but cannot be imposed. Minor repair can be done by a local "fundi" but even then spare parts must be supplied from a central store. There is a need for a regular check up of pump, well and surrounding even if the village takes a bigger responsibility of maintenance in the future. The central maintenance organization must remain as a main component in any project as long as hand pumps are used.

## 10. A CASE STUDY: IGAGANULWA VILLAGE:

To exemplify the nature of rural water supply based on wells and hand pumps a brief description of the supply in one village in Shinyanga Region (Igaganulwa, Bariadi District) will be given.

Emphasis is placed on what is considered to be the more questionable features of water supply of this type. The findings are tentative and a future study on micro level will hopefully cover these aspects in more detail.

The layout of Igaganulwa village is illustrated on map 7 on the following page. 5238 people lived in the village in 1978. During 1977 11 wells were built and equipped with hand pumps (Nos.1-11 on map 7). Another three well sites were surveyed (12-14) but never constructed.

### Level of supply:

With 11 wells within its boundaries Igaganulwa is a well supplied village compared to most others (475 people/well). In January 1982 one hand pump was out of order. Two wells had insufficient recharge in the dry seasons. Considering these shortcomings there is an average of 655 consumers per well (assuming the whole population is using the wells).

### Technical aspects:

The aquifer for the majority of the wells consists of weathered granite, a thick clayey overburden prevents pollution of the ground water for all wells. All wells are hand dug except no1, 4 and 11. No.4 is an old MAJI borehole 25 m deep). Wells 1 and 11 were drilled by percussion drill. The depth of the wells constructed during 1977 is average 8.3 m (range 6-10 m). All wells were equipped with the so called Shinyanga Pump. They were all in good condition with the exception of one.

### Quality:

Following data on quality is based on Final Report Part I (DHV 1978)

- conductivity average 940 umho/cm (range 450-1400)
- flouride average 4.3 ppm (range 0.6-10.2)

Two wells (No.13 and 14) were abandoned at the survey due to high content of fluoride (8.6 and 10.2 ppm respectively).

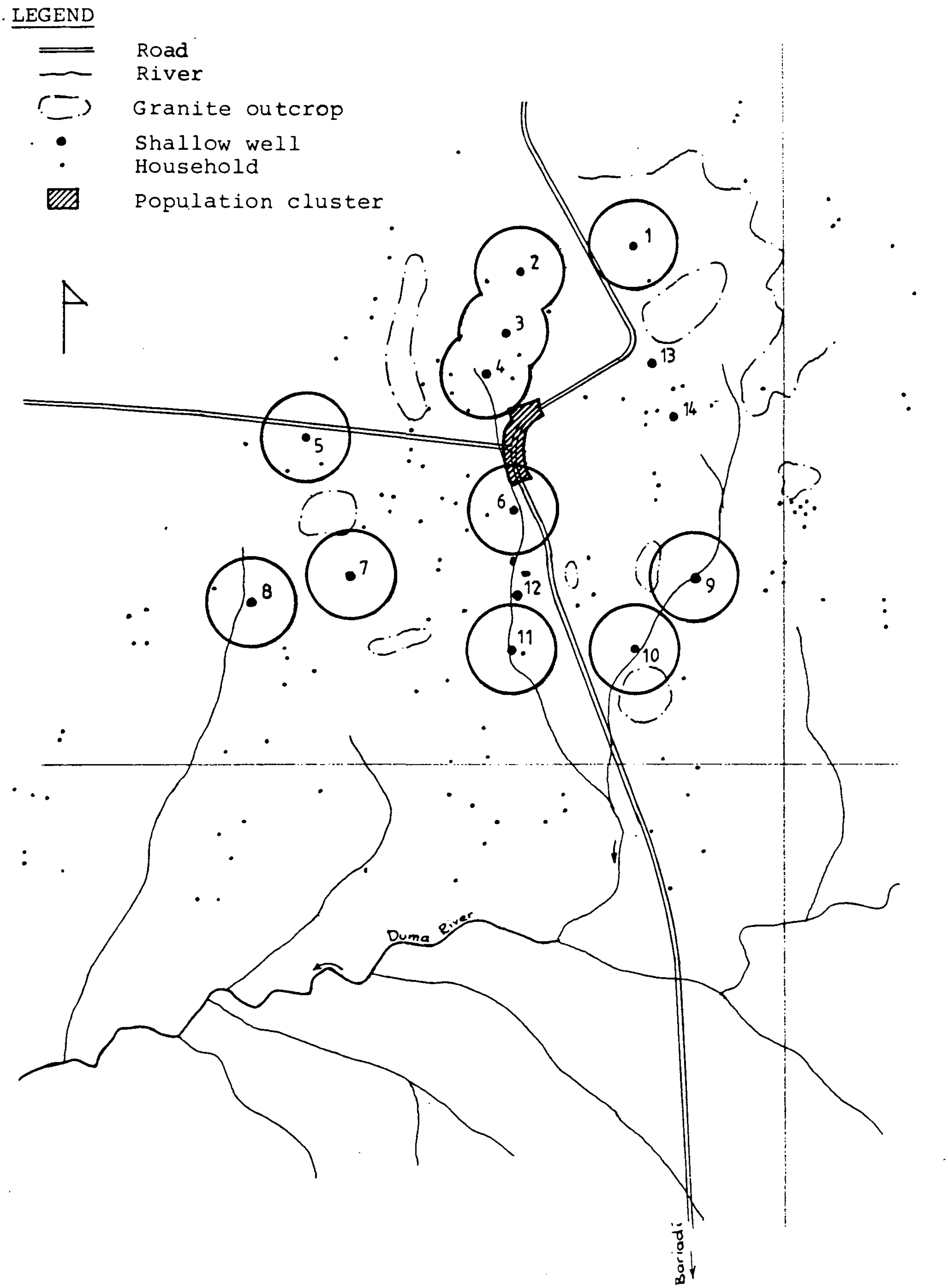
No data is at present available on the bacteriological quality of the water in the wells but three of the wells were surrounded by muddy pools of water and the slab had cracks indicating possible pollution. The water was considered to have a "good taste" by the users.

Accessibility:

10 of the 11 wells in the village were within 2.0 km distance from the outskirts of the main cluster, 6 within 1.5 km and 4 wells within 1.0 km. The well closest to the village was 200 m from the outskirts. The average distance between nearest house and well was found to be about 200 m (range 20-400m). On map 7 areas with acceptable accessibility (400m) are indicated as circles around each well.

Quantity and water use:

Discussions with the users revealed that people used the well as the only source of domestic water if no other alternative was closer. However, traditional pools or unlined wells were often used for washing clothes and bathing if such sources were more conveniently located than the well with hand pump. As there is a small stream passing near the village many people still use this as the sole source of domestic water as long as water is available in the river bed.




7

WATER SUPPLY IN IGAGANULWA VILLAGE

BARIADI DISTRICT     SHINYANGA REGION     SCALE 1:50.000

## 11 SUMMARY AND SOME TENTATIVE RECOMMENDATIONS:

A well and hand pump project such as the one carried out in Shinyanga can never by itself meet the objectives as stated in the national policy. To cover the whole rural population there must be a strategy for the development fo water resources based on different technologies. The availability of ground water limits the options for wells in many areas. However low cost technologies like wells and hand pumps must be the basic tool for development, if improved water supplied are to be more than a privilege for a selected few.

A shift in level of supply also means a trade off between cost and effort borne by the state and that borne by the public. The funds for the development of rural water supplies are very limited compared to the needs. The input from the government must be lowered at the expense of the users' effort. The relationship is illustrated in figure 7.

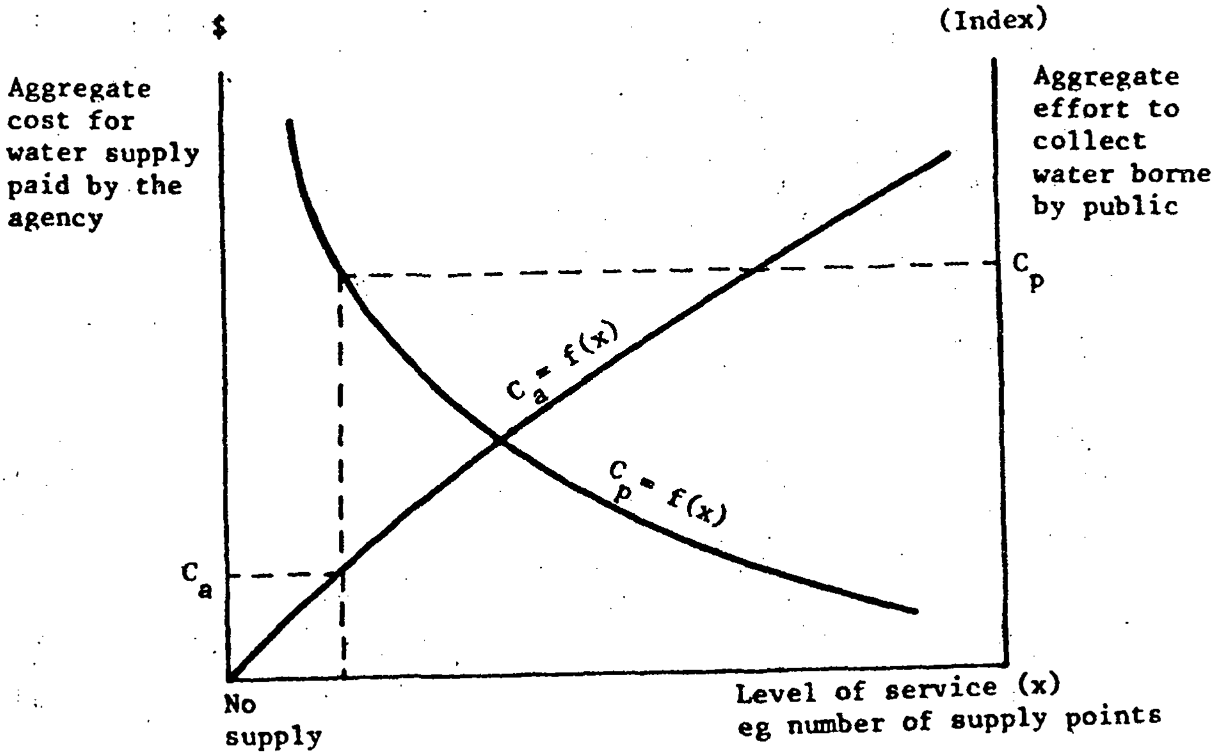



Fig 7. Trade-offs between costs borne by the water agency ($C_a$) and costs borne by the public directly ($C_p$) as a function of level of supply. (Adapted from Abler,R. et al. 1977)

There are of course severe problems in giving monetary value to the effort for water collection that is borne by the public and which increases when the level of service is reduced. However there exists a social optimum where the cost for the state of providing water plus the cost/effort by the public to collect it is least. Given all economic constraints in the present Tanzanian society, there is no alternative for the producer (MAJI) but to choose the least cost alternative. Low cost solutions will imply lower level of service which in turn means more effort must be spent by the public to obtain water for their domestic needs.

A low cost technology does not necessarily mean a supply of inferior quality. Quite the opposite as this study has shown. Wells equipped with hand pumps are, as a whole, a more reliable way of supplying water than diesel powered, piped schemes.

A shift in policy from piped supplies to hand pumps will involve change in many of the stated objectives of rural water supplies. Present standards cannot be met in terms of accessibility, quality and quantity. There is a need for revision of these standards, to lower them to what is realistic to achieve.

The major problems in a water supply without any distribution system to the users, are related to low accessibility. The shift in use from the traditional and polluted source to improved supply is seldom complete. The old source is often used for washing and bathing all year around. In wet season when most time is spent in the fields the overworked women of course choose to collect water from the closest source which is seldom the improved well with hand pump. When the hand pump is out of order the users will in most cases go back to traditional sources. Time and energy collecting water is saved mainly in dry seasons but conditions during rainy periods remain unchanged. There is no released labour to be utilized for farming activities when it is most needed.

Major health improvement cannot be expected from a water supply system based on wells and hand pumps like the one in Shinyanga Region for the same reasons as given above. The rather unhygienic conditions around the wells make the situation worse. To improve health the village must not only have a sufficient number of wells but the location of the supply points must be soaccessible that other polluted sources are abandoned for good at all times of the year and for all water use. With the break down of one pump the alternative source must also be of acceptable standard and within reach.

There are two major ways to make people use an improved water supply.

- Convenient location of the new improved supply. This is an obvious advantage to the user. Time and energy will be saved if the new source is more accessible than the old and polluted source.

- Education and information to the users carrying the message: Permanent use of more water of better quality will bring improved health. Abandon the old polluted source even if it is the most convenient. The extra effort spent to collect water from a more distant but better source will pay off in the future in the form of improved health for all.

A project based on extraction of shallow ground water and no reticulation can only in exceptional cases provide water within easy reach for all users. The probability that closer and polluted sources will be in continued use is very high indeed. Emphasis must instead be placed on communication with the users not only in matters related to water use but also hygiene, sanitation etc. to improve the overall health conditions.

Are the wells and hand pumps as developed in the Shinyanga Shallow Wells Project appropriate to the user? Apart from the problem of accessibility, a water supply of this form seems appreciated by the consumers. Although the concept of "simple" technology has paid an important role in the development, the final design of the Shinyanga hand pump is dependant on a certain level of infrastructure which has not yet been reached. Spare parts are not available, the maintenance organization faces serious logistic problems, village organizations are not capable of carrying out maintenance etc. The project was carried out in an era when concepts of economic growth and improved infrastructure governed the planning. The infrastructure has deteriorated rather than improved since then, especially since the Dutch support more or less ceased in 1978.

Is there an alternative model for rural water projects than the development as described in Shinyanga Region? If present policy to speed up implementation to reach the 1991 goal persists, the answer is probably No. Water projects will be carried out in isolation without considering other development activities, supporting infrastructure etc. The projects will depend heavily of foreign inputs, in form of funds, manpower and equipment. If this approach is chosen then the donor must also be prepared to remain for a long period to support maintenance and operation.

There is another more idealistic school of though emphasizing an evolutionary form of development. According to this school the development of water resources should be based on existing traditional sources. Of prime importance is the dialogue between the user and the supplier. Education and information is supposed to bring about change.

By simple means and locally available material the traditional supply can be improved. The hand dug well can be lined and covered, the spring can be protected. This model seems very attractive but it is time-consuming and also expensive if a centralized organization such as the one existing within MAJI today should be the implementor. Outsiders, such as promotion officers, can initiate the project but otherwise most of the actual implementation must be carried out by the villagers. A serious set back for this ideal model is the fact that there are often no reliable sources to improve in the close neighbourhood of the village. Then there is no alternative but to apply more advanced techniques. Or relocate the village which is a very unpopular move today.

The one model does not exclude the other, however. Many traditional wells can by simple means be improved to acceptable standard. In this way the users don't have to choose between old or new well. The water collection pattern will remain but water of better quality will be used. The improved well must be as reliable as the old or better. The main problem today in maintenance is to keep the hand pumps in working condition. Either the performance of the maintenance organization must improve or other more reliable means of drawing water must be used. There is however, little chance in the short run to obtain more funds to expand the maintenance organization or to transfer the full responsibility for repair of pumps to the villagers. The other option remains. Abandon the hand pump at hand dug wells where other means of drawing water can be used!

A bucket and rope mounted to a windlass could be an alternative. The design of the shallow well as developed in Shinyanga is appropriate also for windlasses. Concrete rings should be used for lining. On top there must be a impervious concrete apron and a headwall about 1.0 meter above the apron. The surrounding should be drained so waste water does not run in to the well etc. The well mouth must be covered when not in use. The use of wind lass instead of pump makes the well more vulnerable to pollution and vandalism. Such problems can however be handled by an organization at the village level while a hand pump out of order must be repaired by a skilled workman.

For many villages with no potential for shallow ground water the alternative is drilled wells. The only viable option to draw water is then the hand pump. Experience from Shinyanga Region indicates that deep boreholes can often be located closer to the village than shallow wells, thus reducing the problem of accessibility.

If use of hand pumps had been restricted to drilled wells in the Shinyanga Shallow Wells Project, the number of hand pumps required in Shinyanga Region could have been reduced by 80% to less than 200. A number which could have been efficiently maintained by the present central maintenance organization. Lower level maintenance could then pay more attention to control of pollution etc.

What is proposed is summarized below:

- <u>A shallow well programme without hand pumps.</u>
  The basic idea behind this is to concentrate limited resources on basic improvements, maintenance and sanitary inspections.

  Simple means must then be used for drawing water e.g. windlass. (If out of order bucket and rope can be used). Implementation and especially upkeep of such a programme could be handled by a decentralized organisation with little input from outside. More emphasis should instead be given to supporting activities like health education, sanitary improvements, provisions for clothes washing and bath near the supply point.

- <u>A separate drilled well programme with hand pumps.</u>
  Implementation of such a programme is outside the capacity of the local society as well as the maintenance. Construction and maintenance must, for the foreseeable future, be handled by a central organization like the present set up in Shinyanga. Special attention must be paid to the location of the borehole to ensure a continous use of the pump.

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