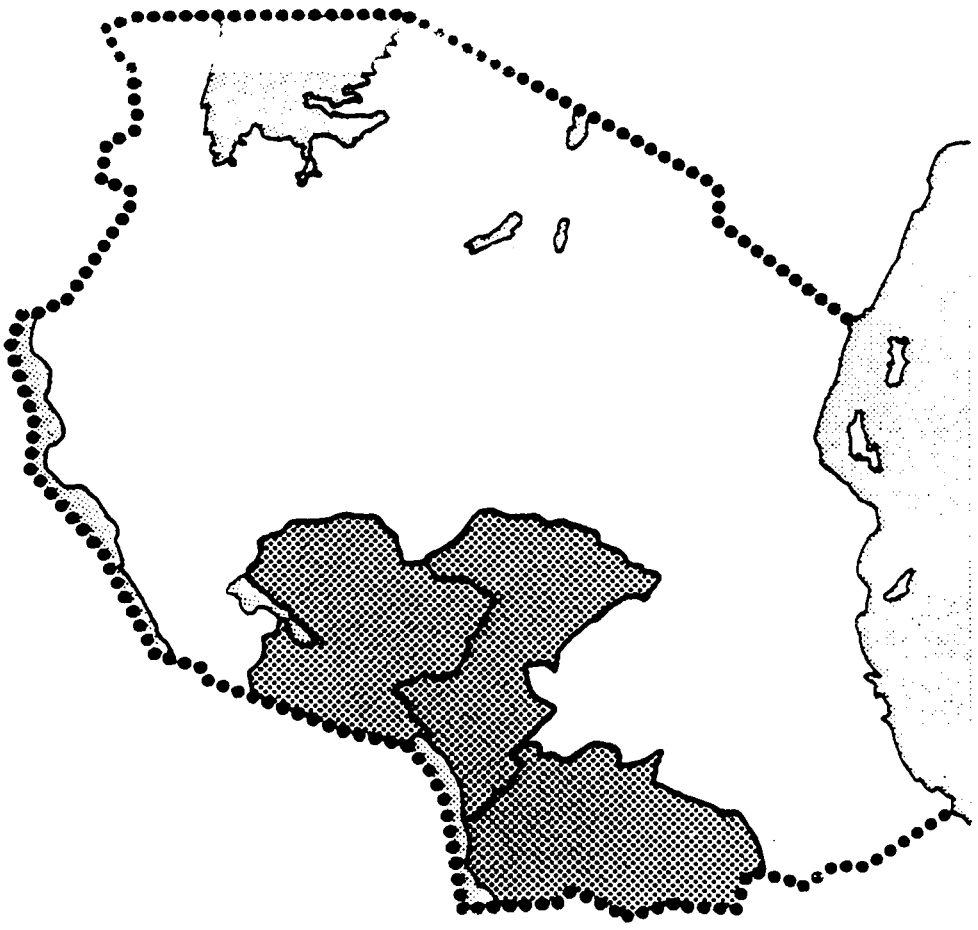
UNITED REPUBLIC OF TANZANIA

DANISH INTERNATIONAL DEVELOPMENT AGENCY • DANIDA

IMPLEMENTATION OF WATER MASTER PLANS FOR IRINGA, RUVUMA AND MBEYA REGIONS

GROUP SCHEME RE-EVALUATION 1984



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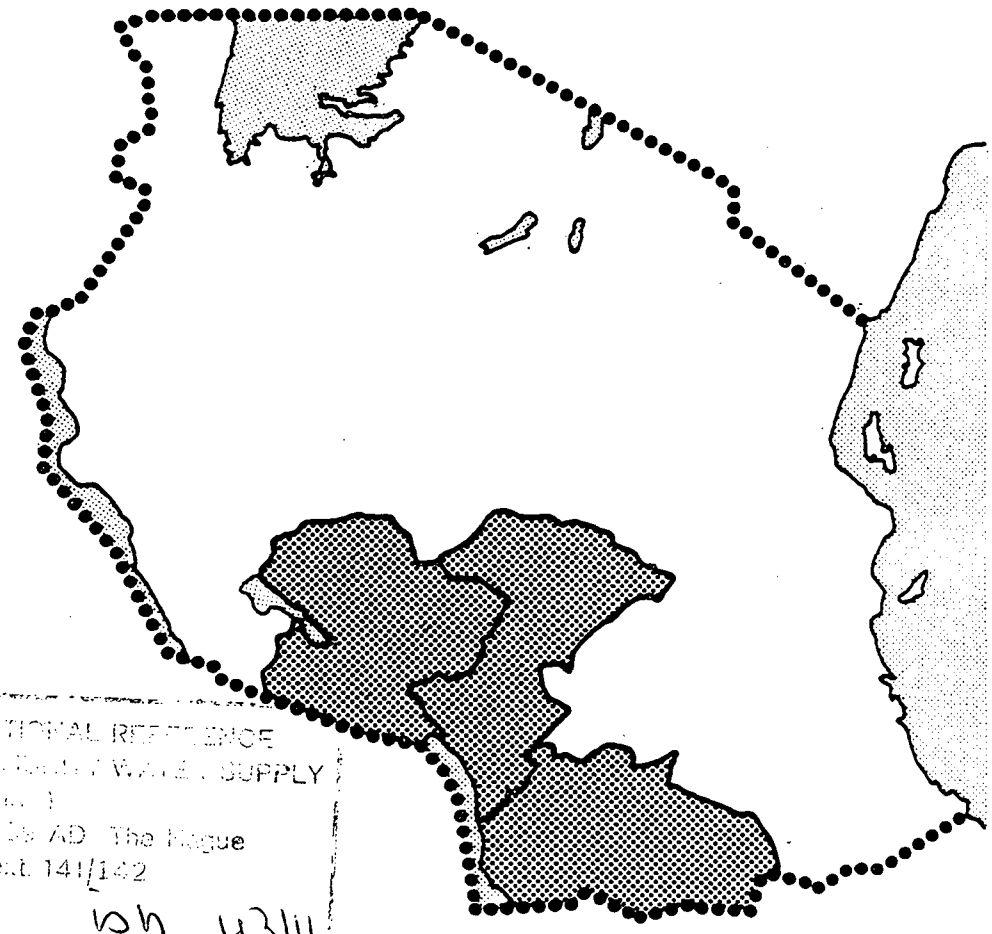

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UNITED REPUBLIC OF TANZANIA

IMPLEMENTATION OF IRINGA
RUVUMA AND MBEYA WATER MASTER PLANS

GROUP SCHEME RE-EVALUATION

IN

DANIDA SPONSORED IMPLEMENTATION PLANS

FINAL REPORT

MAY 1986

~~DECEMBER 1984~~

CCKK
CARL BRO • COWICONSULT • KAMPSAX - KRÜGER

CONTENTS

1. INTRODUCTION

1.1 Background

The basis of specialist studies in connection with the implementation of the Water Master Plan for Iringa, Ruvuma and Mbeya Regions was embodied in the Contract for Consultancy Services dated October 1983.

In the light of actual experience on the Implementation Project, the need for specialist inputs was re-evaluated and presented in a report prepared by CCKK in March 1984.

Based on this report and subsequent discussions, the Danida Steering Unit prepared both a list of short-term specialist inputs which were immediately required on the project and also Terms of Reference thereon. This was presented in a letter to CCKK dated 25th May, 1984.

The contents therein were slightly modified in a letter from CCKK dated the 5th June, 1984, to the Danida Steering Unit and subsequently accepted.

One of the specialist inputs so identified was in connection with re-evaluation of large group schemes. This report comprises the draft results of the Re-Evaluation of Large Group Schemes.

1.2 Terms of Reference

The Terms of Reference for the re-evaluation of large group schemes as outlined in the letter from CCKK to the Danida Steering Unit involved:

"The re-evaluation of large group schemes proposed by the Water Master Plans in view of the sociological and operational problems which resulted in such schemes during construction and operation".

A time schedule for this first stage evaluation was given as 1 manmonth in the period mid-September to mid-November, 1984.

1.3 Time Schedule

The Consultants' nominated Water Supply Engineer for the study, Mr. Miles Burton, visited Tanzania from the 23rd September to the 13th October inclusive in order to collect data inputs and to hold discussions with Danida, Maji and CCKK personnel involved. Mr. Burton was accompanied by Mr. Mike Hutson who specifically covered the data collection and analysis of this report. The effected time schedule was as follows:

30.09.84	Travel to Iringa
01.10.84-02.10.84	Iringa - discussions with Danida Implementation Unit Staff and preparation of base drawings for Usalule Group Scheme.
02.10.84	Travel to Njombe
03.10.84	Njombe - discussions with District Engineer and visit to Usalule Group Scheme area. Return to Iringa.
04.10.84-05.10.84	Iringa - discussions with Maji staff and preparation of drawings of Mtitu Group Scheme.
06.10.84	Iringa - visit Mtitu Group Scheme area.
08.10.84-09.10.84	Iringa - finalize data recording and drawings.
10.10.84	Return to Dar-es-Salaam.

The reporting phase of the project has been completed in the period form 10th to 16th November in Denmark.

2. SUMMARY

The identification of large group schemes requiring sub-division to enable a more feasible construction and operation system to be effected resulted in Usalule Group Scheme in Njombe District and Mtitu Group Scheme in Iringa District being highlighted. The former contained 53 villages with 49% being priority, whereas the latter contained 34 villages with 75% priority.

The possible alternative surface sources in the area of each scheme together with the possibility of ground water sources were investigated.

In both cased, sub-divided schemes were identified which have been outlined on the drawings accompanying this report. It has been roughly calculated that these schemes would be no more costly than the original scheme proposed based on the quantities of main pipelines involved.

During detailed consideration of these schemes, the possibility of incorporating adjacent villages which may have problems with the source solution previously proposed should be taken into account.

3. USALULE GROUP SCHEME (WMP Group I-34)

3.1 General

Usalule Group Scheme is located mainly in Njombe District but extending slightly into Mafindi District of Iringa Region. The scheme was previous to the Water Master Plan identified in similar format by MAJI. The area covered by the scheme varies from hilly near the proposed source around Njombe, to undulating and then flat at the extreme northern boundary near Makambako. The eastern limits of the scheme are characterized by some steep river valleys.

The scheme is extremely large covering 53 villages and a design population of 195,000 persons.

The objectives in re-evaluating the scheme were to try to sub-divide it into several schemes by identifying alternative sources. The alternative sources and schemes so identified would also, of course, be required to comply with the Water Master Plan principles in respect of water quality, source development and scheme cost.

In the following, reference can be made to drawings 1 to 5 accompanying this report.

3.2 Surface Water Availability

Four river sources were investigated as possible alternative means of supply of the original Usalule Group Scheme area:

. Mpanda River, the original identified source of the Usalule Group Scheme.

. Ruhudji River also rising in the high land to the south of Njombe.

. Nyenga River, a tributary of the Ruhudji upstream of Njombe.

. Fukulwa River rises in the lower parts of the supply area.

The 1 in 10 year flow in the Mpanda River at the road bridge near Njombe is estimated to be 90 l/s from 8 complete years of records. The total scheme demand is currently calculated to 60 l/s. However Makambako (WMP Ref. 75) may require some additional supply due to its urban nature. This could increase the normal rural demand of 25 l/h/d to an additional demand on the scheme of 4 l/s. The total demand of the scheme is therefore very close to the 1 in 10 year minimum yield of the River at an elevation necessary to serve the whole area by gravity.

The Ruhadji River at Njombe is large and it is estimated that the 1 in 10 year flow is in the order of 2,000 l/s based on a relative catchment comparison with the Mpanda.

The Nyenga River is estimated to have a 1 in 10 year minimum flow of approximately 150 l/s again on a relative catchment comparison and based on flow measurements taken during the field investigation.

The Fukulwa River is estimated to 70 l/s 1 in 10 year minimum flow. However, this river was difficult to gauge due to stream bed irregularities and was also reported by the District Water Engineer to be fed by springs. The river is reported to always have flow.

It is concluded that all four rivers investigated are likely to have adequate flows for any sub-scheme of Usulale proposed. The Mpanda and Fukulwa Rivers, however, on their own each have a limiting capacity close to the total demand of the Usalule Scheme.

3.3 Surface Water Quality

On the basis of catchment utilisation, the quality of the four rivers can be assessed as follows:

- Mpanda: Good, looks clear.
- Ruhudji: Fair if well upstream of Njombe, turbid at Njombe.
- Nyenga: Good although looks quite turbid.
- Fukulwa: Poor, looks moderately clear.

Any supply to Makambako (design population 18,000) should probably be treated although an untreated supply from the Mpanda might be acceptable. A supply using the Fukulwa should definitely be treated.

3.4 Gravity Supply

Altimeter readings suggest that the contours shown on the 1:125,000 sketch map are reasonably accurate. The large unknown quantity is the exact location of villages since this can affect the village altitude considerably. The following comments can however be made with reasonable confidence since the highest altitude from village inventories, contours and altimeter readings has been used.

The villages to the North East can be supplied by the Fukulwa.

Makambako (75) can either be supplied by an intake near the head of the Fukulwa or by a long pipeline from one of the 3 southern rivers.

The villages along the main North to South road can only be supplied by the 3 southern rivers.

The Ruaha could be used to supply the North East villages, but as it is farther from them than the Fukulwa there is little advantage in this.

3.5 Groundwater

Much of the area is marked as an area of high potential for shallow groundwater (on the Water Master Plan drawings), including the central area which includes the higher villages near the main, North to South road which require long trunk mains from the southern rivers if a gravity surface water supply is used.

It is also known that there are several springs near this central ridge (e.g. the one(s) supplying the Fukulwa river).

It may be worthwhile excavating a few trial, shallow wells in this central area since the topography is more of a wide plateau rather than a ridge and hence shallow groundwater may not be quite as unlikely as first thought.

3.6 Conclusions

It would be possible to sub-divide the Usalule Group Scheme into either a 3- or 5- scheme system. These are shown on drawings 4 and 5 and are summarized in Table 3.1.

Scheme	No. of Villages	Priority Village	Total Demand l/s	Sources
3-scheme				
Fukulwa	15	11-73%	22.8	Fukulwa River
Ruhudji	20	9-45%	19.1	Ruhudji River
Mpanda	20	7-35%	17.5	Mpanda River
5-scheme				
Lower Fukulwa	11	8-73%	11.6	Fukulwa River
Upper Fukulwa	14	5-36%	21.2	Fukulwa River
Ruhudji	15	7-47%	14.0	Ruhudji River
Upper Mpanda	7	2-29%	7.1	Mpanda River
Lower Mpanda	8	5-62%	6.8	Mpanda River

Table 3.1 Proposed sub-division of Usalule Group Scheme.

It would obviously be beneficial to reduce the size of this scheme to the greatest extent possible. However, the lower sources identified in the case of the 5-scheme solution above would almost definitely involve poor quality and high pollution. The alternatives between scheme operation and water quality constraints will need to be investigated more closely in order to evaluate the choice once detailed investigations are made on this scheme.

It can be seen that the scheme could be extended to serve two villages to the North of the original supply area, Kiliminzowo (446) and Ipilimo (451) which may be problematic in respect of the original solutions proposed. In addition several villages to the East of the original supply area could also be served from the Ruhudji scheme. These villages are located on the tops of ridges and therefore problematic to serve from adjacent sources. However they are also generally low priority villages and therefore may not be acceptable to incorporate at this point of time in the implemented supplies.

4. MTITU GROUP SCHEME (WMP Group I-8)

4.1 General

Mtitu Group Scheme is located in Iringa District of Iringa Region. The scheme was previous to the Water Master Plan identified in similar format by MAJI.

The area covered by the scheme is basically flat plain but interspersed with hilly terrain resulting in significant altitude variations in close proximity to each other. The Little Ruaha River forms the southern boundary of most of the scheme while the main Iringa to Mbeya road forms the northern boundary for the most part.

The scheme is extensive covering 35 villages and a design population of about 100,000 persons.

The objectives in re-evaluating the scheme were to try to sub-divide it into several schemes by identifying alternative sources. The alternative sources and schemes so identified would also of course require to comply with the Water Master Plan principles in respect of water quality, source development and scheme cost.

In the following, reference can be made to Drawings 6 and 7 accompanying this report.

4.2 Surface Water Availability

Three surface water potential sources were investigated.

. The Mtitu River which was the original source proposed.

. The Little Ruaha River which flows along most of the southern boundary of the scheme.

. The Kipoloi River which rises within the supply area.

The Mtitu River is of estimated 515 l/s capacity and therefore of adequate capacity for either the total scheme or for any sub-scheme which may be devised. A further scheme could be served from a lower point on the Mtitu River for these villages at a lower elevation.

The Little Ruaha River is the source of the Iringa Town Supply and again is of adequate capacity but is of much lower elevation and therefore only suitable to serve the villages at lower elevation.

The Kipoloi River is conveniently situated in the central part of the supply area to serve the villages immediately downstream to the east.

4.3 Surface Water Quality

The surface quality of all three rivers investigated is moderate to poor due to the size of the river and the large number of villages upstream of the draw-off point. In detail, the situation is as follows:

. Mtitu River - moderate to poor quality, treatment recommended.

. Little Ruaha River - poor quality, treatment required.

. Kipoloi River - moderate quality, treatment recommended.

4.4 Groundwater

The groundwater potential in the supply area of the Mtitu Scheme is poor. The possibility of identifying even local areas which could be utilized for groundwater supplies is remote.

4.5 Conclusions

It is proposed to sub-divide the Mtitu Scheme into four separate schemes. These are shown on Drawing No. 7 and summarized in Table 4.1.

Scheme	No. of Villages	Priority Villages	Total Demand l/s	Source
Little Ruaha	4	4-100%	1.8	Little Ruaha River
Lower Mtitu	10	9- 90%	9.1	Mtitu River
Kipoloi	7	7-100%	5.1	Kipoloi River
Upper Mtitu	11	4- 36%	7.9	Mtitu River

Table 4.1 Proposed sub-division of Mtitu Group Scheme.

The proposed sub-divisions in Table 4.1 also serve the benefit of identifying three schemes with an almost complete occurrence of high priority villages.

Some villages around Iringa Township could also be included in the proposed scheme layout. These villages, however, were originally envisaged to be served by the Iringa Urban water supply and the final solution adopted for these villages would depend very much on the developments with this latter project.

The three villages to the extreme east of the originally proposed group scheme, Mbigiri (208), Mazombe (209) and Ikokoto (213), are proposed to be served from individual sources since they are remote and therefore costly to include in the group supply.

5. COST ESTIMATES

5.1 General

Costs for the proposed group schemes are given in the appendices to the report. A cost comparison has been made of the proposed sub-divisions to the original single group schemes of Usalule and Mtitu, all calculated to WMP cost basis.

Although there are cost economies in producing a single very large group scheme, it is considered that this is more than balanced by the advantages which can be gained by splitting the scheme up.

So as to enhance the success of the scheme control and management both in construction and operation and maintenance, it is felt from experience gained on the implementation programme to date that it would be best to limit the size of group schemes to no more than about 15 villages.

The planning and organization of construction work would involve fewer groups of village water committees. This would mean that group meetings for the schemes would not be such a huge logistical task where transport can prove difficult and unreasonable walking distances might severely handicap communication. It would be expected that smaller groups would be able to sit together to discuss work and overcome problems.

Similarly the day to day running and repairs on smaller completed water supply schemes should make operation and maintenance more efficient - although probably not cheaper.

It is noted that the cost assessments of operation and maintenance in the WMP are related to both type and size of schemes. As all these schemes are gravity schemes, and all group schemes, it can be taken that the costs per capita will be of the same order, whether it is for one, three, four of five schemes.

Selection of a large scheme requires a large volume of water to be extracted from a water source in order to satisfy demands. This not only limits the choice of possible alternative single sources but could (as in the case of Usalule) come near to exhausting the amount of available supply. This could mean not only that the water is insufficient but there may be a greater risk of pollution in extracting a very high proportion of the river. The WMP had allowed for treatment of both of the original group schemes and generally schemes with a design population of over 10,000 people were identified as possibly requiring treatment. In sub-dividing the schemes into the smaller components there will be greater confidence in being able to satisfy water demands and therefore greater reliability.

However, in the particular cases studied it is conceded that due to the geography of the area, some of the smaller schemes would be drawing water from lower reaches of rivers where there is a bigger risk of pollution. This problem coupled with cost should be weighed against the above advantages before any conclusion as to whether such a scheme should be recommended for implementation or not.

It is recommended that more detailed water quality test analyses are made on the various proposals throughout as many seasons as possible, in order that the need of treatment can be evaluated. It is also expected that in time, some feedback will be obtained from the pilot treatment plants earmarked in Mbeya and Iringa Regions.

From a practical point, the river water quality could be expected to be improved by optimum siting of the intake structure at any given cross-section and extending the transmission pipeline and thus intake position upstream to a higher altitude. Where the flow is large compared to the amount extracted, a side intake without weir wall should be considered. Sometimes weir walls trap silt carried in turbid river water, particularly during rainy seasons. This can give rise to problems of removal and result in inacceptable turbid drinking water in need of sedimentation treatment.

Moving the source upstream might eliminate pollution risks but this must be balanced with both cost and reduction in the quantity of water available in the river.

The outlined sub-divisions bring the higher priority villages more together in groups. Usually, whether a scheme is to be selected for implementation depends heavily on social need shown in the priority rating given in the WMP. It should be pointed out that the WMP study was carried out around 1980 and time can change the circumstances in which people are living. The WMP should generally therefore not be taken as fixed but as flexible to any updating resulting from feedback

gained during experience on implementation. In exceptional cases a review of priority may be made in the light of any fresh significant changes (health factors) to the situation of a village life style. This review would be subject to notifying the proper authorities and seeking permission for revision should they be favoured.

5.2 Conclusions

1. Usalule Scheme(s)

The breakdown of Usalule single scheme into five looks the best because of improved priority grouping and control. Before the extent of schemes are finally decided the question of groundwater potential needs to be checked. If the yields of boreholes and well coverage in the village are enough, shallow wells are cheaper and faster to install compared to long gravity pipelines. They could also fill a gap where the gravity scheme might have a water scheme of unacceptable quality.

2. Mtitu Scheme(s)

Dividing Mtitu single scheme into four produces two schemes, Lower Mtitu and Kipoloi of high priority and probably acceptable cost. The high costs per capita of Little Ruaha and Upper Mtitu (also characterised by low priority) are due to the relatively long length of transmission main for the populations involved. Little Ruaha group, because of the high priority rating, should be investigated further for any other alternative water supplies and in this aspect the position with groundwater sources could be checked more thoroughly.

USALULE

Summary of 3 scheme costs

	Villages	per capita	total x 1000
Fukulwa	15	454	29,583
Ruhudji	20	570	40,406
Mpanda	20	483	28,703
			98,692 x 10^3

i.e. 98.692 m Tsh.

Compare to single Usalule group scheme in WMP

Table 9.13 - 54 villages to cost 92,146 x 10^3 Tsh.

Subtract village of Igwachanga (191)
(part included in Usalule single) 724
91,422

Add villages of Kiliminzowo (446)
and Ipilimo (451) 1647
(included in 3 schemes) 1613 3,260
94,682

Difference is (98,692 - 94,682) x 10^3 = 4,010 x 10^3

i.e. $\frac{4,010}{94,682}$ x 100% = 4.2% more

USALULE

Summary of 5 scheme costs

	Villages	per capita	total x 1000
Lower Fukulwa	11	496	20,041
Upper Fukulwa	14	533	31,760
Ruhudji	15	548	26,557
Upper Mpanda	7	446	11,015
Lower Mpanda	8	555	12,329
			101,702 x 10^3

i.e. 101.702 m Tsh.

Compare to single Usalule group silence in WMP

Table 9.13 - 54 villages to cost 92,146 x 10^3 Tsh.

Subtract village of Igwachanga (191) (part included in Usalule single)		724
		91,422
Add villages of Kiliminzowo (446) and Ipilimo (451)	1647	
(included in 5 schemes)	1613	3,260
		94,682

Difference is (101,702 - 94,682) x 10^3 = 7,020 x 10^3

i.e. $\frac{7,020}{94,682}$ x 100% = 7.4% more

MTITU

Summary of 4 schedules

	Villages	per capita	total x 1000
Little Ruaha	4	1038	6,526
Lower Mtitu	10	641	20,278
Kipoloi	7	575	10,242
Upper Mtitu	11	882	25,470
			65,516 x 10^3

i.e. 62.516 m Tsh.

Compare to single Mtitu group scheme in WMP

Table 9.11 - 35 villages to cost 58,879 x 10^3 Tsh.

Add for error in Table 9.11 on villages of Mgongo (233) and Udumuka (489)	467	
	761	1,228
		60,107
Subtract the villages of Ikokoto (213), Mazombe (209) and Mbigiri (208) (not included in 4 schemes)	1,413	
	2,992	
	3,116	7,521
		52,586

Difference is (62,516 - 52,586) x 10^3 = 9,930 x 10^3

i.e. $\frac{9,930}{52,586}$ x 100% = 18.9% more