5.2 Water Resources Development Plan

5.2.1 General

Despite rather abundant water resources in the Mkomazi river basin, their effective use for irrigation purposes cannot be attained without storage dams because of the seasonal fluctuation. In order to make an optimal water resources development plan in the valley, several alternative development plans are examined from the economic and technical viewpoints as well as from the social point of view.

5.2.2 Selection of dam schemes

In order to develop the water resources to their maximum extent, the following dam schemes are conceivable.

Dam Scheme	River	Catchment Area (km^2)	Annual Runoff ($10^6 m^3$)	Irrigation Scheme
Igoma	Kambaga	749	45	Igoma
Hingilili	Hingilili	42	30	Gonja
Yongoma	Yongoma	56	29	Ndungu
Mkuyu	Mkuyu	45	15	Kihurio

In addition to the above dam schemes, the existing Kalimawe dam is also included in the study of an alternative development plan. The Kalimawe reservoir has a effective storage capacity of $5.5 \times 10^6 m^3$, but his capacity is too small to meet the annual runoff of $166 \times 10^6 m^3$. For this dam scheme, it is therefore, required to heighten the dam up to the optimum height in the water balance study mentioned below.

5.2.3 Water balance and economic comparison of dam scheme

In order to determine the optimal development scale of the project, a water balance study is made on the basis of the monthly runoff for the period from 1963 to 1982 and the irrigation water demand. The balance study is made for two cases: Case-1; irrigation development without construction of new storage dam and Case-2; irrigation development with

construction of new storage dam. In case-1 the Igoma Irrigation Scheme is not considered, because dependable discharge even in the rainy season can not be expected from the Kambaga river without construction of the storage dam. The results of the study are shown below (see details in ANNEX F).

Case-1: Without Construction of New Storage Dam

Irrigation Scheme	Dam Scheme	Effective Storage Capacity ($10^6 m^3$)	Irrigable Area			Irrigation Water req. ($10^6 m^3$)
			Dry Season (ha)	Rainy Season (ha)	Total (ha)	
Kisiwani	-	-	180	360	540	5.9
Gonja	-	-	300	600	900	9.8
Ndungu	-	-	230	680	910	9.8
Kihurio	-	-	180	930	1,100	11.8
Kihurio	Kalimawe	5.5	440	740	1,180	13.0
Total		5.5	1,330	3,310	4,640	50.3

Case-2: With Construction of New Storage Dam

Irrigatiom Scheme	Dam Scheme	Effective Storage Capacity ($10^6 m^3$)	Irrigable Area			Irrigation Water req. ($10^6 m^3$)
			Dry Season (ha)	Rainy Season (ha)	Total (ha)	
Kisiwani	-	-	180	360	540	5.9
Gonja	Hingilili	7.8	800	1,200	2,000	22.1
Ndungu	Yongoma	8.5	770	1,180	1,950	21.5
Kihurio	Mkuyu	7.7	1,140	1,140	2,280	25.5
Kihurio	Kalimawe	5.5	530	530	1,060	11.9
Igoma	Igoma	39.4	750	750	1,500	16.8
Total		68.9	4,170	5,160	9,330	103.7

Since the annual runoff from the entire catchment area is estimated to be 234 x $10^6 m^3$ in the previous chapter, the ratio of irrigation water requirement to the annual runoff in Case-1 and Case-2 is calculated at 21% and 44% respectively. The utilization of water resource is considerably heightend by storage dams.

For the same cases as the studied in the above, the economic viability is examined in terms of the internal rate of return (IRR) based on the direct agricultural benefits as shown below.

Irrigation Scheme	Case-1	Case-2	
	IRR (%)	IRR (%)	IRR /1 (%)
Kisiwani	17.3	-	-
Gonja	20.2	11.3	8.2
Ndungu	20.3	11.3	8.4
Kihurio	21.6	11.1	5.2
Igoma	-	12.1	12.1

Note: /1: Against the increment of irrigable area by the construction of storage dam.

The above economic study shows that the economic viabilities of the Gonja, Ndungu and Kihurio Scheme are lowered to the less feasible ranges, if the irrigable areas are extended by constructing the storage dams. However, the extension of irrigable area through the construction of the storage dams would be justified if the following secondary benefits induced by the construction of storage dams and social benefits are counted in the economic evaluation:

(1) hydro-electric power benefit,

(2) fishery benefit,

(3) more resettlement chances for farmers living in the mountainous areas, and

(4) increase of recreational opportunities in the valley.

The Igoma scheme in Case-2 shows to provide the highest economic viability as well as increment of new development area.

5.2.4 Assessment of overall development plan

In order to establish the most economical overall development plan in the valley, alternative studies are made for the following three cases:

Alternative-1: Overall development with provision of all the newly proposed storage dams.

Alternative-2: Overall development with provision of the Igoma storage dam.

Alternative-3: Overall development without provision of any dams.

For the above alternative cases, the economic viability is examined also in terms of IRR as shown in the following table.

Alternative	Irrigable Area			Construction cost	IRR
	Dry Season (ha)	Rainy Season (ha)	Total (ha)	(TSh.x10^6)	(%)
1	4,170	5,160	9,330	1,168	11.9
2	2,080	4,060	6,140	540	18.0
3	1,330	3,310	4,640	368	20.1

Alternative-1 has the advantage of a large annual irrigable area, but the economic viability is low and it is judged that its earlier implementation is not economical. The economic viability of Alternative-3 is the highest among the three alternatives, but its social impact is lower than Alternative-2, because of no development of the new agricultural land. Alternative-2 develops the new agricultural land of 750 ha through construction of the Igoma storage dam and gives much social impacts such

as provision of more resettlement area to farmers in the mountainous area and increase of employment opportunities to people in the area. Thus, Alternative-2 is recommended for the Project.

In conjunction with the Alternative-2 development plan, a further alternative study is made to determine the optimum reheightening of the existing Kalimawe dam in view of the most effective use the Mkomazi river discharge which is regulated by the Igoma reservoir. An alternative study is made for the following three cases.

Alternative 2-1 : Present (full water level = EL. 504.70 m)

Alternative 2-2 : The full water level is changed from present EL 504.7 m to EL 505.3 m.

Alternative 2-3 : The full water level is changed from present EL 504.7 m to EL 505.9 m

The results of the economic comparison are as follows:

Alternative	Full Water Level (EL.m)	Effective Storage Capacity (10^6m^3)	Irrigable Area			IRR (%)
			Dry Season (ha)	Rainy Season (ha)	Total (ha)	
2-1	504.7	5.5	2,080	4,060	6,140	18.0
2-2	505.3	8.0	2,380	4,060	6,440	18.7
2-3	505.9	14.9	2,780	4,060	6,840	19.0

The above table shows that the alternative 2-3 gives a higher economic return and more irrigable area in the dry season than others. Then, the higher priority is given to the alternative 2-3.

Based on the above comparative studies, the following definite plan is selected as the initial development project in the Mkomazi valley area.

- Construction of the Igoma storage dam for development of the new agricultural land of 750 ha.
- Reheightening of the existing Kalmawe dam for 1.2 m to give the storage capacity of 14.9 x 10^6m^3.

Under the selected definite plan, the following area would be irrigated.

Irrigation Scheme	Irrigable Area						
	Farm land (ha)	Dry Season (ha)	Rainy Season (ha)	Total (ha)	Rain-fed (ha)	Total (ha)	Crop inten-sity
Kisiwani	360	180	360	540	180	720	2.0
Gonja	1,040	300	600	900	740	1,640	1.6
Ndungu	940	230	680	910	710	1,620	1.7
Kihurio	1,670	1,320	1,670	2,990	350	3,340	2.0
Igoma	750	750	750	1,500	-	1,500	2.0
Total	4,760	2,780	4,060	6,840	1,980	8,820	1.9

5.3 Agricultural Development

5.3.1 Presumption of population and farm size

As stated in Chapter 4, the project area was inhabited by a farm population of 24,500 in 1982. The total number of farm families is estimated at approximately 5,020, in which one family consists of 4.9 persons on an average. In addition to this, taking into account 3% in annual growth rate of the population, it is estimated that the population and farm-household will increase to about 41,100 and 6,000 respectively, and the average family size will also increase to about 6.8 persons per household, of which some 2.9 persons are considered to be the family labour force for agriculture. Based on these estimates, the average farm size per farm-household is estimated at 0.65 ha; smaller than the present farm size of 0.75 ha, in the target year of 2000.

In addition, it is estimated that when the project is implemented, about 1,300 farm families with 9,000 persons will be able to trans-migrate to the expanded area stated in Section 5.2 of this Chapter. Accordingly, the population and farm families in the project area will be about 50,000 and 7,300 respectively for the target year of 2000.

5.3.2 Land development and land use plan

The land development and land use plans are formulated in line with the development strategies and based on the development potential of land and water resources as well as the agricultural constraints prevailing in the project area. With the project, an irrigable paddy field of 4,760 ha is developed, taking into account the topography and present land use under traditional furrow system of which 4,060 ha is irrigable in the rainy season and 2,780 ha in the dry season. On the other hand, 70 ha of the presently cultivated land in the Ndungu Scheme area will be submerged by the reheightening the Kalimawe dam. Considering this, the future land use plan in the entire project area is made as follows.

(See Table 10)

Gross Project area	5,860 ha
Farm land (net project area)	4,760 ha
Existing farm land	3,890 ha
Newly reclaimed land	940 ha
Submerged area by means of the development	70 ha
Cultivated area	
Rainy season irrigation paddy	4,060 ha
Dry season irrigation paddy	2,780 ha
Rainfed maize	1,980 ha
Total	8,820 ha
Crop intensity	1.9

5.3.3 Transmigration

The arable land of about 210 ha in the Kihurio scheme and 730 ha in the Igoma scheme, will newly be reclaimed in the future with-project conditions. However, due to submergence of 70 ha of land in the Ndungu scheme, net incremental arable land will be expected at 870 ha in total. These lands will be able to receive about 1,300 families of transmigrants, assuming that each farmer is given the same acreage of land as the estimated average holding size for the target year of 2000.

5.3.4 Selection of crops

In preparing the future agricultural production program for the area contemplated for development, paddy is first selected as the most essential crop in the project area. Maize and beans are also selected as major staple crops, particularly in rainfed area.

With respect to livestock development, the present free-grazing will be continued even in the future conditions with the project. No diversification to special feeder crops is therefore contemplated due to the limited potential of both the land and water resources.

In order to attain a higher return of crop cultivation, the introduction of high-yielding varieties is essential. In the selection of high-yielding varieties, further consideration is paid to the specific terms of crop growing, which will have to be shorter period for its maturation, so as to secure the most optimum crop season particularly from the viewpoint of effective water utilization. In addition, the availability of seeds in Tanzania, adaptability of varieties to the local conditions in the project area, high resistibility against pest and deseases, quality of production to be acceptable for marketing, etc. are taken into consideration as important matters for the selection of crops.

The varieties of the crops preliminarily selected are as follows:

Recommended Crops and Varieties		Estimated Growing Days
Paddy	TOS-103	120 - 135
	BC-90-2	120 - 130
	IR.22	120 - 130
	IR.24	120 - 130
	IR.28	100 - 110
	Afaa Mwanza	130 - 140
	Afaa Kilombero	130 - 140
Maize	Katumani	90
	ICW	110 - 120
	UCA	110 - 120
Beans	Canadian Wonder	90 - 110
	Kidney Dark Red	90 - 95
	Santa Ana	90 - 110
	California Red	80 - 95

5.3.5 Proposed cropping pattern

The most adaptable cropping calendar is elaborated, taking into account the climatic conditions, soil moisture conditions to be controlled under irrigation/drainage operation, and plant physiological characteristics of the selected varieties of crops. In this connection, particular attention is paid to heavy precipitation in the rainy season and a lower air temperature and shorter sunshine hours in the earlier half of the dry season. These climatic conditions would become the restrictive factors on the proper farm operation and effective growing of crops especially for paddy.

Based on the results of the agronomic study on the critical conditions for crop cultivation and the study on the most optimum use of irrigation water, the recommendable cropping calendar for each crop is formulated below (See Fig. 7).

Major Crops	1st Cropping		2nd Cropping	
	Seeding	Harvesting	Seeding	Harvesting
Under irrigated conditions:				
Paddy	September	January to mid-February	mid-January to February	June
Under rainfed conditions:				
Maize	November	February	-	-
Bean	November	February	-	-

In the proposed cropping pattern, paddy cultivation is primarily practiced in the irrigation area both in the rainly season and dry season. Maize and beans will be cultivated under rainfed condition in the area, which is to be irrigated twice in every 3 years under the year rotational operation in the irrigation program. Since the land holding size per farm household is small in general, cultivation of maize mixed-standing with beans is planned in this cropping pattern.

Based upon the basic layout of the cropping pattern and the prospective irrigation development plan, cultivation area of major crops in each scheme area is planned as shown below:

Unit: ha

Major Crop	Scheme					Total
	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	
Paddy						
- Dry season	180	300	230	1,320	750	2,780
- Rainy season	360	600	680	1,670	750	4,060
Sub-Total	540	900	910	2,990	1,500	6,840
Maize/Beans	180	740	710	350	-	1,980

5.3.6 Proposed farming practices

In order to attain higher returns of crop production after implementation of the project, improved farming techniques will be introduced to the area. Such improved farming techniques are studied taking into account the following factors:

(a) Field conditions after the project implementation,
(b) Familiarity of farmers with irrigation practices and modernized farming techniques,
(c) Desire and intention of farmers toward the agricultural development,
(d) Extent of the present mechanized farming, and
(e) Availability of labour force in the project area.

The recommended farming practices are outlined as follows:

Plowing

Soil preparation for all the crop cultivation will be made using tractors in accordance with the farm mechanization program of the Government.

Introduction of high-yielding varieties

High-yielding varieties recommended in preceding Section 5.3.4 will be introduced for all the crops, even for the cultivation of maize and beans under rainfed conditions.

Fertilizers and Agro-chemical use

For the application of nitrogenous fertilizers, ammonium sulphate is recommendable for both paddy and upland crops, and triple superphosphate for the element of phosphorous for also both crops. No application of potash will be needed in this area. The split application method is recommended to favorably control crop growing. Since herbicides are still harmful for human being and live-stock, the weeding is proposed to be carried out by labour force.

Field husbandry

The cultivation of maize will be practiced by applying the mixed-standing with beans, so as to extend the cultivation area particularly in small farms. For increasing paddy production in the project area, most important technical point is to increase the number of grains per square meter and percentage of ripened grains through the following practices:

a. to create favorable growing condition during the period from the initiation of young panicle to heading stage,
b. to apply top-dressing with nitrogeneous fertilizer at the full heading time,
c. to prevent the plants from lodging, and
d. to select varieties which yield a high percentage of ripened grains.

Detailed farming practices for paddy is as stated in Chapter 4, ANNEX E.

5.3.7 Prospective crop yield

According to the technical information on the high yielding varieties provided by TANSEED and the practical records on crop yield, it is conservatively estimated that the prospective crop yield will be 2.0 tons/ha for maize, and 0.8 tons/ha for beans.

With regard to paddy, no statistical data on yield and production are available in the project area. Therefore the sampling survey for paddy is carried out to check the present yield per hectare and to clarify the yield components.

The paddy yield is a product of a mass of the number of grains per square water, percentage of ripened grains and weight of 1,000 grains. From technical viewpoint, it is easy to increase the number of grains per square meter up to 20,000 - 28,000, and also to increase percentage of ripened grains up to the 70 - 80% level through recommended farming practices. Expected yield components and yield are mentioned below.

Yield Components	Unit	Expectation
Number of grains/m^2	nos	28,000
Percentage of ripened grains	%	80.0
Weight of 1,000 grains	gram	24.4
Yield of paddy	t/ha	5.5

Based on the above assessment and the results of field trials in the Mombo Irrigation Scheme in 1979, the yield of rainy season paddy is expected to be 5.0 tons/ha. As for the dry season paddy, the conservative yields of 4.5 tons/ha as compared with that of the rainy season paddy is set for this project considering the fact that the low temperature during the early growing period of paddy adversely affects the paddy growth.

5.3.8 Anticipated crop production

Based on the crop yield estimated above and the cropping pattern and cultivation areas stated in the preceding section 5.3.5, anticipated annual crop productions are estimated at 32,810 tons of paddy, 3,960 tons of maize and 1,580 tons of beans in full development stage. Thus, future production will be 13 times for paddy and 1.5 times for maize and beans as compared with the present production level. The anticipated build-up period after the implementation of the development would varies depending on the present field conditions. In Igoma Scheme area, where virgin land prevails, the target yield would be attained after 5 years while in the other scheme areas, where most of the lands are being cultivated, 3 years will be required for attaining the target yield.

5.3.9 Market prospects

In Tanzania, the present productive level of cereals such as maize, paddy, wheat, sorghum and millet is still low due to the lesser development of infrastructures and the insufficient agricultural support services. Recent crop production rather decreases and gives an impetus of spending a large amount of capital for the import of supplementary food. The average import of cereals during 1978 to 1980 amounted to 190,000 tons per annum.

In the past, in the Kilimanjaro Region, production of cereals except finger millet had a surplus above the regional demand. However, because of recent crop production decrease mainly due to drought problem and population increase, the Region is obliged to import cereals; mainly rice and maize, from the outside. The total amount imported was 13,300 tons in 1980/81 and 12,500 tons in 1981/82, and it is expected that the demand for these cereals will increase because of population increase particularly in urban areas in the Region.

In order to estimate the marketable surplus of rice and maize in the project area after the implementation of the project, the following demand and supply balance study is made for the year 2000:

(Unit; tons)

	Paddy	Maize
- Production in the project area	32,800	4,000
- Consumption in the area	6,500	2,500
- Seed requirement and waste	3,300	400
Surplus	23,000	1,100

From the above study, it is expected that the surplus of paddy and maize are 23,000 tons (14,300 tons of rice) and 1,100 tons. These surplus would be consumed in the urban areas in the Region.

5.3.10 Price prospect

In estimating the future cost and price of agricultural commodities, the shadow price factor (SPF) is evaluated to assess the realistic economic viability of the proposed agricultural development. Based on the current external trade in Tanzania, SPF is estimated at 1.12. Applying this SPF, the current exchange rate of US$1.0 equal to TSh.12.0 (as of July 1983) in terms of financial prices is converted to a rate of US$1.0 equal to TSh.13.5 in terms of economic prices. In addition, conversion between the international market prices and the farm gate prices is made based on "The Price Prospects for Primary Commodities" prepared by IBRD, July 1982.

The financial prices of agricultural commodities are evaluated based on the available data on farm gate prices collected through farm economy survey and prevailing local market prices in the project area.

Both the economic and financial prices of major agricultural commodities are as follows (See Table 11):

Unit: TSh./ton

Commodities	Economic Price	Financial Price
Products		
- Paddy	5,280	6,000
- Maize	4,830	4,000
- Beans	5,580	8,000
Farm Inputs		
- Fertilizers		
- N	15,200	9,400
- P_2O_5	12,200	4,600
- Agro-chemicals		
- Incectisides	49,900	32,250
- Fungicides	65,900	39,500

5.3.11 Processing and storage

The total processing efficiency is estimated at approximately 35 tons per day with 20 rice mills in the project area at present. If 250 workable days can be expected in a year, the annual processing capacity is about 8,750 tons, which seem sufficient to process 6,500 tons of paddy estimated as annual consumption for the target year of 2000. For the 23,000 tons of surplus paddy, new processing facilities will be required.

The present storage capacity is estimated at about 2,000 tons. Since the marketable surplus of crop products is expected to be approximately 23,000 tons, the construction of new storage facilities will be required in the project area.

5.3.12 Farm economy

On the basis of the financial prices, the annual gross and net production return of the farmers are estimated for the full development stage. The following table shows the summary of the farm budget of average farmer in the project area.

Unit: TSh.

Item	Without Project	With Project
Gross Income	8,000	31,920
Gross Outgo	8,000	17,310
Net Reserve	0	14,610

As seen in the above table, it is expected that the living standard of the farmers will largely be raised up from that of the present level.

5.4 Irrigation and Drainage Development Plan

5.4.1 Irrigation development plan

(1) Water source

The water sources for the Project are the Kambaga river and four tributaries of the Mkomazi river (the Nakombo, the HIngilili, the Yongoma and the Saseni rivers).

(2) Irrigation water requirements

Irrigation water requirements are estimated based on the proposed cropping pattern and using the effective rainfall, which is calculated by the daily water balance calculation for the past 20 years.

Potential evapotranspiration is estimated by the modified Pennan method, using the meteorological data recorded at the Kalimawe Meteorological Station.

The total canal conveyance losses are assumed to be 10% of the diversion water requirements for the main and secondary canals to be lined with concrete. The field operation losses are assumed to be 20% in paddy fields. Thus, the overall irrigation efficiency is calculated to be 72% for paddy field irrigation. The irrigation water requirement of dry season paddy and rainy season paddy is estimated at 1,200 mm and 1,040 mm in total depth respectively.

The peak diversion irrigation requirements estimated in the monthly basis are shown below.

Dry season paddy	1.47 ℓ/sec/ha
Rainy season paddy	1.33 ℓ/sec/ha

(3) Delineation of irrigation area

The irrigation area of each scheme is delineated as shown below, taking into consideration such factors as topography, present land use, land suitability classification and available water for irrigation.

Unit: ha

Scheme	Development area		Irrigation area (Paddy)			Irr. Water
	Gross	Net	Dry seas.	Rainy seas.	Annual	req. ($10^6 m^3$)
Kisiwani	420	360	180	360	540	5.9
Igoma	860	750	750	750	1,500	16.8
Gonja	1,360	1,040	300	600	900	9.8
Ndungu	1,340	940	230	680	910	9.8
Kihurio	1,880	1,670	1,320	1,670	2,990	33.2
Total	5,860	4,760	2,780	4,060	6,840	75.5

According to the results of water balance study, the water resources will limit the irrigation area for the Gonja scheme to 600 ha and for the Ndungu scheme to 680 ha. In order to use such limited water effectively, a rotational irrigation method on annual basis is introduced to both the Gonja and Ndungu schemes.

5.4.2 Irrigation system

The layout planning of the irrigation system is made using the topographic maps on a scale of 1/5,000. The following is a brief description of the irrigation system in the respective schemes.

(1) Kisiwani scheme

The Kisiwani scheme has a total net irrigable area of 360 ha. Irrigation water to the scheme will be taken off by two diversion weirs on the Nakombo river, i.e. the Nakombo weir and the Kisiwani weir.

The Nakombo weir will newly be constructed at the debouching point of the Nakombo river. The weir will cover an area of 205 ha which extends on the left bank of the Nakombo river through the Nakombo main canal. The Nakombo main canal of 3.6 km branches off from the weir and delivers 0.29 m^3/sec of irrigation water in maximum.

The Kisiwani weir, which exists 200 m downstream from the Same-Tanga road bridge, will be improved under the project. The weir will command an area of 128 ha on the left bank of the Nakombo river and an area of 27 ha on the right bank respectively. The Kisiwani main canal of 1.4 km will branch off from the weir and supplies 0.21 m^3/sec of water in maximum. One secondary canal will branch off from the weir to irrigate an area of 27 ha.

(2) Gonja scheme

The Gonja scheme has a total net irrigable area of 1,040 ha. The Hingilili is the water source of the scheme. The irrigation area is limited to only 600 ha, because of water shortage. Then, rotational irrigation on annual basis will be practiced.

The proposed Hingilili diversion weir will be constructed just upstream of the existing Maore weir site, 700 m upstream from the Same-Tanga road crossing point. Irrigation water of 0.82 m^3/sec will be taken from the intake structure provided at the left side of the weir and delivered to the service area through the Hingilili main canal of 7.6 km.

(3) Ndungu scheme

The proposed Yongoma diversion weir will be provided at the debouching point of the Yongoma river. Irrigation water of 0.93 m^3/sec in maximum will be taken by the intake structure provided at the right side of the weir and supplied to the service area through the Yongoma main canal. The Yongoma main canal will start from the weir and will bifurcate into two main canals, i.e. the Yongoma right main canal and the Yongoma left main canal, at 1.4 km downstream from it head. The Yongoma right main canal of 3.0 km long will cover a service area of 427 ha, while the Yongoma left main canal of 3.5 km long will command a service area of 513 ha. The Yongoma right main canal will be constructed by partly incorporating with the existing Ndungu furrow irrigation canal.

(4) Kihurio scheme

The Kihurio scheme has a total land of 1,670 ha and is irrigated from two water sources, i.e. the Saseni river and the Kalimawe dam.

A new diversion weir is proposed at the debouching point of the Saseni river. The proposed Saseni weir commands a service area of 930 ha and has two intake structures at both sides. The Saseni left main canal with a total length of 4.5 km irrigates the service area of 214 ha which extends on the left bank of the Saseni river.

The Saseni right main canal with a total length of 5 km commands the service area of 716 ha which extends on the right bank of the Saseni river. The service area of 400 ha out of 716 ha is irrigated by water from the Kalimawe dam in the dry season.

In order to extend the irrigation service area fed by the existing Kalimawe dam, the dam is improved under the Project by means of heightening its crest. The improved dam commands a service area of 740 ha in the rainy season, while 1,140 ha in the dry season including the service area of 400 ha commanded by the Saseni weir. Irrigation water of 1.82 m^3/sec in maximum is taken from the Kalimawe right main canal and delivered to the service area by both the Kalimawe right main canal and left main canal. The Kalimawe right main canal with a total length of 2.8 km commands a service area of 210 ha in the rainy season, while 610 ha including 400 ha of the service area fed by the Saseni weir in the dry season. The Kalimawe left main canal with a total length of 4.8 km serves an area of 530 ha on the left bank of the Mkomazi river.

(5) Igoma Scheme

A new diversion weir is proposed at 1.5 km downstream from the proposed Igoma storage dam. Irrigation water exploited by the Igoma storage dam is taken by the weir to both side, 0.58 m^3/sec to the left side and 0.62 m^3/sec to the right side. The Igoma left main canal with a total length of 4.3 km irrigates the area of 365 ha which extends on the left bank of the Mkomazi river. The Igoma right main canal serves an area of 385 ha on the left bank of the Mkomazi river and its canal length is about 4.3 km.

5.4.3 Drainage and flood protection plan

(1) Drainage plan

The lowlying areas and depressed areas in the project area are often affected by floods from the hinterlands and excessive rain water in the area. In order to improve the poor drainage conditions in these area, main and secondary canals will be provided over the project areas.

In preparing the drainage plan, the unit drainage water requirements are firstly estimated based on the following criteria.

(i) Two-day consecutive rainfall with a probability of 20% is taken as the design rainfall.

(ii) Excess water caused by the design rainfall is drained within two days.

The estimated unit water requirements are as follows:

Scheme	Unit Drainage Water Requirements (ℓ/sec/ha)
Kisiwani, Igoma, Gonja	5.67
Ndungu, Kihurio	3.13

The design drainage discharge from the hinterland is calculated employing the Rational Method. For the sake of quick calculation, the specific discharge-catchment area curve is prepared for 20-year probable rainfall (ANNEX-A).

(2) Flood protection plan

The flow capacity of each tributary of the Mkomazi river system is partly small to cope with its floods. Consequently, agricultural land along each tributary is often damaged by floods. A flood protection plan is made for the irrigation development of each scheme mainly by means of improvement of the river channel and by new construction of floodways.

The design flood discharge for improvement of each tributary is estimated as follows based on the 20-year probable rainfall.

River	Catchment Area (km^2)	Design Flood Discharge (m^3/sec)
Nakombo	48.5	77
Hingilili	55.8	127
Yongoma	70.5	127
Saseni	192.0	203
Kambaga	749.0	70/1

/1 : discharge after control by the Igoma dam

(3) Drainage and flood protection system

The drainage system in each scheme consists of the main and secondary drains and on-farm drain. Excess water collected by these drains is drained out to the nearest river or stream. The flood protection system is composed of the improved river channel and the new floodway. The rivers and streams are incorporated into the drainage and flood protection system as many as possible to reduce the construction cost.

(4) River improvement plan of Mkomazi river

At present, the periphery of Lake Manka is inundated every year due to insufficient flow capacity of the Mkomazi river and the floods from the Saseni river and the Kalimawe dam. The inundated area is about 210 ha. An improvement plan of the Mkomazi river is established to control the floods from the Saseni river and the Kalimawe dam by using the storage capacity of the Lake Manka created by the construction of a polder dike. After construction of the polder dike, Lake Manka will have a water surface area of about 180 ha. The design flood discharge mentioned above is used for the improvement plan. Under the plan, both flood discharges of 203 m^3/sec from the Saseni river and 126 m^3/sec from the Kalimawe dam are controlled by Lake Manka and the controled discharge of 155 m^3/sec is flowed out from the lake. The Mkomazi river of 6 km length from the Lake Manka to Lasa bridge will be improved so as to have a capacity of this discharge.

6. PROPOSED PROJECT WORKS

6.1 Dam and Reservoir

6.1.1 Heightening of the Kalimawe dam

The spillway crest elevation of the Kalimawe dam will be heightened for 1.2 m from EL. 504.7 m to EL. 505.9 m. Thus, the effective storage capacity would increase for 9.4 x 10^6 m^3 from the present 5.5 x 10^6 m^3 to 14.9 x 10^6 m^3. For the spillway design of the dam, it is recommended to adopt 700 m^3/sec adding 20% to the 200-year probable flood. The overflow type spillway with non-gate is proposed instead of the present spillway with a stoplog.

The main features of the improved Kalimawe dam are shown below with comparison to the present features.

Main Features	Present	Improved
Elevation of dam crest	EL. 509.23 m	EL. 511.50 m
Width of dam crest	1.8 m	4.0 m
Elevation of spillway crest	EL. 504.76 m	EL. 505.90 m
Flood water level	EL. 507.43 m	EL. 508.60 m
High water level	EL. 504.76 m	EL. 505.90 m
Upstream slope	1:3.0	1:3.0
Effective storage capacity	5.5 x 10^6 m^3	14.9 x 10^6 m^3

6.1.2 Igoma storage dam

In view of the proposed height of the Igoma dam, the homogeneous type of earth fill dam is selected. The width of the dam crest is determined to be 10 m so as to connect the existing Same-Tanga road with the dam crest. A relatively gentle slope of 1 to 3.0 is provided for upstream of the embankment against the rapid drawdown. A well graded layer will be put on the embankment to protect the upstream slope from erosion. A slope of 1 to 2.5 is conservatively provided for the downstream slope of the embankment.

For the design of the dam spillway, it is recommended to adopt 500 m^3/sec adding 20% to the 200-year probable flood. The proposed spillway will be of overflow type and provided at the right side of the dam.

The main features of the Igoma storage dam are as follows:

Catchment area	749 km^2
Type of dam	homogeneous earthfill dam
Height of dam	25 m
Elevation of dam crest	EL 665.0 m
Flood water level	EL 662.4 m
High water level	EL 661.0 m
Low water level	EL 650.5 m
Effective storage capacity	39.4 x 10^6 m^3
Dead storage capacity	7.5 x 10^6 m^3
Type of spillway	overflow spillway
Design discharge of spillway	500 m^3/sec
Length of the spillway	150 m

6.2 Irrigation and Drainage Facilities

Each scheme of the project includes the following major works:

1) headworks with a concrete weir,
2) concrete-lined main and secondary canals, and related structures,
3) unlined tertiary and quaternary canals and related structures,
4) on-farm works including land levelling for paddy fields and land reclamation,
5) drainage system for excess rain water,
6) farm road networks, and
7) river improvement works or short cut floodway.

The main features of project works for each scheme are shown as follows.

PRINCIPAL FEATURES OF KISIWANI SCHEME

1.	Source of irrigation water	Nakombo river	
2.	Net development area	360 ha	
3.	Diversion weir	Nakombo diversion weir	Existing Kisiwani diversion weir
	(1) Design discharge of intake	0.29 m^3/sec	0.25 m^3/sec
	(2) Weir type	Floating type	Fixed type
	(3) Weir height x Crest length	2.6 m x 25 m	1.6 m x 10 m
4.	Irrigation canal		
	(1) Canal type (Main & Secondary)	Trapezoidal concrete lined canal	
	(2) Canal length	8.7 km	
5.	Drainage canal		
	(1) Canal type	Trapezoidal unlined canal	
	(2) Maximum design discharge	50.4 m^3/sec	
	(3) Canal length (Main & Secondary)	9.4 km	
6.	On-farm development	360 ha	
7.	Farm road	18.1 km	
8.	River improvement		
	(1) Design discharge	77 m^3/sec	
	(2) Length of river	2.6 km	

PRINCIPAL FEATURES OF GONJA SCHEME

1.	Source of irrigation water	Hingilili river
2.	Net development area	1,040 ha
3.	Diversion weir	
	(1) Design discharge of intake	0.82 m^3/sec
	(2) Weir type	Fixed type concrete weir
	(3) Weir height x Crest length	3.5 m x 20 m
4.	Irrigation canal	
	(1) Canal type (Main & Secondary)	Trapezoidal concrete lined canal
	(2) Canal length	20.9 km
5.	Drainage canal	
	(1) Canal type	Trapezoidal unlined canal
	(2) Maximum design discharge	67.4 m^3/sec
	(3) Canal length (Main & Secondary)	17.7 km
6.	On-farm development	1,040 ha
7.	Farm road	38.6 km
8.	Shortcut (River improvement)	
	(1) Design discharge	127 m^3/sec
	(2) Length of the flood way	4.6 km

PRINCIPAL FEATURES OF NDUNGU SCHEME

1.	Source of irrigation water	Yongoma river
2.	Net development area	940 ha
3.	Diversion weir	
	(1) Design discharge of intake	0.93 m^3/sec
	(2) Weir type	Fixed type concrete weir
	(3) Weir height x Crest length	9.4 m x 25 m
4.	Irrigation canal	
	(1) Canal type (Main & Secondary)	Trapezoidal concrete lined canal
	(2) Canal length	17.6 km
5.	Drainage canal	
	(1) Canal type	Trapezoidal unlined canal
	(2) Maximum design discharge	34.4 m^3/sec
	(3) Canal length	15.4 km
6.	On-farm development	940 ha
7.	Farm road	33.0 km
8.	River improvement	
	(1) Design discharge	127 m^3/sec
	(2) Length of river	4.2 km
9.	Flood dike Length	2.5 km

PRINCIPAL FEATURES OF KIHURIO SCHEME

		Saseni Sub-scheme	Kalimawe Sub-scheme
1.	Source of irrigation water	Saseni river	Kambaga river
2.	Net development area	930 ha	740 ha
3.	Diversion weir and dam		
	(1) Design discharge of intake	1.27 m^3/sec	1.82 m^3/sec
	(2) Weir type and dam type	Fixed type concrete weir	Center core earthfill type
	(3) Weir height x Crest length	13.5 x 40 m	-
4.	Irrigation canal		
	(1) Canal type (Main & Secondary)	Trapezoidal concrete lined canal	Trapezoidal concrete lined canal
	(2) Canal length	18.2 km	11.5 km
5.	Drainage canal		
	(1) Canal type	Trapezoidal unlined canal	Trapezoidal unlined canal
	(2) Maximum design discharge	38.8 m^3/sec	59 m^3/sec
	(3) Canal length	13.7 km	9.4 km
6.	On-farm development	930 ha	740 ha
7.	Farm road	31.9 km	20.9 km
8.	River improvement	Saseni river	Mkomazi river
	(1) Design discharge	203 m^3/sec	155 - 126 m^3/sec
	(2) Length or river	3.0 km	6.0 km
9.	Flood dike Length	6.5 km (Lake Manka)	

PRINCIPAL FEATURES OF IGOMA SCHEME

1.	Source of irrigation water	Kambaga river
2.	Net development area	750 ha
3.	Diversion weir	
	(1) Design discharge of intake	1.20 m^3/sec
	(2) Weir type	Floating type concrete weir
	(3) Weir height x Crest length	3.5 m x 20 m
4.	Irrigation canal	
	(1) Canal type (Main & Secondary)	Trapezoidal concrete lined canal
	(2) Canal length	15.8 km
5.	Drainage canal	
	(1) Canal type	Trapezoidal unlined canal
	(2) Maximum design discharge	29.4 m^3/sec
	(3) Canal length	3.4 km
6.	On-farm development	750 ha
7.	Farm road	19.2 km
8.	River improvement	
	(1) Design discharge	70 m^3/sec
	(2) Length of river	5.3 km
9.	Flood dike Length	1.5 km

7. ORGANIZATION AND MANAGEMENT

7.1 Organization for Implementaiton

For the successful implementation of the Project, it is proposed to establish an executing organization tentatively called the Project Office under the jurisdiction of the Regional Development Director (RDD). In order to coordinate, guide and assist the Project Office during the implementation period, an Executive Committee will also be organized under RDD. The Committee will constitute representatives concerned such as Regional Planning Officer, Regional Manpower Management Officer, Regional Accountant, Regional Irrigation Engineer, Regional Agricultural Development Officer, Regional Officer of Tanzania Rural Development Bank, District Development Director and Village Chiefs.

The Project Office will consist of one main office and five branch offices. The main office will have five working sections, i.e. (i) Survey and Design Section, (ii) Construction Supervision Section, (iii) Mechanical Section, (iv) Accounting Section and (v) Administrative Section under management of the Project Manager to be appointed by RDD. The organization chart is shown in Fig. 8. Total number of staff required for the Project Office would be around 90 persons.

7.2 Organization for Operation and Maintenance

After completion of the construction works, the Project Office at the implementation stage will be re-organized into the operation and maintenance office with five working sections: (i) Operation Section, (ii) Maintenance Section, (iii) Mechanical Section, (iv) Accounting Section and (v) Administrative Section. The O & M Office will be responsible for operation and maintenance of the dams and reservoirs, irrigation and drainage facilities and road networks down to inlets of tertiary blocks. The operation and maintenance of the tertiary blocks will be entrusted to the Water User's Association to be organized by the farmers themselves. The organization of the O & M Office is shown in Fig. 9.

The Kilimanjaro Agricultural Development Center (KADC), which was established in the Chekereni village under the technical and financial assistance of the Japanese Government, will directly coordinate and assist the O & M Office in the operation and management of the Project.

The O & M Office will consist of one main office and five branch offices. All the main and branch offices established in the implementation stage will be used for operation and maintenance. The main office will be responsible for the overall activities necessary for the proper operation and maintenance of all the project facilities including preparation of overall operation and maintenance program, design and construction supervision of maintenance works, budgeting, training of staffs, etc. The branch offices will provide operation and maintenance works according to the program prepared by the main office, and periodical consultation to Water User's Associations on operation and maintenance of tertiary canals down to terminal facilities. Total number of the O & M staff required in full operation stage would be around 50 persons including the staff for the main office and all the branch offices.

7.3 Agricultural Support Services

7.3.1 General

In order to attain the expected crop production through the introduction of double cropping a year with irrigation and drainage improvement, it is essential to provide for more intensive agricultural support services, in addition to proper operation and maintenance of the project facilities.

For this purpose, further improvement of the present supporting services will be required, particularly for extension services and research works. In addition, it is recommended to establish the water users' association not only for proper water management, but also for supporting farm management of farmers in the project area.

7.3.2 Extension services and research works

The present farming practices in the project area are still primitive, and the farmers are not familiar with modernized irrigation farming. The extension workers responsible for propagation of technical knowledge on crop cultivation are insufficient in number at present. Equipment and materials for extension activities are also insufficient. The extension activities will become more important in the future with project condition for proper guidance on application of improved techniques. It is therefore desirable to increase number of extension workers and strengthen

their technical knowledge in order to spread evenly the improved farming techniques to the individual farmer. The appropriate command area per extension worker would be about 500 ha of farm land. In order to maintain prospective crop production throughout the project operation, the training of extension workers as well as leading farmers is essential to be constantly carried out by KADC. Further improvement would also be required for equipment and instruments necessary for extension activities such as motor bicycle, soil testing apparatus, etc.

In order to attain the projected target in the area, a systematic research program of crop adaptation test, varieties trials, fertilizer and chemical application test is essential. In this context, the present Miwaleni substation under Lyamungu Agricultural Research Institute should be extended and strongthened in staff, facilities, equipment, etc. In addition, many of trial results to be made in KADC would be applied to the project area.

7.3.3 Water users' association (WUA)

At the farmers' level, Water User's Associations (WUA) will be organized in each scheme to operate and maintain the tertiary system under the supervision of the Project Office. WUA will be a farmers' group similar to the present communal working group in each village. WUA would have to coordinate and to maintain good communication with the Project Office in water supply management and maintenance of facilities. Under WUA, Farmer's Groups will be set up at the rate of one group per about 20 ha which will correspond to the on-farm area covered by one tertiary canal.

In addition, it is proposed to establish a committee of WUA for efficient management of WUA. The committee will be organized by representative farmers and take responsibilities not only for water management, but also for supporting farm management of member farmers. Through the committee, WUA will be given strong support from all the agricultural supporting agencies. Besides the proposed water management, WUA and its committee will take the following duties for supporting the farm management of members.

a) Supply of farm inputs;

To make close contact with TANSEED, TFC, and DADO and to arrange such farm inputs as high yielding variety seeds, fertilizers, agrochemicals and tractor plowing services.

b) Arrangement of farmers' credits;

To arrange TRDB credits for purchase of above farm inputs.

c) Marketing of products;

To make close contact with NMC and to ship farmers' products timely.

8. PROJECT IMPLEMENTATION SCHEDULE

8.1 Basic Considerations of Project Implementation

The implementation schedule for the Project shown in Fig. 10 is worked out on the basis of the following basic considerations:

(1) The Project consists of five independent schemes, i.e. the Kihurio Scheme, the Ndungu Scheme, the Gonja Scheme, the Kisiwani Scheme and the Igoma Scheme. In principle, the implementation of the five schemes will be made simultaneously. The implementation of the Igoma Scheme, however, will be commenced after the detailed investigations for the design and construction of the dam.

(2) Taking into consideration the dispersion of the five schemes and the scale of the construction works for each scheme, the Project will be implemented stagewise as follows:

- Detailed design and construction of project facilities for the Kihurio, Ndungu, Gonja and Kisiwani Schemes, and aerophoto mapping of the dam site, reservoir area and irrigation area for the Igoma Scheme, and

- Detailed design and construction of project facilities for the Igoma Scheme.

(3) As the civil works include a large volume of earth works, mechanized construction method will principally be introduced. To increase employment opportunity among the local people, however, the construction method by manpower will be adopted as much as possible.

(4) Since there are few local contractors in Tanzania with sufficient experience and enough equipment for this kind of work, it is proposed that the construction work will be undertaken by qualified international contractors selected through international competitive bidding.

(5) The consultant will be engaged by the Project Office for the preparation of the detailed design and tender documents, and the supervision of the construction works, and assistance and guidance in operation and maintenance of the project facilities.

(6) Since the ownership of all lands in Tanzania belongs to the Government, no compensation will be required for land acquisition and right of way for the project facilities.

8.2 Work Quantities and Construction Materials

The quantities of major works and major construction materials needed for the project are estimated as shown in the following table.

Work Quantities

	Unit	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	Total
Excavation	10^3m^3	400	900	800	1,800	600	4,500
Earthfill	10^3m^3	200	500	400	800	700	2,600
Concrete	10^3m^3	1	2	2	14	13	32
Lining concrete	10^3m^3	1	2	2	4	2	11
Form	10^3m^2	8	13	9	69	38	137

Construction Materials

	Unit	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	Total
Cement	10^3t	0.6	1.2	1.2	5.4	4.5	12.9
Reinforcement bar	t	40	60	50	220	280	650
Gate	t	60	70	80	100	100	410
Gravel for concrete	10^3m^3	1	3	3	12	10	29
Gravel for road pavement	10^3m^3	7	9	6	17	7	46
Sand for concrete	10^3m^3	0.8	1.6	1.6	7.4	6.2	18.8
Rock for gabion	10^3m^3	4.1	1.2	1.8	8.8	1.6	17.5
Timber	10^3m^3	0.2	0.3	0.3	1.4	0.9	3.1
Fuel	Kℓ	500	1,000	900	2,000	1,000	5,400

8.3 Construction Time Schedule

The time required for implementation of the project would be 69 months (about 6 years) including the detailed design and preparatory work of about 26 months. The detailed design works including the preparation of tender documents for four schemes, Kisiwani, Gonja, Ndungu and Kihurio will take about 10 months. Prior to the detailed design works for the Igoma scheme, more detailed topographic mapping with either aerial photo or actual field survey and geological investigation as well as construction materials investigations are indispensable. The time required for those investigations as well as for the detailed design and selection of contractors for the Igoma scheme would be about 31 months.

The construction works for four schemes will be carried out in parallel. In order to obtain irrigation benefits as early as possible, the headworks will be completed first and followed by irrigation canals. In the case of Igoma scheme, the construction of dam will be made first, which will require about 29 months.

8.4 Construction Equipment

The construction equipment needed for the project inplementation is estimated based on the work quantity, construction time schedule and the site conditions in the project area. The major construction equipment needed for the project are shown in Table 12.

9. COST ESTIMATE

9.1 General

The cost of the implementation of the Project is estimated on the basis of the preliminary design of the project facilities, taking into account the construction method to be applied, capability of labour, productivity of machinery and also the following assumptions:

(1) The exchange rate used in the estimate is:

US$1.00 = TSh.12.00
= ¥ 240

(2) The main construction works will be carried out by contractor(s) selected through international competitive bidding. The construction machinery and equipment required for the construction works will be imported by the contractor(s).

(3) Taxes on the construction materials, machinery and equipment to be imported from abroad are exempted from the estimation of the construction cost.

(4) The unit prices are divided into foreign and local currency portions. Local currency portion is estimated based on the current prices in 1983 in the Kilimanjaro region, and on the cost data of on-going civil works obtained from the Government authorities concerned. The foreign currency portion is estimated based on the CIF prices at Tanga, making reference to FOB prices of materials and equipment in Japan in 1983. The allocation of local and foreign currency portions is defined as follows:

Local currency portion

- Labour force,
- Sand, gravel, rock and wooden materials,
- Inland transportation costs, and
- Administration expenses.

Foreign currency portion

- Reinforcement bar and structural steel,
- Fuel, oil, etc.,
- Cement,
- PVC pipe and steel pipe,
- Steel gates for dam, intake facilities and canal related structures,
- Depreciation costs of construction machinery and equipment,
- Contractor's general expenses and profits for foreign contractor(s),
- Expenses and fees of engineering services by foreign consultants.

(5) Physical contingency related to the construction quantities, 10% of the direct construction cost, is included.

(6) Price contingency; 5% per annum for the foreign currency portion and 15% per annum for the local currency portion, is also included.

(7) The associated costs to be financed by the Government, such as the costs for strengthening the extension services, facilities of the water users' association, and improvement of the social structures are not included in this estimate.

9.2 Cost Estimate

9.2.1 Investment cost and annual disbursement schedule

The total construction costs of the Project are estimated at US$61.2 million equivalent, which comprise US$37.7 million equivalent of foreign currency and US$23.5 million equivalent of local currency as summarized in Table 13. The annual disbursement schedule is tentatively worked out based on the construction time schedule and shown in Table 14.

9.2.2 Operation and maintenance costs

The annual operation and maintenance costs include the salaries of

the project administrative and water control staff, the materials and labour costs for repair and maintenance of project facilities, the costs for operation, repair and maintenance of O & M equipment and the running costs of project facilities.

The annual operation and maintenance costs at the full development stage of the Project is estimated at TSh.5.3×10^6 approximately. The breakdowns of these costs are shown in ANNEX I.

9.2.3 Replacement costs

Some of the facilities, especially mechanical and electrical facilities have shorter useful life than the civil works and have to be periodically replaced within the project useful life. The replacement costs and useful lives of these facilities are listed in ANNEX I.

10 PROJECT EVALUATION

10.1 General

Project evaluation is performed in order to ascertain the viability of the project in view of economic, financial and socio-economic aspects.

The economic viability of the project is evaluated in terms of the internal rate of return (IRR). Further, sensitivity analysis is made to evaluate the economic viability of the Project against the possible changes in estimates of the project costs and benefits.

The financial analysis is made on the capacity to pay of farmers and the repayment schedule of the project capital cost. The calculation of the capacity to pay is to confirm the soundness of the project from the farmer's viewpoint. The repayment schedule is made to estimate the Government annual subsidy based on the estimated fund requirements with the assumed financial terms of conceivable loans and the expected revenue from the project.

Intangible benefits of the project are briefly assessed in due consideration of the effects of the project on the regional development.

10.2 Economic Cost

The economic costs consist of i) cost of preparatory works, ii) cost of civil works including on-farm development, iii) general administration cost, iv) procurement cost of O & M machinery, v) cost of engineering services by foreign consultant and vi) physical contingencies of 10%. The above economic costs are estimated based on 1983 price levels. The economic costs exclude both price contingencies and transfer payments such as taxes and duties. The foreign currency portion estimated based on border prices of goods is converted into the economic cost by multiplying by 1.12, which is the shadow price factor(See ANNEXES E and J).

The economic cost of the project is estimated at TSh.558,200 x 103 equivalent in total as shown below.

Unit: TSh.x10^3

Scheme	Economic Cost
Kisiwani	45,400
Gonja	83,500
Ndungu	81,600
Kihurio	178,500
Igoma	169,200
Total	558,200

10.3 Project Benefits

In addition to the agricultural and flood protection benefits, benefit of water release for potable water are counted among such indirect benefits as increase of tourism opportunity by construction of Igoma dam, improvement of livestock productivity and quality by use of by-product of paddy cultivation, etc.

(1) Agricultural benefit

The agricultural benefits are evaluated as the difference of net incomes from crops in future between "with project" and "without project". The benefit will start in 1986 and increase year by year. It will attain its maximum in 1996. Total annual incremental benefits from all the schemes are estimated at TSh. 112,100 x 10^3 at the full development stage, as shown in the table below:

Unit: TSh. x 10^3

Scheme	Net Return With Project	Net Return Without Project	Negative Benefit/1	Net Direct Benefit
Kisiwani	10,350	1,910	-	8,440
Gonja	20,550	3,160	-	17,390
Ndungu	20,690	3,240	-	17,450
Kihurio	51,560	6,840	170	44,550
Igoma	24,310	40	-	24,270
Whole Project	127,460	15,190	170	112,100

Note: /1 = Production losses for 70 ha of farm land due to submergence by the hightening the Kalimawe dam.

(2) Flood protection benefit

By virtue of the proposed flood protection facilities, the existing marshy and swampy area of 750 ha will be changed to arable land, furthermore, about 2,000 ha of arable land including the above new arable land will be protected from seasonal inundation, so that the prospective agricultural production from the area is secured substantially. In addition to the above benefit which is already evaluated as the agricultural benefit along with the irrigation benefit, a certain flood damages for private properties and public facilities will be reduced by the proposed facilities. These reduced values of damages are counted as the project benefit in the economic evaluation and are estimated at about TSh.120 x 10^3 per annum as shown below.

Scheme	Flood Protection Benefit (TSh. x 10^3)
Kisiwani	10
Gonja	30
Ndungu	20
Kihurio	40
Igoma	20
Whole Project	120

(3) Benefit of water release for potable water

A certain amount of water will be released from the Igoma dam throughout the year for potable water use for the houses in the Igoma scheme. The value of this water is evaluated in monetary terms on the assumption that as the alternaive use, this water is used for the crop production which is the most beneficial use. The value is thus evaluated at TSh. 420 x 10^3 per annum and also counted as the project benefit.

10.4 Economic Evaluation

10.4.1 Internal rate of return

On the basis of the economic cost and benefit estimated in the preceding sections, the internal rate of return (IRR) of the project is calculated for each scheme and for the entire project. The calculation of IRR is made based on 50 years of the project life. The result indicates that the project is quite feasible with the IRR of 19.0% of the entire project as shown below.

Unit: %

Scheme	Internal Rate of Return (IRR)
Kisiwani	17.3
Gonja	20.2
Ndungu	20.3
Kihurio	21.6
Igoma	12.1
Whole project	19.0

10.4.2 Sensitivity analysis

In order to evaluate further the soundness of the Project to possible changes of economic conditions in future, the sensitivity analyses are made for the following conditions:

i) cost increase of 10%,
ii) cost increase of 20%,
iii) benefit decrease of 10%,
iv) benefit decrease of 20%, and
v) simultaneity of the above four cases.

The results of the sensitivity analyses are as follows:

Unit: %

Cost increase	Benefit decrease		
	0%	10%	20%
0%	19.0	17.0	14.9
10%	17.2	15.3	13.4
20%	15.6	13.9	12.2

As seen in the table, the elasticity of the project feasibility for the critical condition is not sensitive at 12.2% under the most adverse conditions caused by a 20% price decline and 20% cost overrun.

10.5 Financial Evaluation

10.5.1 Capacity to pay

In order to evaluate the project viability from the financial aspect of farmers. An average farm budget analysis is made in both the future with and without project conditions as and outlined below:

Unit: TSh.

Item	Without project	with project
Gross Income	8,000	31,920
Gross Outgo	8,000	17,310
Net Reserve (capacity to pay)	0	14,610

As seen in the above table, the capacity to pay expected under "with project" condition in TSh. 14,610 per farm.

10.5.2 Repayment capability

For the repayment capability analysis, it is assumed that the investment requirement would be arranged under the following conditions:

(a) Foreign currency portion: This is financed under bilateral finance agreement or by international finance agencies at an interest rate of 3% per annum. Repayment period is 30 years including a grace period of 10 years.

(b) Local currency portion: This is financed by the budget allocation of the Government.

Based on the above assumption, the full charges to the water users for repayment are estimated at about TSh. 6,300/user/year corresponding to about 45% of the capacity to pay. On the other hand, the water charge which is equal to the annual O&M and replacement costs is estimated at TSh.1,200/user/year. This charge corresponds to about 10%

of the capacity to pay. Generally, the charge to be collected from water users should be within a reasonable range in the capacity to pay that can still give sufficient incentive to the farmers for agricultural increases. In this view, it is anticipated that the farmers could pay the annual operation and maintenance cost, and have the repayment capacity for replacement of the project facilities.

The financial cash flow at the project level is calculated throughout the project life as shown in Table 15, in which temporarily, the O&M and replacemet costs are assumed to be borne by beneficiary farmers and all other costs including amortization of the loan are provided by the Government as subsidy to the project.

10.6 Socio-economic Impact

In addition to the benefits stipulated in the economic evaluation, indirect benefits and favourable intangible socio-economic impacts are expected from the implementation of the project.

(1) Saving of foreign exchange

Agricultural production will substaintially increases under the project, in particular about 14,300 tons of rice, after deduction of consumption in the project area, will be diverted to consumption within the country. This means that foreign exchange amounting about US$8,250 x 10^3 for rice import will be annually saved.

(2) Increase of employment opportunity to local people

Employment opportunities to local people will increase with the project implementation, and favourable impact will be given to the national economy. Furthermore, the employees will be able to gain more experience, technical know-how, skillfulness in the various working fields. This accumulation of knowledge would be used to the future development in the region.

(3) Improvement of local transportation

Local transportation will be much improved by the construction, of roads along the irrigation canals. The expanded road network will not only enhance the economic activity in and around the project area but also contribute to inter-regional accessibility and communication.

(4) Improvement of sanitary conditions

The Project would have a positive effect on the overall ecology of the project area. Health and sanitary conditions would become better with drainage improvement as well as supply of fresh water through the irrigation canal.

(5) Settlement from the densely populated highland

New paddy field of about 870 ha will be created by the new agricultural development of the Igoma scheme and drainage improvement of the Kihurio scheme. If the people from the densely populated highland in the South Pare mountains are settled in this new land, shortage of agricultural land and social condition in the Mkomazi Valley area will be greatly improved.

TABLES

Table 1 AREA CULTIVATED, YIELD AND PRODUCTION OF MAJOR FOOD CROPS IN TANZANIA AND KILIMANJARO REGION IN 1979

Crop	Country /1			Kilimanjaro Region /2		
	Area (10^3ha)	Yield (t/ha)	Production (10^3ton)	Area (10^3ha)	Yield (t/ha)	Production (10^3ton)
Maize	1,300	0.7	900	36.8	1.2	44.2
Rice	200	1.3	250	3.5	1.3	4.6
Wheat	55	1.4	80	8.7	1.4	12.2
Millet	220	0.7	160	5.8	1.0	5.8
Pulses	480	0.4	210	6.4	0.8	5.2
Banana	n.a.	-	780	35.4	9.2	325.7
Roots and Tubers	1,010	4.9	4,970	3.3	4.3	14.2

Source: /1 = FAO Production Yearbook, 1980

/2 = F/S Report on Lower Moshi Agricultural Development Project, JICA

Table 2 PRODUCTION AND TRADE OF MAJOR CROP IN TANZANIA FROM 1978 TO 1980

Unit: 1,000 tons

	Production			Import			Export			Estimated Domestic Consumption		
	1978	1979	1980	1978	1979	1980	1978	1979	1980	1978	1979	1980
Cereals												
- Maize	1,040	900	800	-	-	230	35	40	-	1,005	860	1,030
- Rice	260	250	180	45	25	90	-	-	-	305	275	270
- Wheat	70	80	70	75	35	65	-	-	-	145	115	135
- Others	420	380	380	5	-	-	10	100	-	415	280	380
Total	1,790	1,610	1,430	125	60	385	45	140	-	1,870	1,530	1,815
Roots and tubers	4,870	4,970	5,020	-	-	-	-	-	-	4,870	4,970	5,020
Pulses	210	210	220	-	-	5	15	10	25	195	200	200
Oilseed												
- Seed	245	235	210	-	-	-	15	5	-	230	230	210
- Oilseed cake and meal	-	-	-	-	-	-	35	35	25	-	-	-
- Seed oil	-	-	-	-	-	5	-	-	-	-	-	-
Total	245	235	210	-	-	5	50	40	25	230	230	210
Coffee	50	50	50	-	-	-	50	45	45	-	5	5
Fiber crops												
- Cotton lint	55	60	50	-	-	-	45	40	50	10	20	-
- Saisal	90	80	115	-	-	-	80	75	55	10	5	60
Total	145	140	165	-	-	-	125	115	105	20	25	60
Tobacco	15	15	20	-	-	-	10	15	10	5	-	10

Source: FAO Production Year Book and Trade Year Book, 1980

Table 3 TRADE BALANCE OF AGRICULTURAL PRODUCTS IN TANZANIA

Unit: US$x10^3

	Exports Value			Imports Value			Balance		
	1978	1979	1980	1978	1979	1980	1978	1979	1980
Cereals									
- Maize	7,100	9,000	-	250	380	53,000	6,850	8,620	-53,000
- Rice	30	-	-	17,230	8,640	34,000	-17,200	-8,640	-34,000
- Wheat	-	-	-	13,190	8,460	18,500	-13,190	-8,460	-18,500
- Others	1,220	13,200	-	-	-	-	1,220	13,200	-
Total	8,350	22,200	-	30,670	17,480	105,500	-22,320	4,720	-105,500
Roots and tubers	130	130	130	-	-	-	-130	-130	-130
Pulses	8,310	7,200	16,000	330	-	3,000	7,980	-7,200	13,000
Oilseed									
- Seed	4,600	2,590	1,290	960	-	-	3,640	2,590	1,290
- Oilseed cake and meal	4,410	5,290	4,780	-	-	-	4,410	5,290	4,780
- Seed oil	-	-	-	1,140	2,990	3,900	-1,140	-2,990	-3,900
Total	9,010	7,880	6,070	2,100	2,990	3,900	6,910	4,890	2,170
Beverages and tobacco									
- Coffee	169,410	148,570	136,520	-	-	-	169,410	148,570	136,520
- Tobacco	28,790	35,270	29,000	-	-	-	28,790	35,270	29,000
- Others	21,880	19,840	24,000	1,580	610	610	20,300	19,230	23,390
Total	220,080	203,680	189,520	1,580	610	610	218,500	203,070	188,910
Fiber crops									
- Cotton lint	54,620	59,520	86,000	10	-	-	54,610	59,520	86,000
- Saisal	28,780	31,060	30,000	-	-	-	28,780	31,060	30,000
- Others	-	-	-	240	80	-	-240	-80	-
Total	83,400	90,580	116,000	250	80	-	83,150	90,500	116,000
Others /1	66,860	61,530	59,110	56,190	47,370	50,810	10,670	14,160	8,300
Agri. Products Total	396,140	393,200	386,830	91,102	68,530	163,820	305,020	324,670	223,010
(TSh.x 10^6 equivalent)	(3,046)	(3,248)	(3,172)	(701)	(566)	(1,343)	(2,346)	(2,682)	(1,829)

Note: /1 = Including livestock products and vegetables

Source: FAO Trade Yearbook, 1980

Table 4 ELECTRIC POWER STATION IN TANZANIA AND POWER SUPPLY PLAN IN MKOMAZI VALLEY AREA

ELECTRIC POWER STATION IN TANZANIA

Name	Capacity	Remarks
Hydro Power Stations		
Kidatu Phase I & Phase II	200 MW	50 MW x 2, 50 MW x 2
Nyumba Ya Mungu	8 MW	4 MW x 2
Hale	21 MW	10.5 MW x 2
Pangani Falls	17.5 MW	5 MW x 2, 2.5 MW x 3
Kikuletwa	1.16 MW	600 kW x 1, 400 kW x 1, 160 kW x 1
Sub-total	247.66 MW	
Thermal Power Stations		
Ubango (Dar es Salaam)	47.44 MW	Gas Turbine 15 MW x 1 Diesel 7.5 MW x 2, etc.
Arusha	5.2 MW	
Moshi	0.8 MW	
Sub-total	53.44 MW	
Total	302.1 MW	

POWER SUPPLY PLAN IN MKOMAZI VALLEY AREA

Village	Population	Capacity (kVA)
Mwembe		75
Mkonga	1,780	25
Kisiwani	3,560	50
Kisiwani sisal estate		200
Gonja Maore	4,940	75
Gonja estate		300
Mpirani	1,560	25
Bombo hospital		100
Mjema	1,770	25
Ndungu sisal estate		200
Ndungu	5,450	50
Total		1,125
Gonja substation		775

Table 5 AVERAGE MONTHLY RAINFALL (1963 - 1982)

Unit: mm

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
Tia Dam Site (Alt. 1,670 m)													
Ave.	129	96	194	210	73	16	6	17	30	74	304	312	1,461
Max.	390	182	398	493	210	75	25	49	125	252	751	595	2,367
Min.	1	6	79	41	16	0	0	0	2	9	103	124	706
Gonja Estate (Alt. 549 m)													
Ave.	110	88	165	122	42	8	3	9	18	29	152	223	969
Max.	249	303	575	411	125	46	30	46	82	163	372	459	1,630
Min.	0	7	30	8	0	0	0	0	0	0	74	55	488
Kalimawe Meteo. Station (Alt. 508 m)													
Ave.	55	46	84	74	26	5	3	4	8	23	55	92	475
Max.	193	232	282	242	82	20	12	25	38	98	181	297	1,014
Min.	0	1	3	4	1	0	0	0	0	1	1	3	243

Table 6 CLIMATE AT KALIMAWE METEO. STATION

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean or Total	Period
Mean Max. Temp. (°C)	33.5	34.1	34.0	31.7	29.3	28.5	28.3	28.9	30.4	32.2	33.2	32.3	31.4	'68-'82
Mean Min. Temp. (°C)	21.5	21.9	21.9	21.5	20.3	18.6	17.1	16.2	16.9	19.2	21.1	21.5	19.8	'68-'82
Mean Temperature (°C)	27.2	27.9	27.9	26.5	24.8	23.6	22.7	22.6	24.0	25.7	27.1	27.0	25.6	'68-'82
Min. Temperature (°C)	18.8	19.2	19.2	18.4	17.0	14.7	12.9	13.2	13.3	15.0	17.8	18.7	16.5	'71-'82
Mean Max. Humid. (%)	81	79	81	80	81	78	81	83	83	81	82	82	71	'76-'81
Mean Min. Humid. (%)	33	34	34	39	42	37	35	33	31	29	34	37	35	'76-'81
Mean Humidity (%)	57	57	58	60	62	58	58	58	56	55	58	59	58	'76-'81
Pan Evaporation (mm/day)	6.3	6.6	6.3	5.7	5.5	5.8	5.6	5.5	5.7	6.1	6.0	6.1	5.9	'64-'82
Radiation (mm/day)	16.1	16.3	16.1	15.6	13.5	14.1	13.5	13.9	15.5	16.5	16.0	16.9	15.3	'67-'82
Run of Wind (km/day)	138	134	120	138	184	197	187	145	118	121	129	143	146	'67-'82
Rainfall (mm)	63.6	46.9	80.9	72.8	25.4	4.5	2.2	5.4	8.4	17.2	53.5	96.3	477.2	'62-'82
Rainy days (days)*	7.5 (7.0)	6.0 (5.6)	8.9 (8.2)	11.4 (10.5)	8.0 (7.1)	2.3 (1.9)	1.6 (1.4)	2.5 (2.0)	2.9 (2.5)	6.0 (5.3)	9.5 (8.9)	10.8 (10.1)	77.4 (70.5)	'62-'82

*: The day had less than 0.1 mm (trace) are excluded.

Table 7 ESTIMATED MONTHLY MEAN DISCHARGE

Unit: m^3/sec

River	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Nakombo ($48.5\ km^2$)													
Mean	1.09	0.77	0.94	1.15	0.88	0.65	0.46	0.43	0.41	0.39	0.86	1.61	0.80
Max.	3.24	2.58	2.57	3.25	2.79	2.17	0.87	1.32	1.12	0.99	2.67	5.81	1.87
Min.	0.26	0.29	0.31	0.39	0.37	0.29	0.17	0.12	0.19	0.17	0.19	0.37	0.30
Hingilili ($55.8\ km^2$)													
Mean	1.70	1.20	1.48	1.80	1.37	1.00	0.72	0.68	0.64	0.61	1.35	2.52	1.26
Max.	5.05	4.02	4.00	5.07	4.34	1.28	1.36	2.05	1.75	1.54	4.16	9.03	2.92
Min.	0.41	0.46	0.53	0.62	0.60	0.46	0.27	0.19	0.30	0.27	0.30	0.58	0.48
Yongoma ($70.5\ km^2$)													
Mean	1.87	1.25	1.55	1.74	1.23	0.85	0.60	0.54	0.49	0.47	1.14	2.48	1.18
Max.	4.72	4.56	3.93	4.22	3.67	2.73	1.22	1.57	1.33	1.14	3.18	8.53	2.60
Main.	0.36	0.62	0.52	0.68	0.74	0.36	0.32	0.25	0.25	0.26	0.37	0.75	0.64
Saseni ($198.5\ km^2$)													
Mean	4.39	2.76	3.43	3.39	2.01	1.21	0.83	0.60	0.50	0.49	1.62	4.99	2.18
Max.	8.61	11.37	11.00	7.00	5.20	3.31	2.06	1.55	1.23	0.93	3.08	15.00	4.58
Min.	0.55	0.56	1.18	1.05	0.54	0.41	0.32	0.28	0.20	0.19	0.34	1.61	1.19

Table 8 CROPPING ACREAGE IN THE PROJECT AREA

Unit: ha

Crop	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	Total
I. Maize						
1st cropping maize/1						
Irrigated/H.Y.V.	20	20	30	110	-	180
Irrigated/L.V.	60	60	70	290	-	480
Rainfed/L.V.	50	210	210	110	20	600
2nd cropping maize/2						
Rainfed/L.V.	10	30	40	20	-	100
Rainfed/L.V./4	10	230	170	70	-	480
3rd cropping maize/3						
Irrigated/H.Y.V.	10	10	40	80	-	140
Irrigated/L.V.	20	30	100	200	-	350
Rainfed/L.V./4	60	80	30	440	-	610
Total	240	670	690	1,320	20	2,940
II. Paddy						
Irrigated/L.V.	60	40	170	160	-	430
Rainfed/L.V.	70	290	210	140	-	710
Total	130	330	380	300	-	1,140
III. Beans/5	220	410	480	1,230	20	2,360
IV. Others/6	some	some	some	some	some	some

Note: /1 = Rainy season maize, mixed cropping with Beans
/2 = Rainy season maize
/3 = Dry season maize, mixed cropping with Beans
/4 = Cropping in the lowlying land
/5 = Mixed cropping with Maize
/6 = Including banana, coconut, Cassava, etc.

Table 9 CROPPING ACREAGE AND PRODUCTION IN THE PROJECT AREA

Crop	Kisiwani		Gonja		Ndungu		Kihurio		Igoma		Total	
	Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)	Planted Area (ha)	Production (ton)
I. Maize												
1st cropping maize/1												
Irrigated/H.Y.V.	20	30	20	30	30	45	110	165	-	-	180	270
Irrigated/L.V.	60	60	60	60	70	70	290	290	-	-	480	480
Rainfed/L.V.	50	30	210	125	210	125	110	70	20	10	600	360
2nd cropping maize/2												
Rainfed/L.V.	10	5	30	20	40	25	20	10	-	-	100	60
Rainfed/L.V./4	10	5	230	140	170	100	70	40	-	-	480	285
3rd cropping maize/3												
Irrigated/H.Y.V.	10	15	10	15	40	60	80	120	-	-	140	210
Irrigated/L.V.	20	20	30	30	100	100	200	200	-	-	350	350
Rainfed/L.V./4	60	35	80	50	30	20	440	260	-	-	610	365
Total	240	200	670	470	690	545	1,320	1,155	20	10	2,940	2,380
II. Paddy												
Irrigated/L.V.	60	170	40	80	170	305	160	450	-	-	430	1,005
Rainfed/L.V./4	70	195	290	580	210	380	140	390	-	-	710	1,545
Total	130	365	330	660	380	685	300	840	-	-	1,140	2,550
III. Beans	220	90	410	165	480	190	1,230	490	20	10	2,360	945

Note: /1 = Rainy season maize, mixed cropping with Beans
/2 = Rainy season maize
/3 = Dry season maize, mixed cropping with Beans
/4 = Cropping in the lowlying land

Table 10 INCREMENTAL EFFECT OF LAND USE

Unit: ha

Category	Kisiwani	Gonja	Ndungu	Kihurio	Igoma	Total or Average
A. Without Project Implementation						
Arable Land	360	1,040	1,010	1,460	20	3,890
Cultivated Area:	370	1,000	1,070	1,620	20	4,080
Rainy season irrigation	140	120	270	560	-	1,090
Dry season irrigation	30	40	140	280	-	490
Rainfed area	200	840	660	780	20	2,500
Crop Intensity	1.0	1.0	1.1	1.1	1.0	1.0
B. With Project Implementation						
Arable Land	360	1,040	940	1,670	750	4,760
Cultivated Area:	720	1,640	1,620	3,340	1,500	8,820
Rainy season irrigation	360	600	680	1,670	750	4,060
Dry season irrigation	180	300	230	1,320	750	2,780
Rainfed area	180	740	710	350	-	1,980
Crop Intensity	2.0	1.6	1.7	2.0	2.0	1.9
C. Incremental Effect (B - A)						
Arable Land	-	-	-70	210	730	870
Cultivated Area	350	640	550	1,720	1,480	4,740
Rainy season irrigation	220	480	410	1,110	750	2,970
Dry season irrigation	150	260	90	1,040	750	2,290
Rainfed area	-20	-100	50	-430	-20	-520
Crop Intensity	1.0	0.6	0.6	0.9	1.0	0.9

Table 11 PRICES OF MAJOR FARM INPUTS AND OUTPUTS

Item		Unit	Financial Price	Economic Price
Farm Products	Paddy	TSh/kg	6.00	5.28
	Maize	TSh/kg	4.00	4.83
	Beans	TSh/kg	8.00	5.58
Seed	Paddy (H.Y.V.)	TSh/kg	8.75	10.10
	(L.V.)	TSh/kg	7.40	5.28
	Maize (H.Y.V.)	TSh/kg	13.00	10.20
	(L.V.)	TSh/kg	10.00	4.83
	Beans	TSh/kg	10.60	12.25
Fertilizer	N	TSh/kg	9.40	15.20
	P_2O_5	TSh/kg	4.60	12.20
Agro-chemical	Insecticides	TSh/kg	32.25	49.90
	Fungicides	TSh/kg	39.50	65.90
Machinery	Tractor plowing	TSh/ha	650.00	500.00
	Tractor harrowing	TSh/ha	250.00	350.00
	Spraying	TSh/ha	40.00	26.00
	Threshing	TSh/ton	60.00	40.00
Material	Sacks	TSh/unit	15.00	17.90
Livestock	Cattles	TSh/head	1,780.00	2,040.00
	Goats	TSh/head	330.00	380.00
	Sheeps	TSh/head	300.00	340.00
	Chickens	TSh/head	38.00	44.00
	Milk	TSh/klit	7.00	8.00
Labour	Family labour	TSh/man-day	-	14.00
	Hired labour	TSh/man-day	23.00	23.00

Table 12 REQUIRED MAJOR CONSTRUCTION EQUIPMENT

	Equipment	Specification	Required Number
1.	Bulldozer	21 ton	15
2.	Bulldozer	17 ton	8
3.	Buldolzer	11 ton	18
4.	Backhoe	0.6 m^3	10
5.	Backhoe	0.3 m^3	4
6.	Motor scraper	11 m^3	4
7.	Tractor shovel	1.2 m^3	3
8.	Wheel loader	1.2 m^3	3
9.	Dump truck	8 ton	15
10.	Tamping roller	7.5-15.2 ton	4
11.	Tire roller	6-10 ton	2
12.	Motor grador	3.7 m	2
13.	Vibrating compactor	100 kg	12
14.	Rammer	60-100 kg	15
15.	Tamper	60-100 kg	15
16.	Water tanker	5.5 kℓ	5
17.	Belt-conveyor	10 m	5
18.	Breaker (attachment for backhoe)	200 kg	2
19.	Aggregate plant (Crushing and screening)	165 ton/day	2 sets
20.	Concrete batcher plant	0.5 m^3x1	4
21.	Concrete mixer	0.4 m^3	3
22.	Concrete mixer	0.2 m^3	5
23.	Agitator truck	1.6 m^3	5
24.	Vibrator	45 mm	30
25.	Truck crane	15 ton	2
26.	Wheel crane	5.5 ton	2
27.	Cargo truck with crane	3 ton	6
28.	Cargo truck	6 ton	15
29.	Fork lift	3 ton	3
30.	Fuel tanker	10 kℓ	1
31.	Fuel tanker	4 kℓ	3
32.	Pick-up car	1 ton	15
33.	Micro bus	25 persons	6
34.	Jeep	4 drive	15
35.	Maintenance car	6 ton	1
36.	Grease car	6 ton	1
37.	Submersible pump	100 mm	4
38.	Submersible pump with generator	50 mm	10
39.	Block making plant	5 m^3/day	4
40.	Power supply system		1
41.	Water supply system		1
42.	Testing and survey equipment		1 set
43.	Repair shop equipment		1 set
44.	Truck mounted rotary drilling machine with accessories		1

Table 13 SUMMARY OF CONSTRUCTION COST

Unit: TSh.10^3

Item	Foreign Currency	Local Crrency	Total
1. Preparatory Works	14,120	5,850	19,970
2. Igoma Dam	56,800	18,400	75,200
3. Intake Facilities	24,090	11,150	35,240
4. Canals and Roads			
(1) Irrigation canals	48,330	19,420	67,750
(2) Drainage canals	19,220	8,830	28,050
(3) Farm roads	7,680	2,230	9,910
5. Floodway & Flood Dike	18,320	4,880	23,200
6. Rehabilitation of Existing Dam	13,900	5,400	19,300
7. On-farm Development	51,440	19,640	71,080
8. Office and Quarter	9,200	5,700	14,900
Sub- total	263,100	101,500	364,600
9. O & M Equipment	15,000	1,000	16,000
10. Administration Expenses	-	25,400	25,400
11. Engineering Services	59,600	16,200	75,800
Sub-total	74,600	42,600	117,200
Total	337,700	144,100	481,800
12. Physical Contingency	33,300	14,900	48,200
Total	371,000	159,000	530,000
13. Price Contingency	81,000	123,000	204,000
Grand Total (US10^6)	452,000 (37.7)	282,000 (23.5)	734,000 (61.2)

Note: Price Contingency: Foreign currency 5%, Local currency 15%

US$1.00 = TSh.12.00 = ¥240.-

Table 14 ANNUAL DISBURSEMENT SCHEDULE OF CONSTRUCTION COST

Unit: TSh.10^3

	Item	Investment			1st Year		2nd Year		3rd Year		4th Year		5th Year		6th Year		7th Year	
		FC	LC	Total	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
1.	Preparatory Works	14,120	5,850	19,970	-	-	4,700	2,100	1,900	800	4,700	1,840	1,800	710	800	320	220	80
2.	Igoma Dam	56,800	18,400	75,200	-	-	-	-	-	-	14,600	5,000	28,200	9,000	14,000	4,400	0	0
3.	Intake Facilities	24,090	11,150	35,240	-	-	-	-	14,780	6,960	7,500	3,400	-	-	1,810	790	-	-
4.	Canals and Roads																	
	(1) Irrigation Canals	48,330	19,420	67,750	-	-	-	-	24,780	9,620	16,230	6,970	3,700	1,300	3,620	1,530	-	-
	(2) Drainage Canals	19,220	8,830	28,050	-	-	-	-	4,040	1,670	7,600	3,560	4,480	2,040	3,100	1,560	-	-
	(3) Farm Roads	7,680	2,230	9,910	-	-	-	-	2,700	750	2,500	800	1,510	420	970	260	-	-
5.	River Improvement/ Floodway and Flood Dike	18,320	4,880	23,200	-	-	-	-	300	100	6,470	1,630	8,010	2,190	3,140	860	400	100
6.	Rehabilitation of Existing Dam	13,900	5,400	19,300	-	-	-	-	13,900	5,400	-	-	-	-	-	-	-	-
7.	On-Farm Development	51,440	19,640	71,080	-	-	-	-	17,200	6,800	21,400	7,400	7,700	3,100	5,140	2,340	-	-
8.	Office and Quarter	9,200	5,700	14,900	-	-	5,500	3,400	3,700	2,300	-	-	-	-	-	-	-	-
	Sub-total	263,100	101,500	364,600	-	-	10,200	5,500	83,300	34,400	81,000	30,600	55,400	18,760	32,580	12,060	620	180
9.	O. & M Equipment	15,000	1,000	16,000	-	-	-	-	3,000	-	12,000	1,000	-	-	-	-	-	-
10.	Administration Expenses	-	25,400	25,400	-	2,000	-	2,400	-	4,000	-	5,100	-	5,100	-	4,000	-	2,800
11.	Engineering Services	59,600	16,200	75,800	7,000	2,400	9,400	2,400	17,000	4,000	9,000	2,400	10,000	3,100	9,000	2,400	400	100
	Sub-total	74,600	42,600	117,200	4,800	3,800	9,400	4,800	20,000	8,000	21,000	8,500	10,000	8,200	9,000	6,400	400	2,900
	Total	337,700	144,100	481,800	4,800	3,800	19,600	10,300	103,300	42,400	102,000	39,100	65,400	26,960	41,580	18,460	1,020	3,080
12.	Physical Contingency	33,300	14,900	48,200	500	400	2,000	1,100	10,300	4,400	10,000	4,000	6,300	2,740	4,120	1,940	80	320
	Total	371,000	159,000	530,000	5,300	4,200	21,600	11,400	113,600	46,800	112,000	43,100	71,700	29,700	45,700	20,400	1,100	3,400
13.	Price Contingency	81,000	123,000	204,000	300	600	2,300	3,600	18,000	24,300	24,200	32,200	19,900	30,000	15,600	26,700	700	5,600
	Grand Total	452,000	282,000	734,000	5,600	4,800	23,900	15,000	131,600	71,100	136,200	75,300	91,600	59,700	61,300	47,100	1,800	9,000

Note: Price contingency is estimated based on the annual increase rate of 5% and 15% for foreign currency portion and local currency portion respectively. The conversion rates are US$1.00 = TSh.12.00 = Yen 240.

Table 15 CASH FLOW STATEMENT

Unit: Tsh. x 10^3

Year (Tentative)	Cash Outflow							Cash Inflow					
	Project Investment			Replacement Cost/2	O & M Cost	Loan Repayment	Total	Project Revenue			Government Subsidy / Loan Repayment	Total	Balance of Cash Flow
	F.C	L.C	Total					Loan	Government Budget Arrangement	Water Charge			
1984	5,600	4,800	10,400	-	-	-	10,400	5,600	4,800	-	-	10,400	0
85	23,900	15,000	38,900	-	-	-	38,900	23,900	15,000	-	-	38,900	0
86	131,600	71,100	202,700	-	500	-	203,200	131,600	71,000	500	-	203,200	0
87	136,200	75,300	211,500	-	2,900	-	214,400	136,200	75,300	2,900	-	214,400	0
88	91,600	59,700	151,300	-	4,170	-	155,470	91,600	59,700	4,170	-	155,470	0
89	61,300	47,100	108,400	3,580	4,730	-	116,710	61,300	47,100	8,310	-	116,710	0
90	1,800	9,000	10,800	3,580	5,200	-	19,580	1,800	9,000	8,780	-	19,580	0
91	-	-	-	3,580	5,200	-	8,780	-	-	8,780	-	8,780	0
92	-	-	-	3,580	5,200	-	8,780	-	-	8,780	-	8,780	0
93	(555,390)/1	-	-	3,580	5,200	-	8,780	-	-	8,780	-	8,780	0
94	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
95	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
96	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
97	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
98	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
99	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
2000	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
01	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
02	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
03	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
04	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
05	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
06	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
07	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
08	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
09	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
10	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
11	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
12	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0
13	-	-	-	3,580	5,200	37,330	46,110	-	-	8,780	37,330	46,110	0

Note: /1 = Compound amount of investment for foreign currency

/2 = This expenditure in each year shows an average value of the replacement cost which will be disbursed every 2 to 5 years.

FIGURES

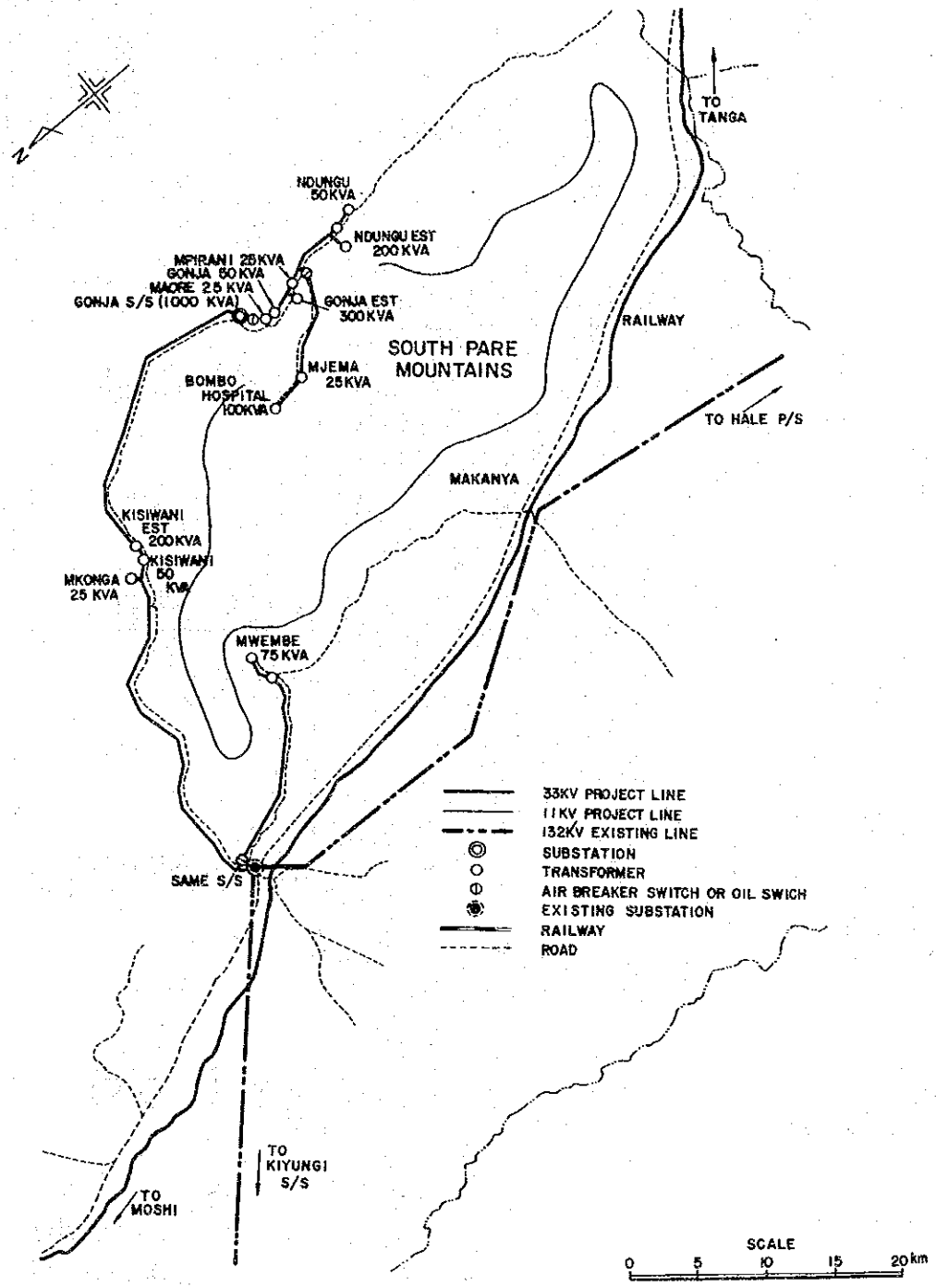


Fig. 1 PLAN OF TRANSMISSION LINE

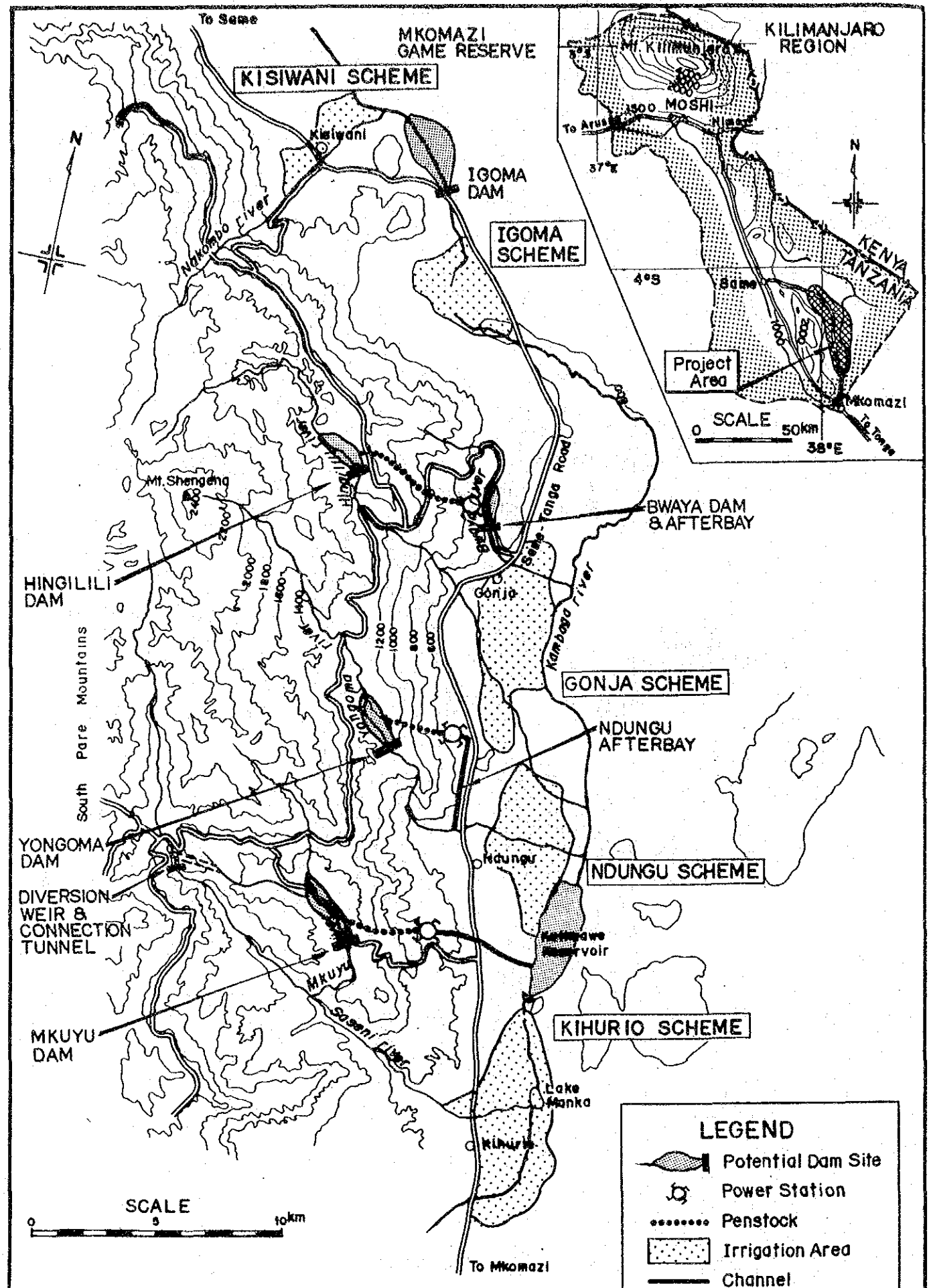


Fig. 2 POTENTIAL DEVELOPMENT PLAN OF MKOMAZI VALLEY

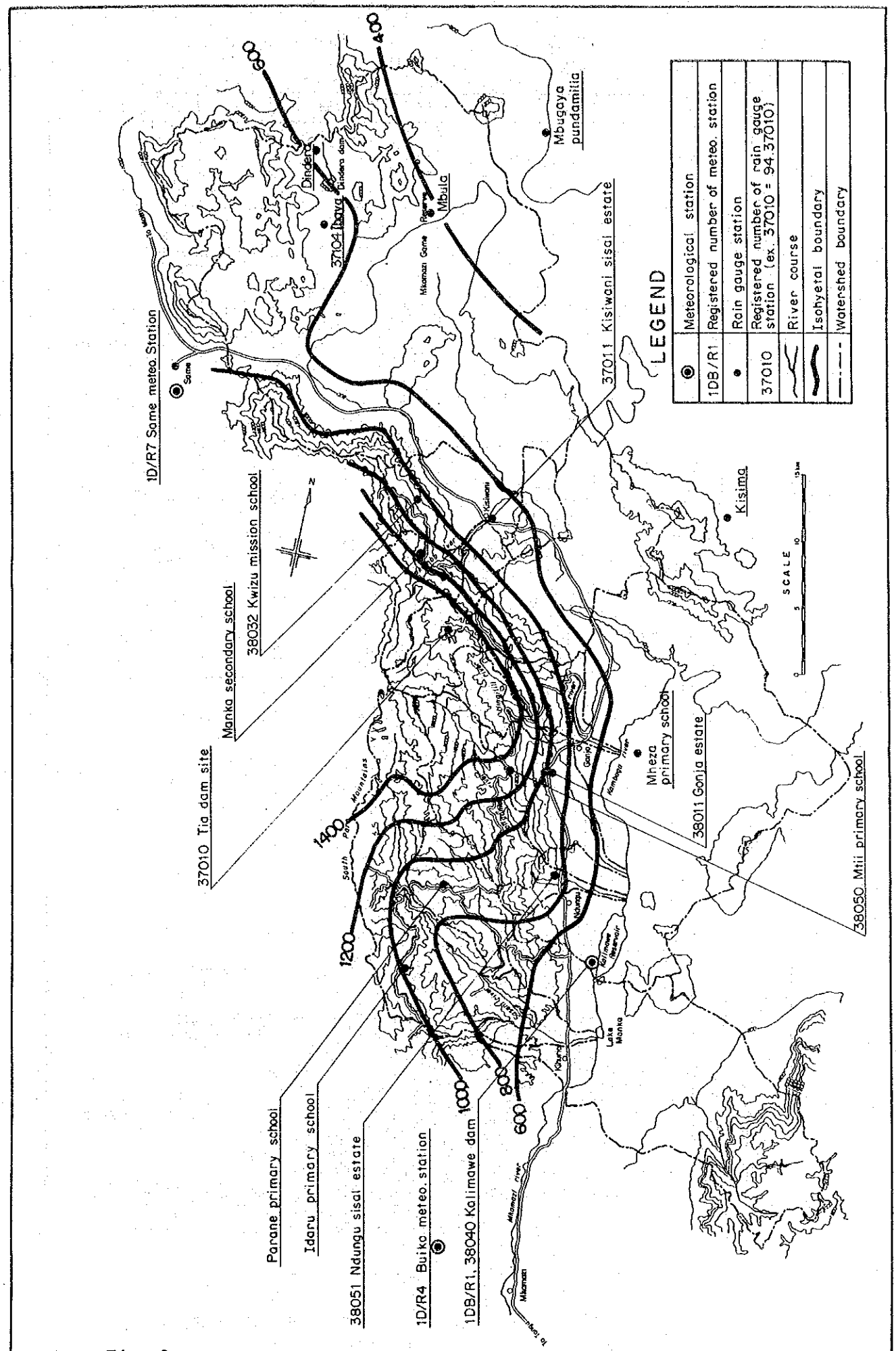


Fig. 3 LOCATION OF METEOROLOGICAL STATIONS AND ANNUAL ISOHYET

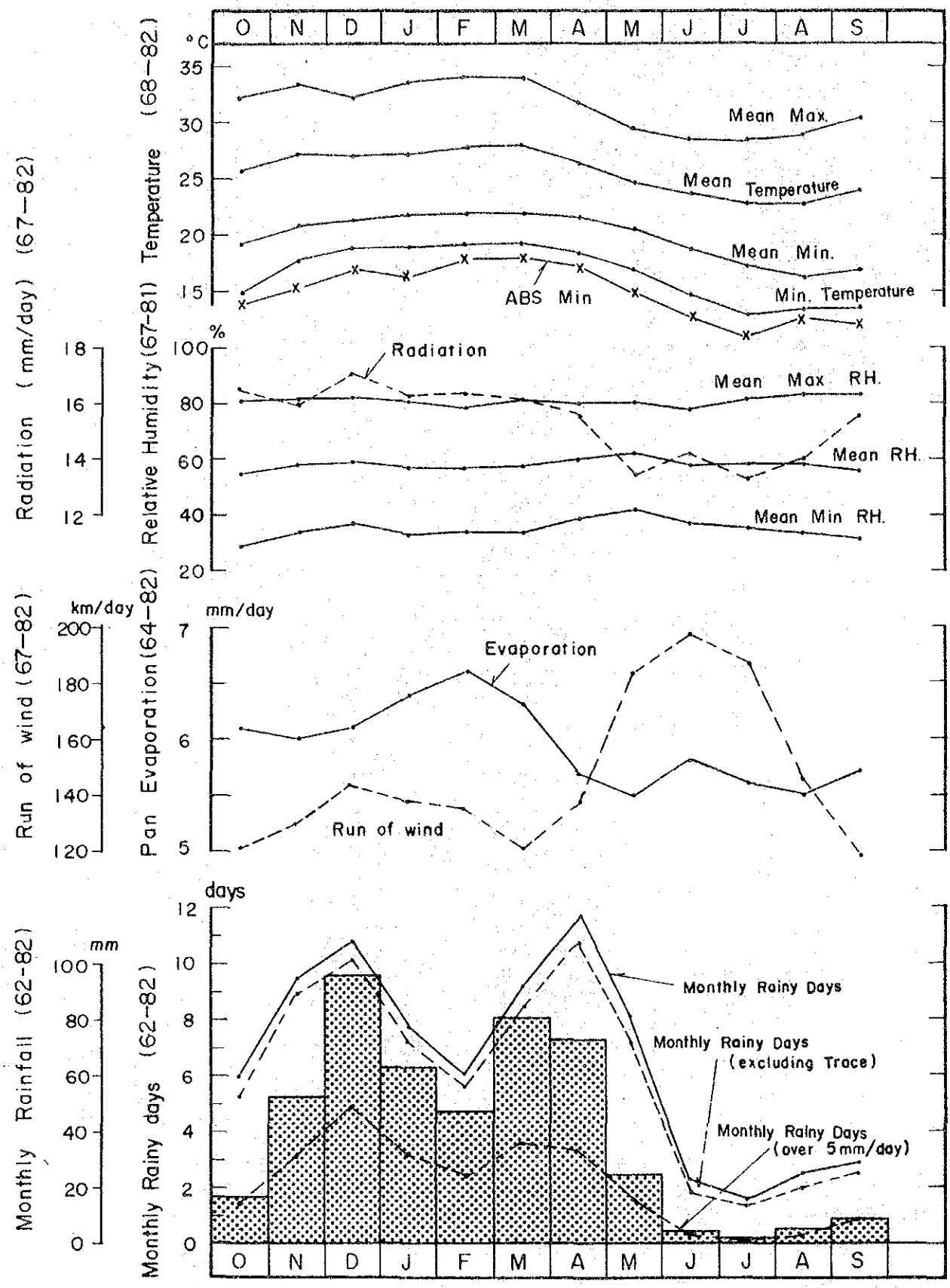


Fig. 4 CLIMATIC FEATURES AT KALIMAWE METEO. STATION

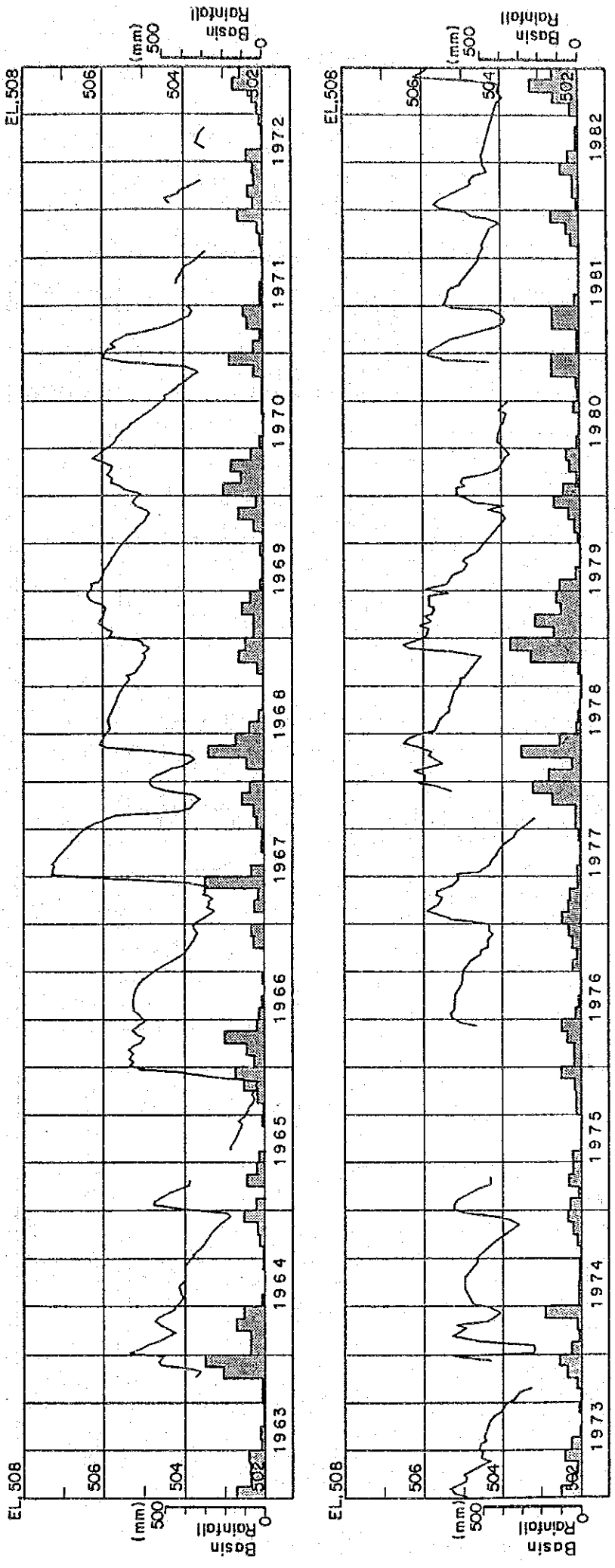


Fig. 5 WATER LEVEL OF KALIMAWE RESERVOIR

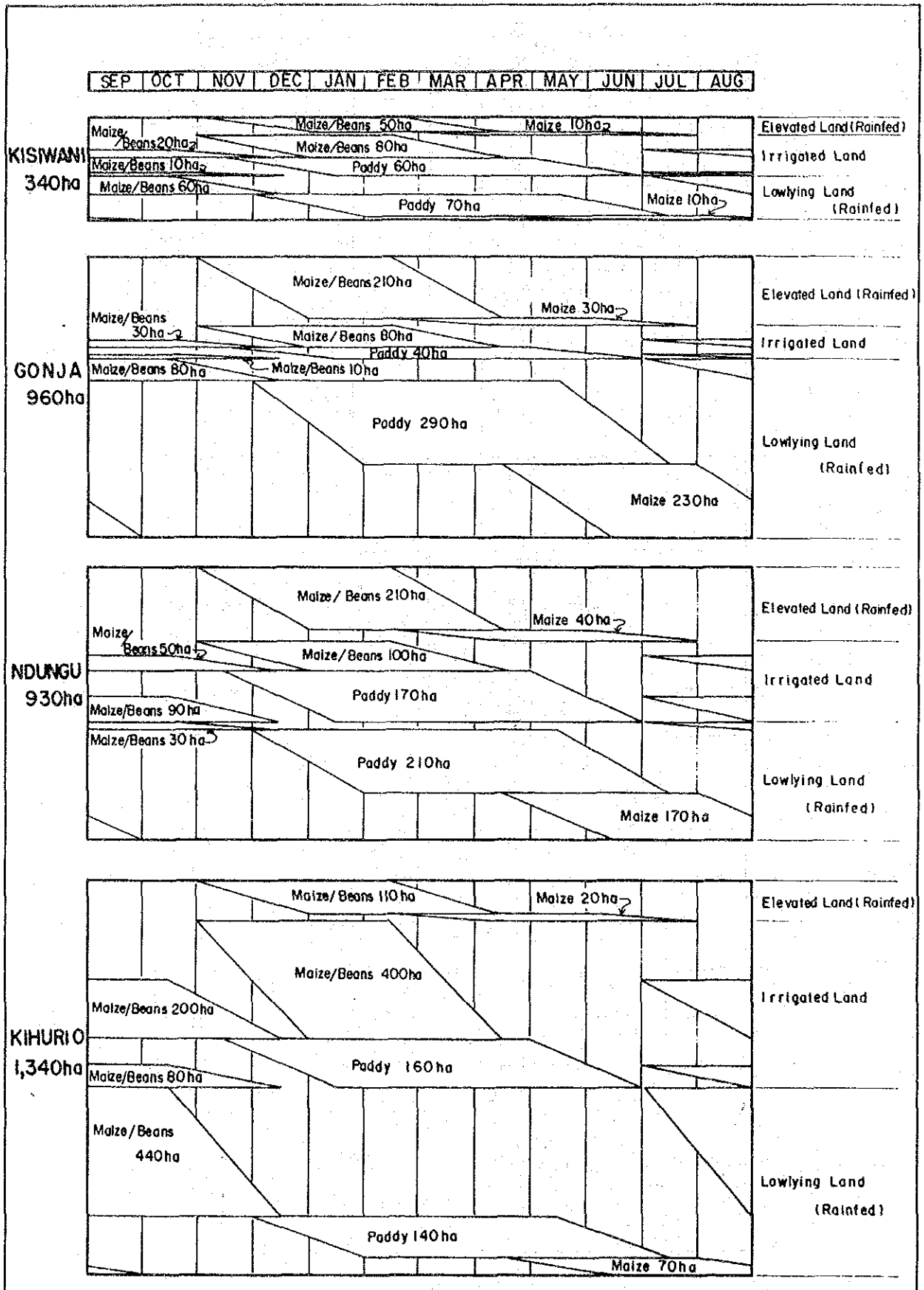


Fig. 6 PRESENT CROPPING PATTERN

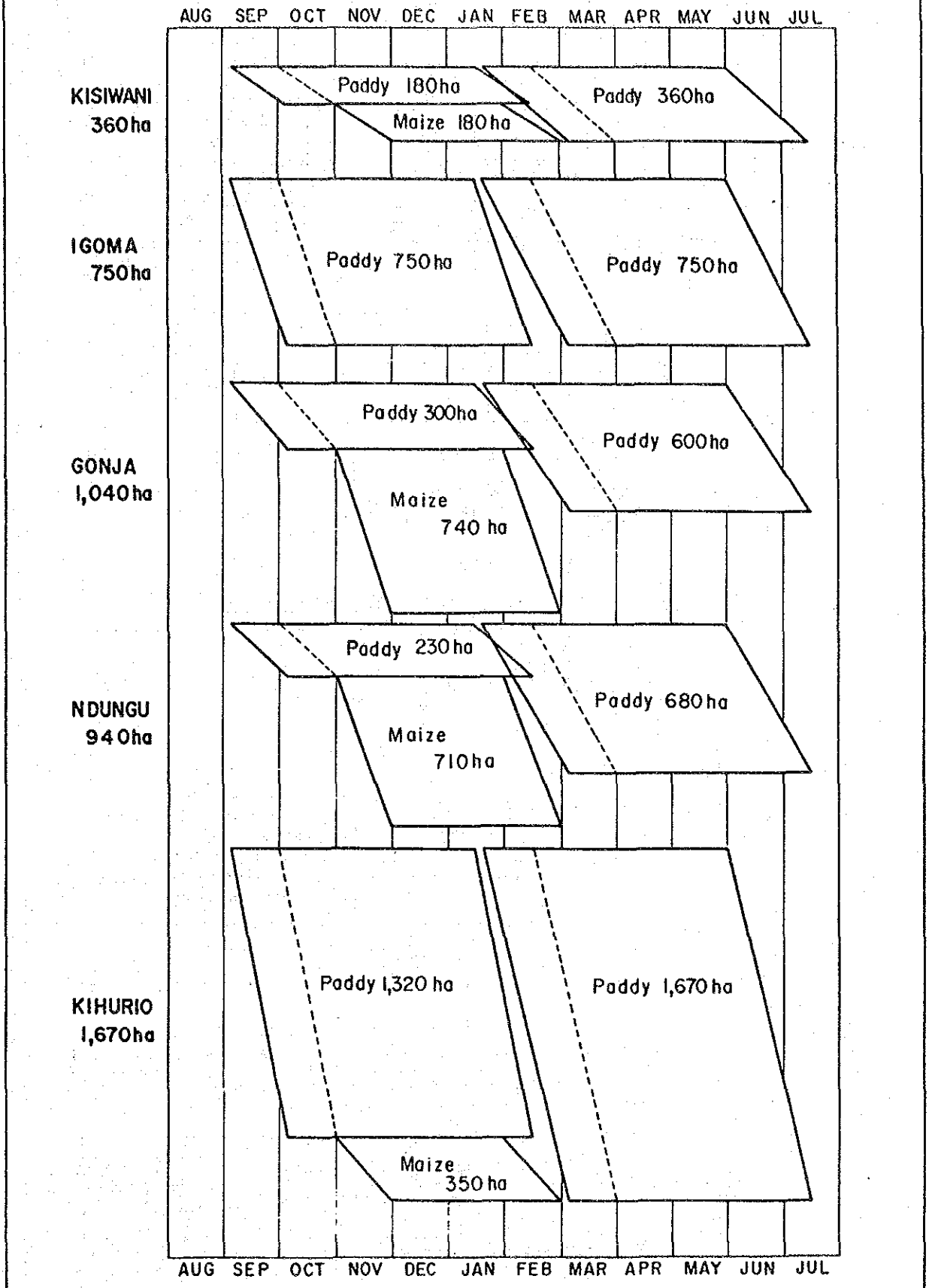


Fig. 7 PROPOSED CROPPING PATTERN

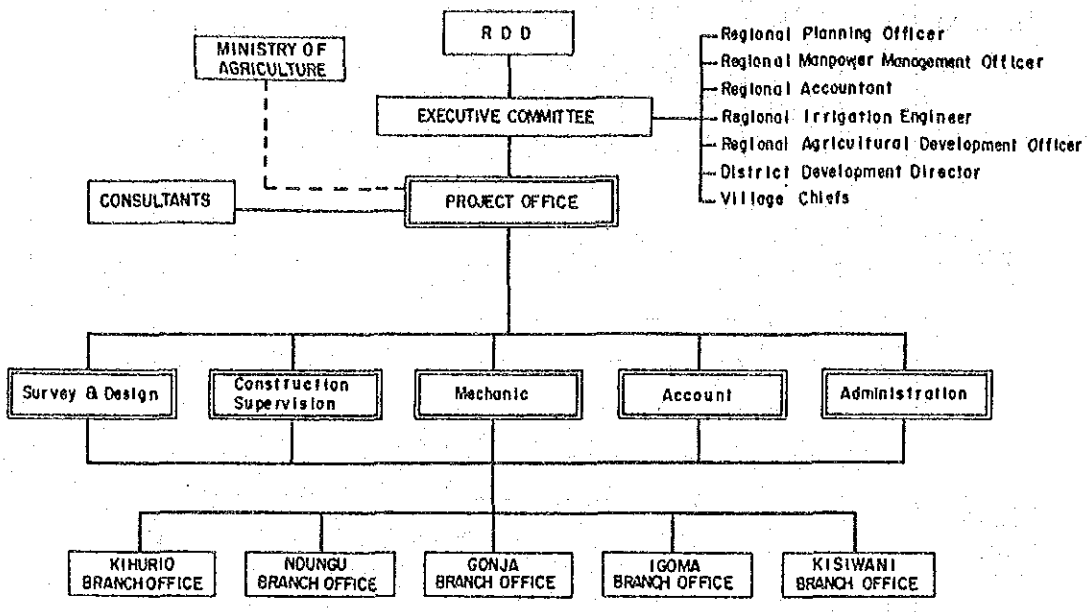


Fig. 8 ORGANIZATION CHART FOR PROJECT IMPLEMENTATION

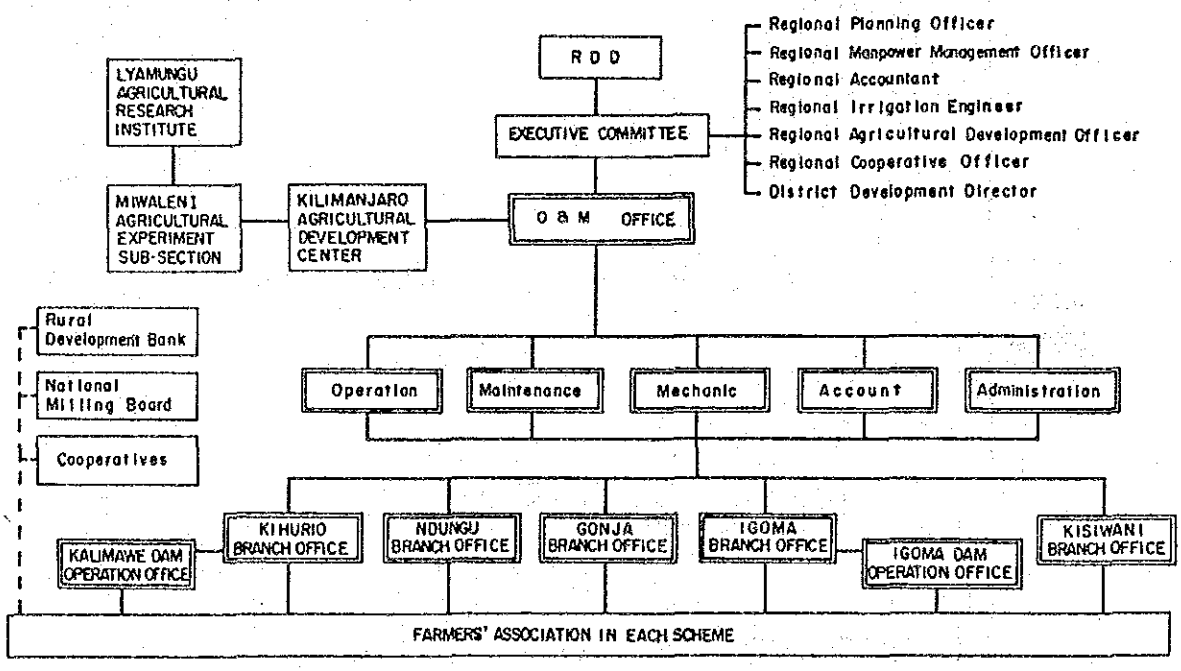


Fig. 9 ORGANIZATION CHART FOR OPERATION & MAINTENANCE

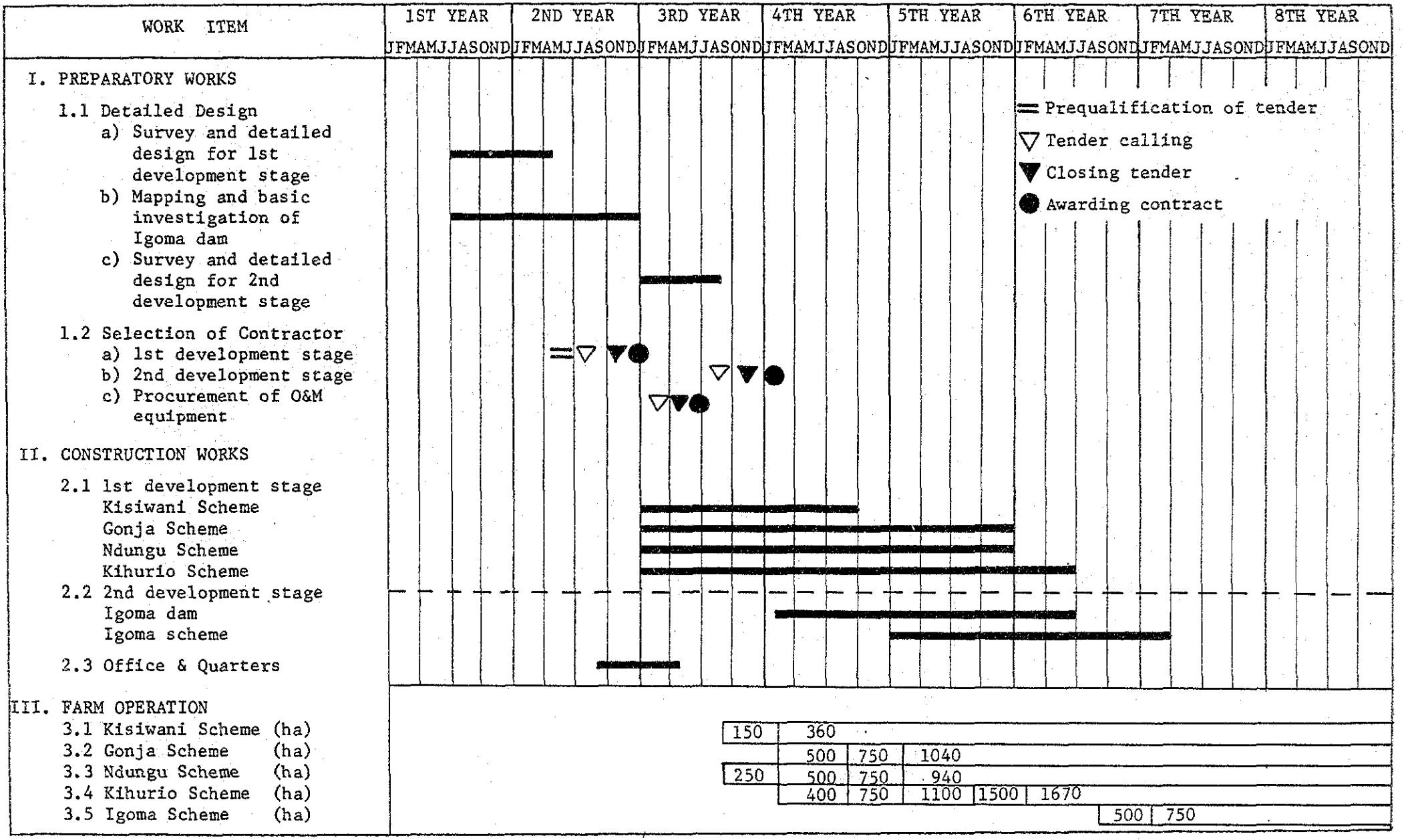
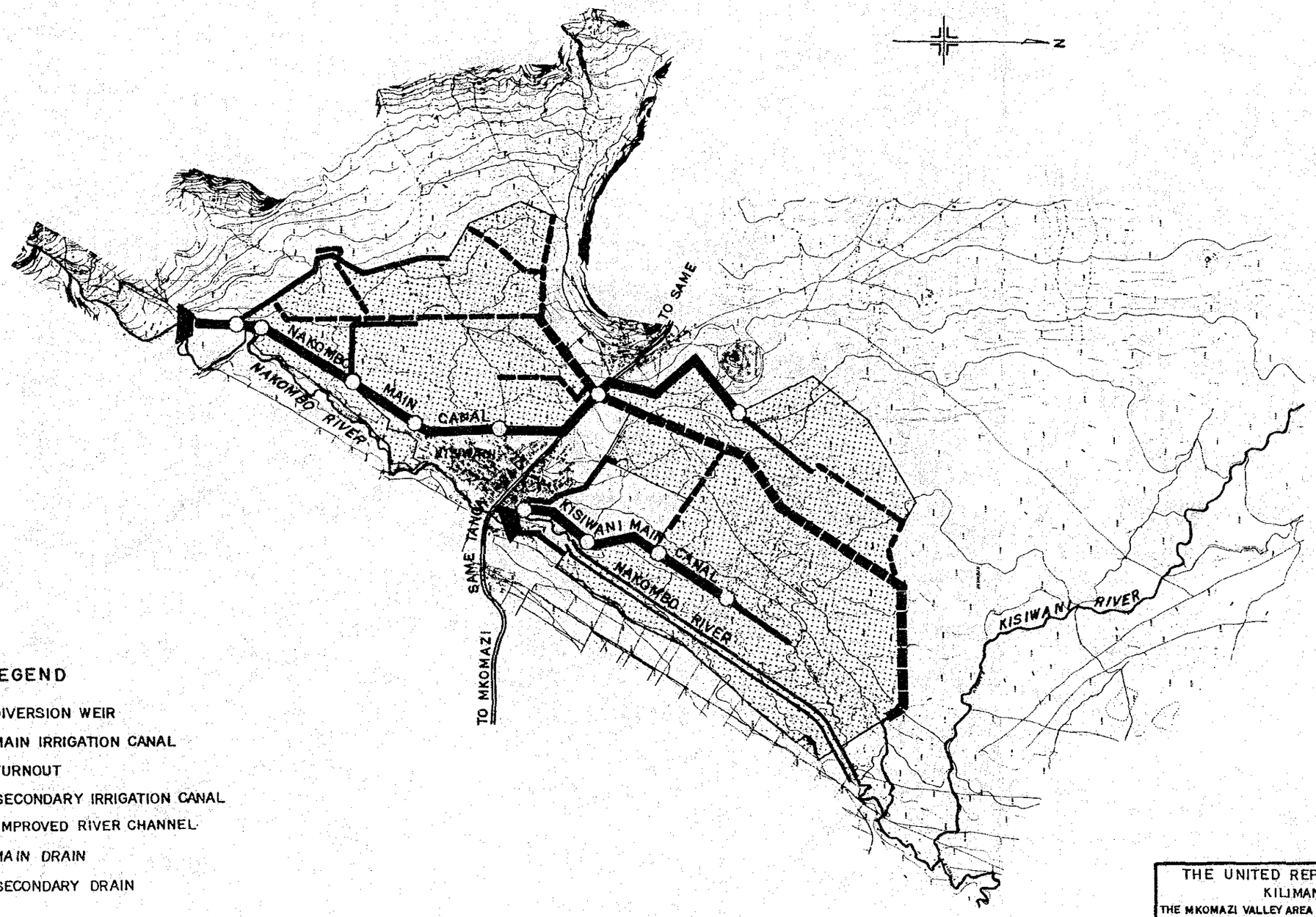


Fig. 10 PROJECT IMPLEMENTATION SCHEDULE

PLATES

PLATE NO. 1



LEGEND

- DIVERSION WEIR
- MAIN IRRIGATION CANAL
- TURNOUT
- SECONDARY IRRIGATION CANAL
- IMPROVED RIVER CHANNEL
- MAIN DRAIN
- SECONDARY DRAIN

SCALE
0 0.5 1.0 km

THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

TITLE OF DRAWING
GENERAL LAYOUT
-KISIWANI SCHEME-

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.

PLATE NO. 2

LEGEND

- DIVERSION WEIR
- MAIN IRRIGATION CANAL
- TURNOUT
- SECONDARY IRRIGATION CANAL
- FLOODWAY
- MAIN DRAIN
- SECONDARY DRAIN

N

SAME - TANGA ROAD

TO MKOMAZI

HINGILILI RIVER

HINGILILI MAIN CANAL

GONJA

TO SAME

KABAMDO

HINGILILI FLOODWAY

KAMBAGA RIVER

SCALE
0 0.5 1.0km

THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

TITLE OF DRAWING

GENERAL LAYOUT
- GONJA SCHEME -

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.

PLATE NO. 3

LEGEND

- DIVERSION WEIR
- MAIN IRRIGATION CANAL
- TURNOUT
- SECONDARY IRRIGATION CANAL
- FLOODWAY
- SECONDARY DRAIN
- FLOOD DIKE

N

YONGOMA MAIN CANAL

YONGOMA RIVER

SAME - TANGA ROAD

TO SAME

NDUNGU

YONGOMA MAIN CANAL

TO MKOMAZI

MAIN CANAL

RIGHT MAIN CANAL

YONGOMA FLOODWAY

KAMBAGA RIVER

KALIMAWE RESERVOIR

SCALE

0 0.5 1.0 km

THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

TITLE OF DRAWING

GENERAL LAYOUT
-NDUNGU SCHEME-

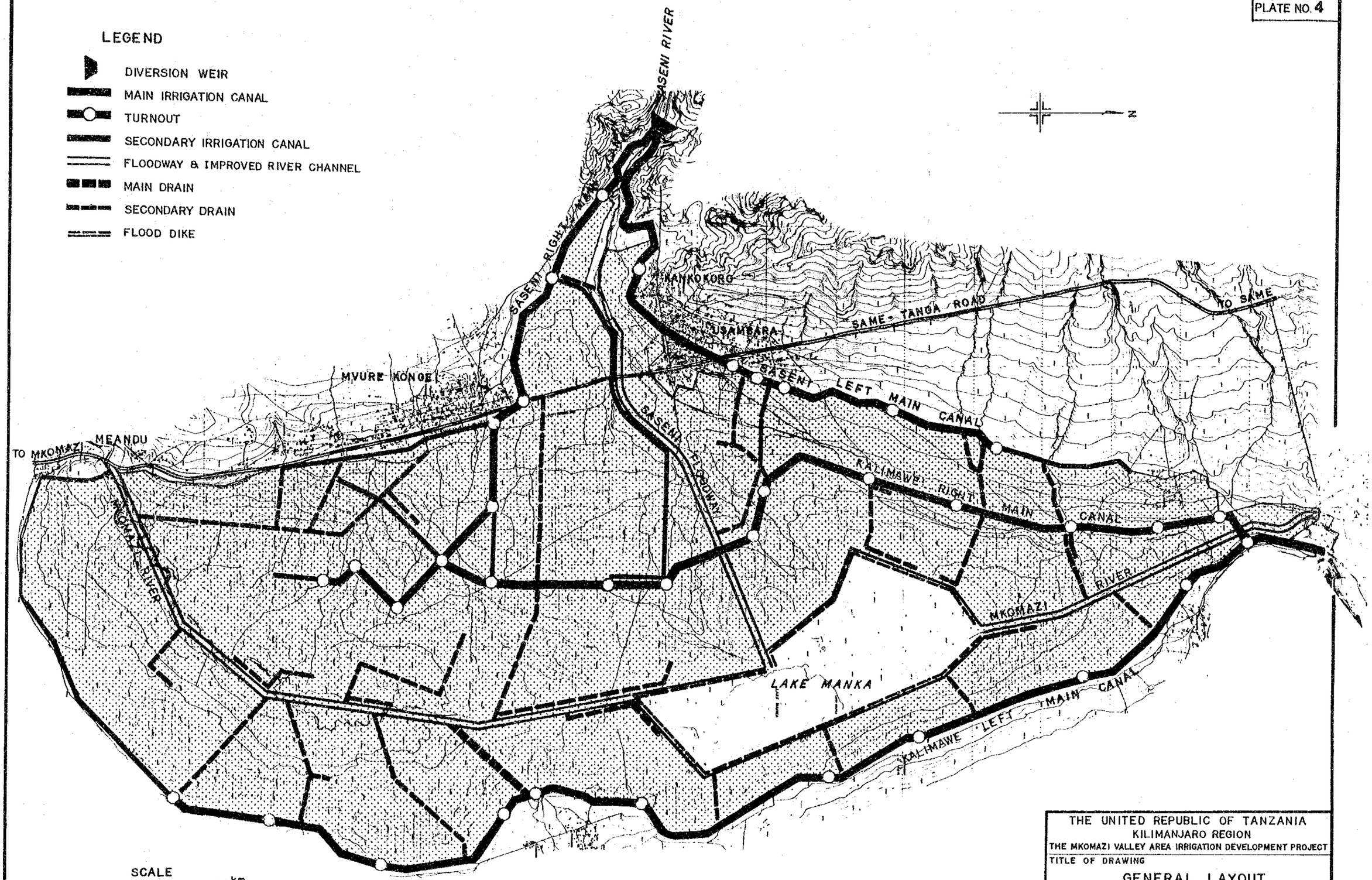
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.

PLATE NO. 4

LEGEND

- DIVERSION WEIR
- MAIN IRRIGATION CANAL
- TURNOUT
- SECONDARY IRRIGATION CANAL
- FLOODWAY & IMPROVED RIVER CHANNEL
- MAIN DRAIN
- SECONDARY DRAIN
- FLOOD DIKE



SCALE
0 0.5 1.0 km

THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

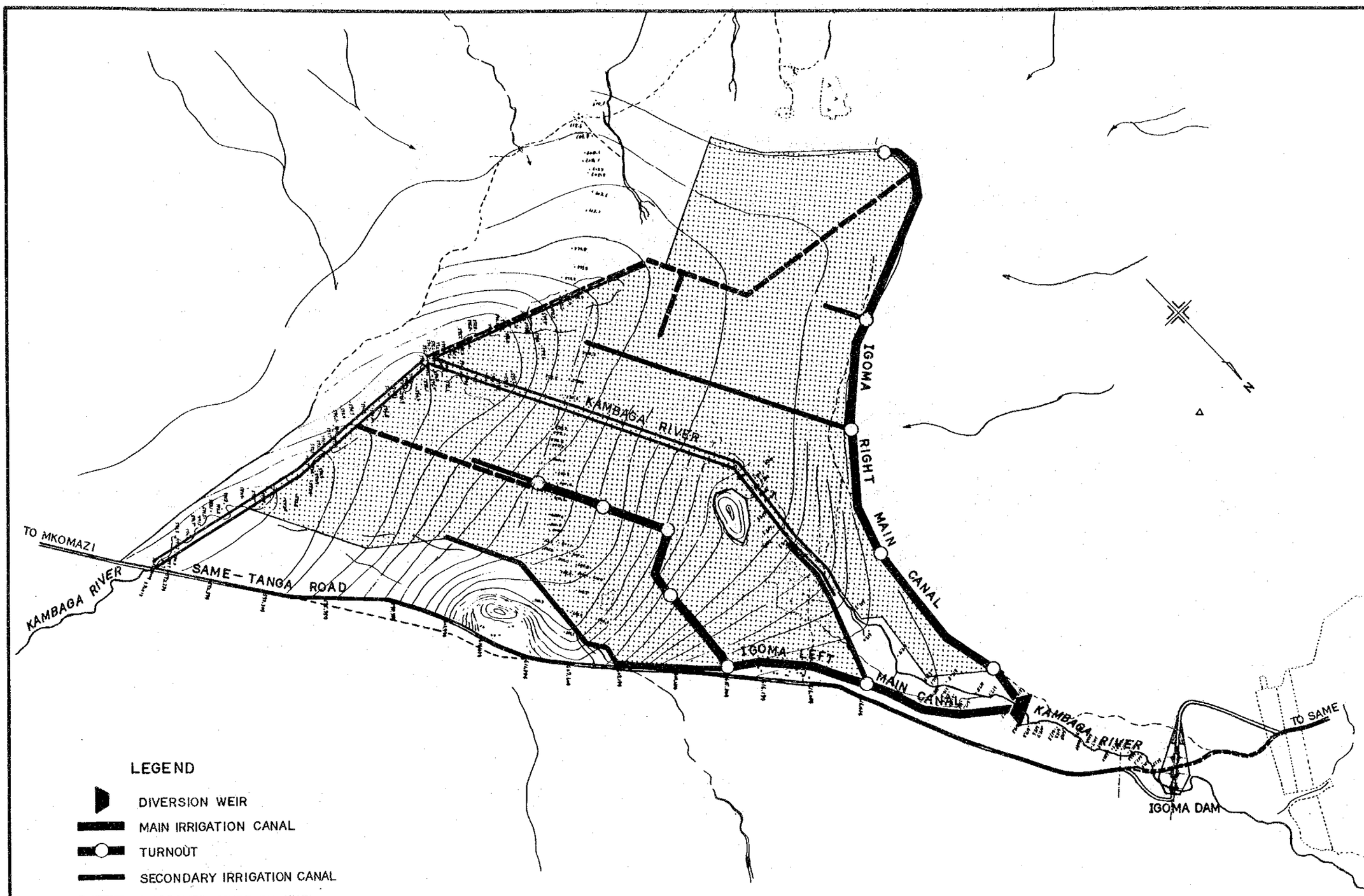
TITLE OF DRAWING

GENERAL LAYOUT
— KIHURIO SCHEME —

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.

PLATE NO. 5



LEGEND

- DIVERSION WEIR
- MAIN IRRIGATION CANAL
- TURNOUT
- SECONDARY IRRIGATION CANAL
- IMPROVED RIVER CHANNEL
- SECONDARY DRAIN
- FLOOD DIKE

NOTE : CONTOUR LINE IS ASSUMED BY THE FIELD INVESTIGATION

SCALE
0 0.5 1.0 km

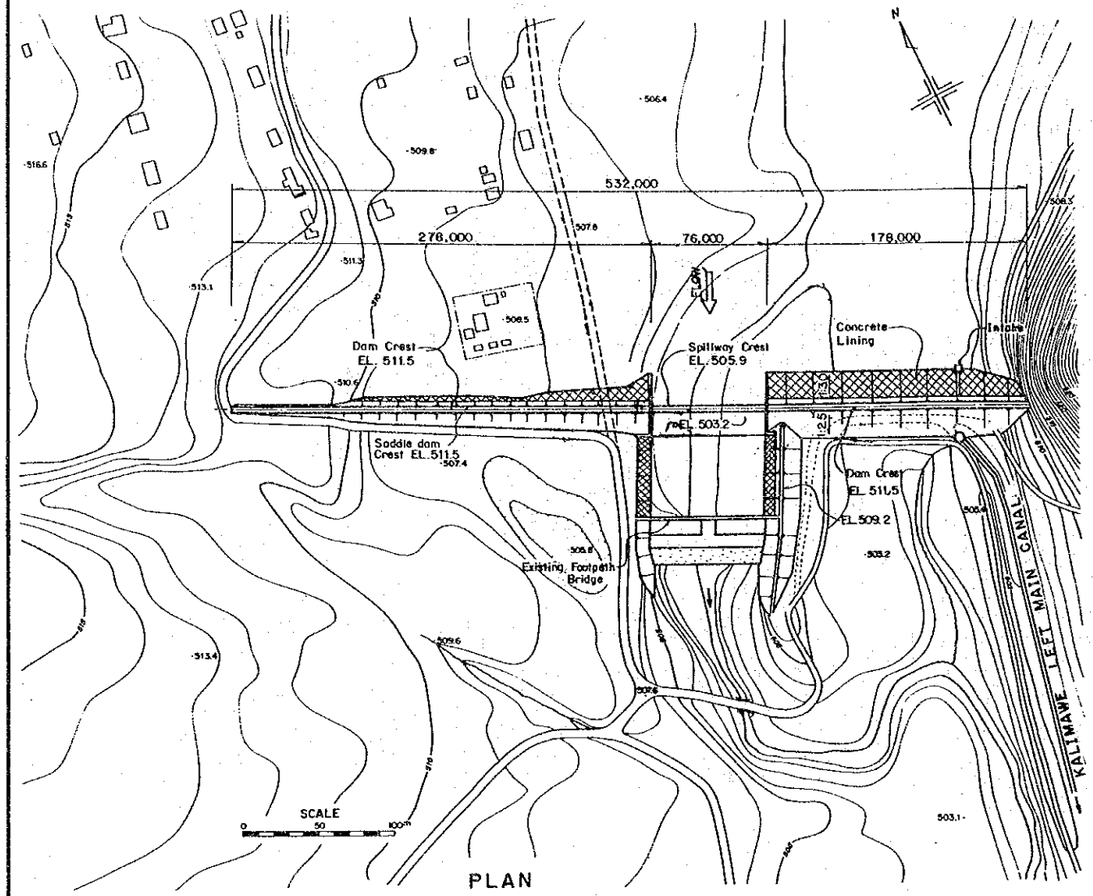
THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

TITLE OF DRAWING
GENERAL LAYOUT
— IGOMA SCHEME —

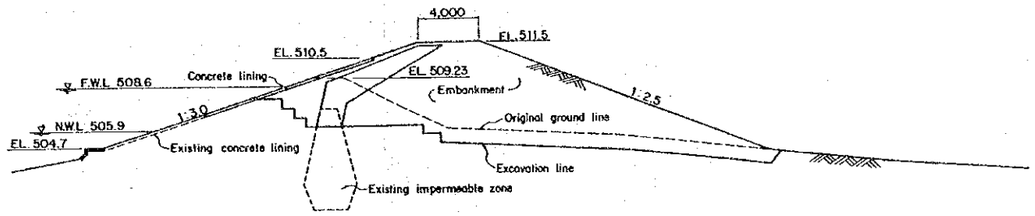
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.

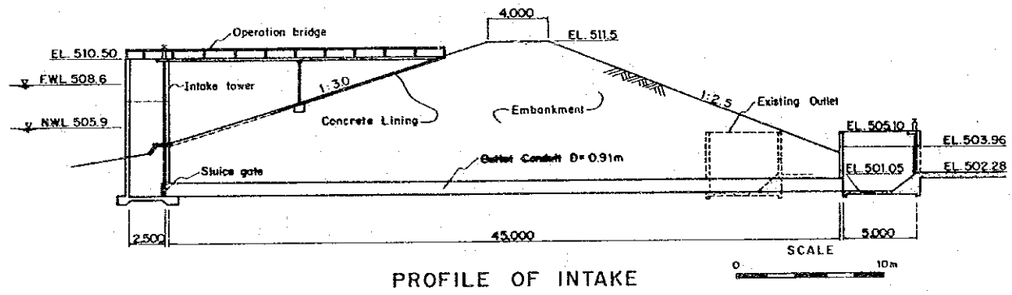
PLATE No. 6



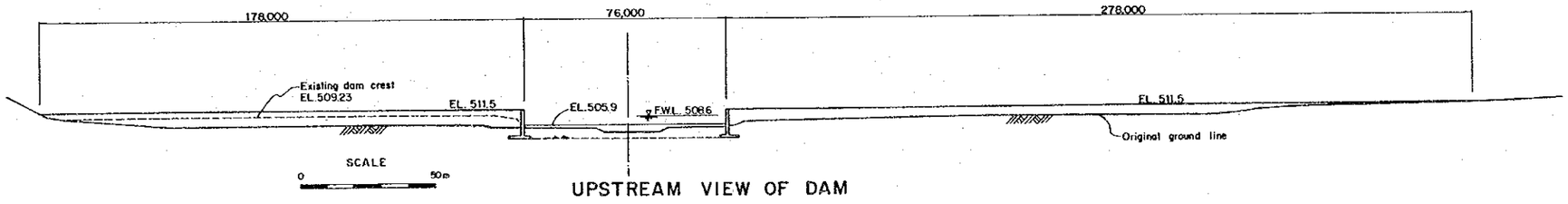
PLAN



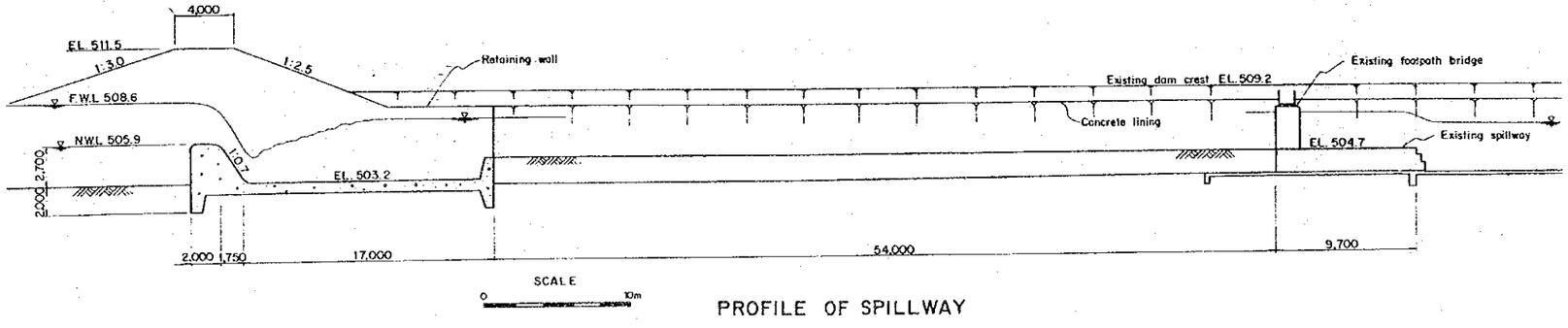
TYPICAL CROSS SECTION



PROFILE OF INTAKE



UPSTREAM VIEW OF DAM



PROFILE OF SPILLWAY

THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

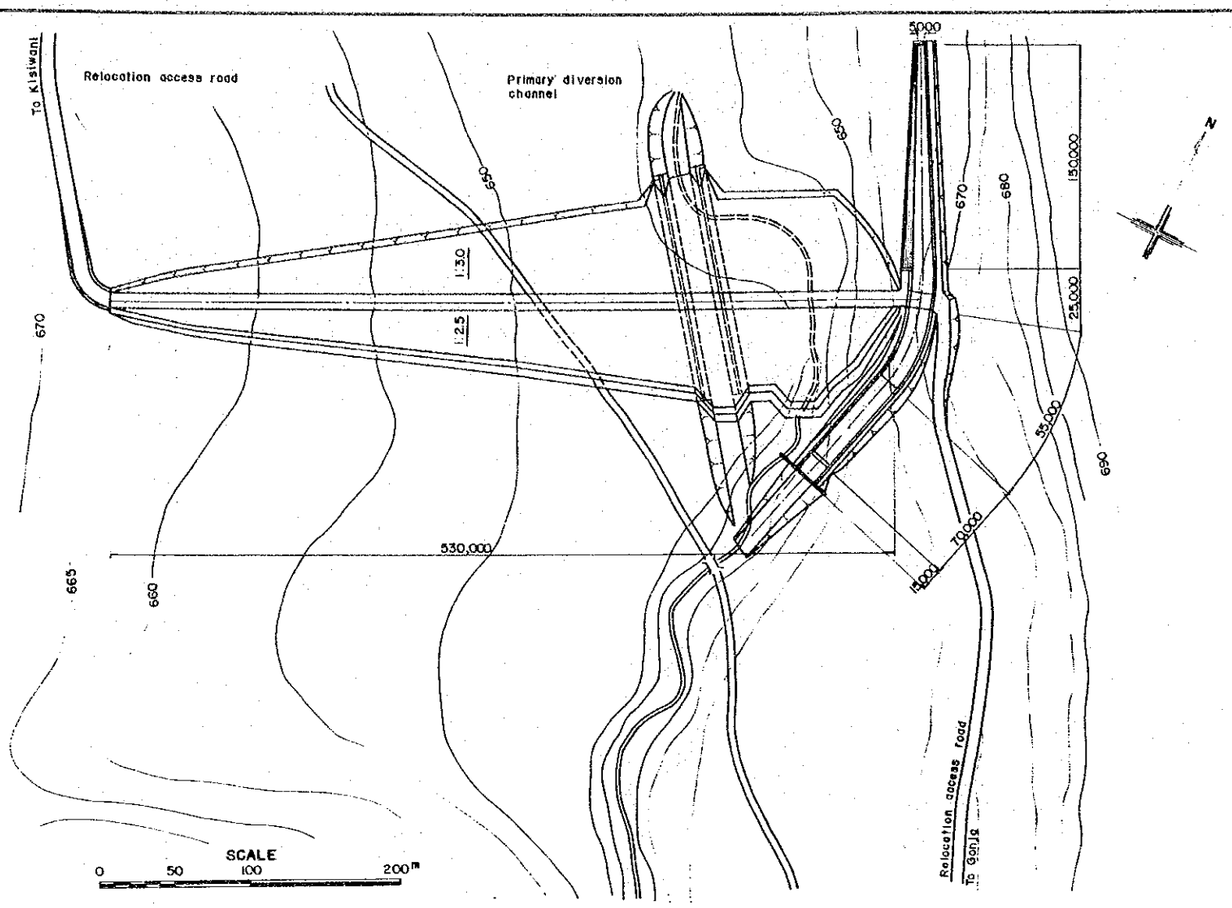
TITLE OF DRAWING

KALIMAWE DAM

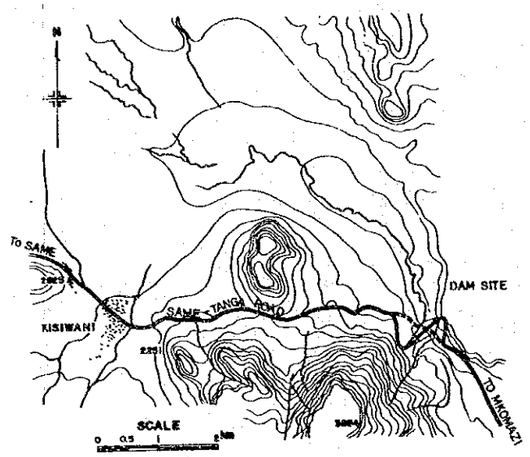
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. No.

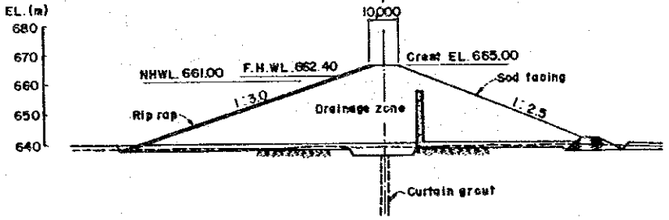
PLATE NO. 7



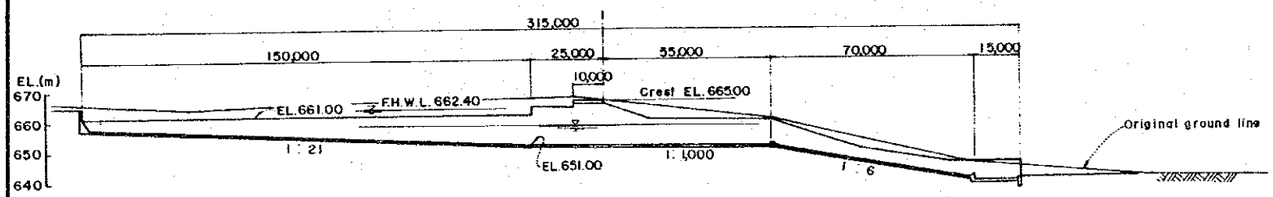
PLAN



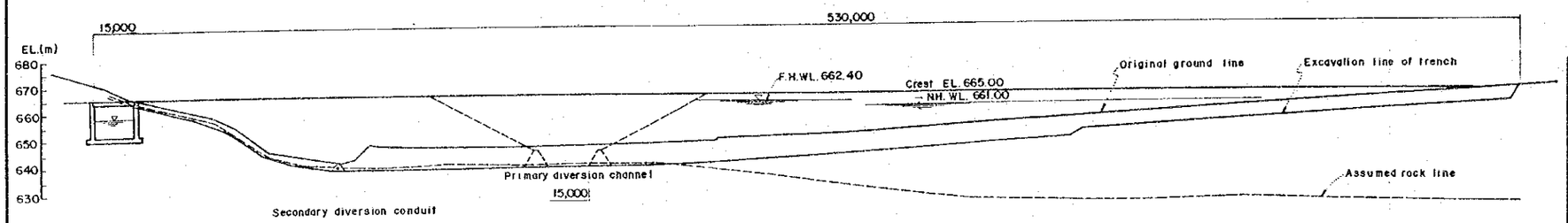
LOCATION MAP



TYPICAL CROSS SECTION



PROFILE OF SPILLWAY



UPSTREAM VIEW OF DAM

THE UNITED REPUBLIC OF TANZANIA
KILIMANJARO REGION
THE MKOMAZI VALLEY AREA IRRIGATION DEVELOPMENT PROJECT

TITLE OF DRAWING

IGOMA DAM

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.