No. 2

FINAL REPORT

FOR

THE FEASIBILITY STUDY ON MEDIUM SIZE DAMS

IN

MASVINGO PROVINCE IN THE REPUBLIC OF ZIMBABWE

MAIN REPORT

PART I

[redacted]

FINAL REPORT

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THE FEASIBILITY STUDY ON MEDIUM SIZE DAMS

IN

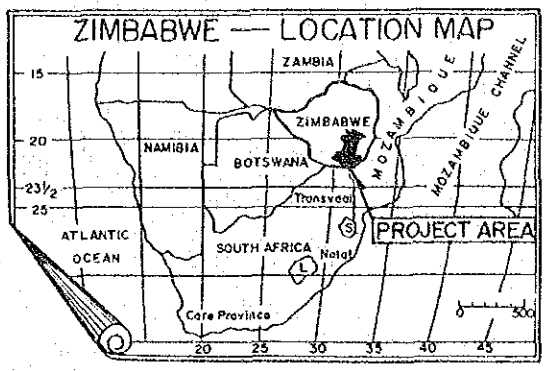
MASVINGO PROVINCE IN THE REPUBLIC OF ZIMBABWE

INVENTORY REPORT

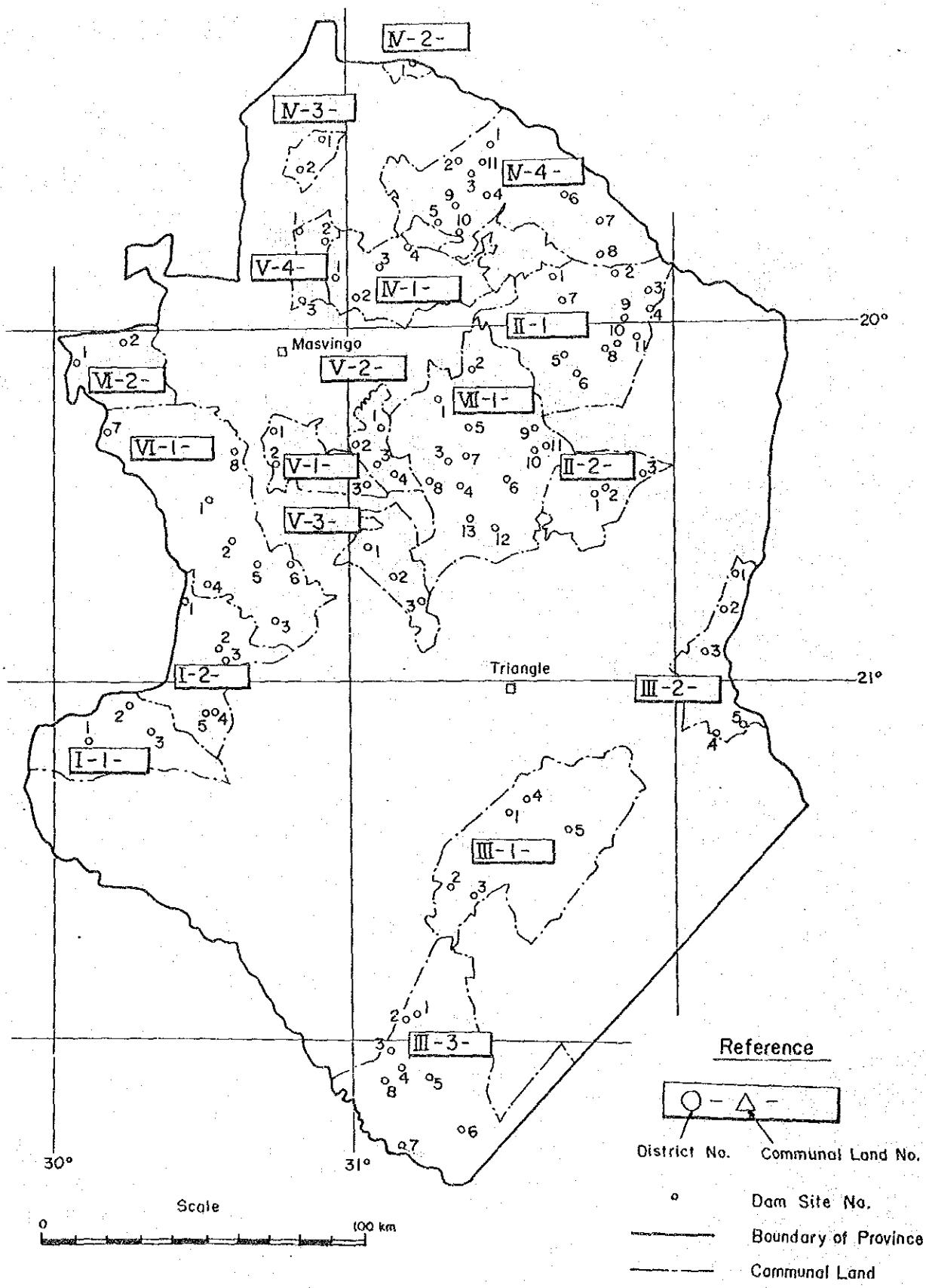
MARCH 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION MAP



MAP OF POTENTIAL DAM SITES



CONTENTS

LIST OF ANNEXES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 THE STUDY AREA

1.1. Location

Masvingo Province is located at the south eastern corner of Zimbabwe stretching from 19°05' to 22°20' of 370 km in South latitude, and from 29°55' to 32°20' of 150 km in East longitude. It is situated off the main development core of Zimbabwe which is along the Harare-Bulawayo line of railway. This peripheral position has led to the neglect of the Province to some extent in the past until the commencement of large scale irrigation in the lowveld.

The border of the Province is faced with three provinces and two countries, namely Matabeleland South Province divided by Bubye and Runde Rivers in the western section, Midlands Province in the northern section, Manicaland Province divided by Nyazwidzi-Sabi Rivers in the eastern section and the international boundary (200 km length) of Mozambique and South Africa in the southern section.

The catchment of the Province is mainly divided into three large rivers sharing almost equivalent vicinity areas, namely Nyazvidzi-Sabi, Runde and Bubye-Limpopo, which flow parallel from northwest to southeast. Those rivers feature the high to low velds respectively, in which about 57 per cent of the Province lies in the lowveld, about 33 per cent in the middleveld and about 10 per cent in the highveld.

Major towns in the Province are characterized both by the administrative centre of Masvingo situated in the central point on the main traffic road from Harare to Beitbridge and agricultural centre of Chiredzri known as large scale commercial farmings under the Kyle Irrigation Scheme.

The area of the whole Province covers 57 000 sq.km, about one fifth of the country, consisting of seven districts, in which eighteen communal lands of 21 000 sq.km, (i.e. 37 per cent of the whole Province) are included.

The names and area of seven districts and eighteen communal lands in the Province are as listed in Table II-1-1.

The network of the national road, which links the neighbouring provinces with good paving conditions, traverses the Province, of which the most important is the bituminous as follows:

1) Bulawayo - (280 km) - Masvingo - (299 km) - Mutare Road
2) Harare - (294 km) - Masvingo - (286 km) - Beitbridge Road and
3) Ngundu - (105 km) - Chiredzi - (299 km) - Mutare Road.

On the other hand, the Somabhula - Maputo railway passes through the southern part of the Province providing a high transport potential for product from the region.

Table II-1-1 Area of Districts and Communal Lands

No.	(District) Name	(Communal Land) Name	Area km²	(District) Area km²
I.	Batanai	Maranda	1026	
		Matibi No. 1	1037	2063
II.	Bikita	Bikita	1931	
		Matsai	700	2631
III.	Gaza Komanani	Matibi No. 2	2206	
		Sangwe	635	
		Sengwe	2445	5286
IV.	Gutu	Chikuwanda	1045	
		Denhere	75	
		Serima	200	
		Gutu	2301	3621
V.	Masvingo	Masvingo	505	
		Mtilikwe	299	
		Nyajena	622	
		Zimutu	290	1716
VI.	Chibi	Chibi	2517	
		Mashava	678	3195
VII.	Zaka	Ndanga	2751	2751
			Total	21263 km²

1.2. Topography and Geology

1.2.1. Topography

The Study Area is located on the southern part of the plateau which carries the division between the Zambezi Basin on the north and the Sabi-Limpopo Basin on the south. The Area slopes gently southward and finally falls into the Limpopo river which bounds the Republic of South Africa. The altitude ranges from 1 400 to 300 meters above sea-level.

The main rivers in the Area, the Sabi, Runde, Tokwe and Bubye, run roughly parallel to one another and drain across the Area from northwest to a southeast direction.

The Study Area is divided roughly into three from topographical features, i.e. (1) Northern land, (2) Middle land and (3) Southern land.

(1) The northern land including Gutu district and Bikita communal land lies at the altitude between 1 300 and 900 meters above sea-level. The land is characterized by the prevalence of drainage system, and the flow of almost all rivers is perennial. The rolling and hilly land which mostly consists of granite offers suitable dam sites.

(2) The middle land including Batanai, Bikita (Matsai communal land), Masvingo, Chivi and Zaka Districts lies between 1 000 and 600 meters above sea-level. The drainage system is relatively well developed except Chivi District. Most of the major rivers are perennial, but they are often reduced to a series of pools in the sandy area. Most of tributaries only flow during the rainy season.
Underlying rocks, granite and gneiss, and their structures have a marked influence on the topography in the land. The granite forms a high plateau of featureless savanna, and undulating domes and ridges which are called "dwalas", "whale-back" or "kastle-kopies" presenting typical Zimbabwean scenary offer very suitable damsites. The gneiss forms very flat and featureless savanna, where intrusive granite and

dolerite make in places low "whale-backs" or small "dwalas". It is not easy to find good damsites in this area than in that of granite.

(3) The southern land including Chiredzi district lies between 500 and 250 meters above sea-level and is featureless periplain. The drainage system is poorly developed. Closely arranged numerous pans and elongated channels of vegetation are the only expression of water courses. Water in all rivers flows seasonally. It is difficult to find dam sites in this land.

1.2.2. Geology

Zimbabwe is roughly divided into two geological provinces by the line drawn from the south-western border, some 65 km north-west of Plumtree, to the Zambezi valley, north of Sinoia.

The eastern side of the line is widely occupied by the Archean Basement Complex, the so-called Rhodesian Craton, and its southern end is in contact with the Limpopo Mobile Belt of east-west trend. The famous Great Dyke emplaced after this orogenic movement. At the western side, the Basement Complex is largely covered with Proterozoic sedimentary rocks and its northern margin is cut by the Zambezi Orogenic Belt Pan-African phase.

Several basins around the mass of these Precambrian system were filled with the terrestrial sediments of Permian to Jurassic in age, including much amounts of basaltic lava, which is named the Karoo System. The Study Area is located in the eastern part of the line and consists of the Basement Complex and Karoo System. The Basement Complex is composed of Archean greenstone and numerous dome-like masses of granite and gneiss (3 500 - 2 700 Ma). The greenstones are stratigraphically divided into three groups; Sebakian, Bulawayan and Shanvaian in ascending order, which largely consist of meta-volcanic to meta-volcano-sedimentary rocks of ultrabasic series. A number of ore deposits of iron, nickel and gold are known in the greenstone belt, but they are rarely found in the communal lands. Granite and gneiss generally show porphyritic texture and are pale in color. All these basement rocks are intruded by many dykes and sills of dolerite and are often sheared and faulted.

The Study Area is roughly divided into three zones from north to south i.e.; (1) Granite zone, (2) Gneiss zone, and (3) Karoo System zone.

(1) Granite zone

Gutu and Bikita districts belong to this zone.
It consists mostly of granite and granitic gneiss showing massive and pophyritic appearances.

Weathering caused rolling ground surface together with domes called "dwalas", where one can find rather easily the suitable dam sites. However, attention must be paid to such disturbed and altered areas as follows; the area where bedrocks altered to permeable ones by numerous vertical and horizontal fractures; the area where dykes and sills of dolerite, several to one hundred meters in width and attaining several kilometers in length, intruded and made surrounding host rocks sheared and brecciated. These areas are less suitable for dam sites. In spite of the strong weathering effect, the location and dimension of intrusive dolerite can be easily recognized from the distributions of dark green to reddish brown surface soils and of slightly protruded ranges on surrounding ground surface.

(2) Gneiss zone

This zone is known as the Limpopo Mobile Belt (27 ±2 Ma) which limits the southern end of the Rodesian Craton and has an extensive east-west trending tract consisting of high grade metamorphic rocks of the Basement Complex.

The zone includes Mwenezi, Bikita, Gutu, Masvingo and Zaka districts, and consists of gneiss, porphyritic granite and dolerite dykes. Rocks are generally massive and hard. However, there are many sheared zones and also dolerite dykes running in the direction of NE-SW and NW-SE, where the surrounding rocks are much fractured and soft. The bedrock is generally suitable for dam foundation from the geological point of view, but it is difficult to find good dam sites because of the flat savanna.

(3) Karoo System zone

It consists of basalt lava, intruded diabase and Cretaceous sedimentary rocks.

Basalt is generally soft because of strong weathering, and has well-developed open fractures. Sedimentary rocks are sandstone and conglomerate which are generally massive and hard. The bedrock are hardly exposed because of the flat land and thick weathered surface, therefore it is not easy to find a suitable damsite.

The stratigraphy of the Study Area is shown in Table II-1-2.

Table II-1-2 Stratigraphy of the Study Area

Age	System or Group	Lithology
Cretaceous U. Jurassic	Cretaceous	Sandstones, Conglomerates. coarse grain, cemented bu calcite
Jurassic Permian	Karoo	Basalt, Sandstone, Siltstone. mostly basalt, fine grain
Early Precambrian	Older Gneisses	Gneisses, Metasediments massive, widely distributed.
	Shamvaian Bulawayan Sebakwian	Metasediments, Metavolcanic Serpentinite distributed in a small area

Intrusive Igneous Rocks

Late Jurassic		Granophite, Granite, Gabbro distributed in a small area.
		Dolerites dykes and sheets, fine, hard rock
Early Pre-cambrian		Granites gneissic, massive and porphyritic, widely distributed.

Simplified from Provincial Geological Map of Zimbabwe, by the Zimbabwe Geological Survey - 1985.

1.3. Meteorology and Hydrology

1.3.1. Meteorological Obseruation

Meteorological stations of the Masvingo Province are operated in the four sites, namely Makoholi, Masvingo, Zaka and Buffalo Range, under the Department of Meteorological Services, Ministry of Transport with proper instruments and staffs. Besides these four, the other two stations (Beitbridge and Middle Sabi) of neighbour provinces are also available to cover the area in southwest and east of the Province.

The collected data of the station such as, rainfall, temperature, radiation, relative humidity, wind velocity, atmospheric pressure, sunshine, cloudiness and evaporation are daily kept in records of the authorized format to report them to the central office of Harare in every month.

In addition to the operation of Meteorological Services, NEWRD keeps the observation of rainfall, evaporation and river discharge for the reservoir management of major dams and publishes the observation records as the Hydrological Summaries in every five years.

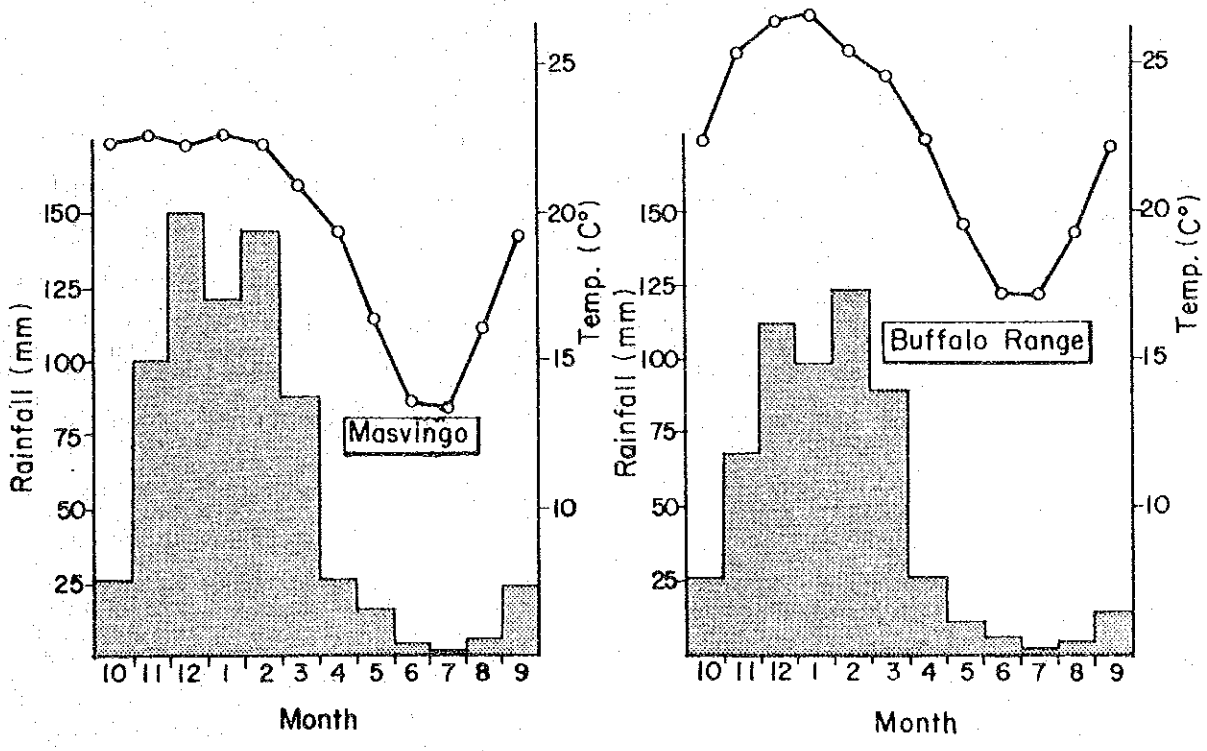
Besides the public observation, the rainfall records are kept privately by commercial farmers and missions locally inhabited mainly for the planning of seeding schedule, because of the wide range of rainfall from year to year and area to area. The availability of those private data collected around 3 000 stations in the whole country is confirmed by the Meteorological Services including suspended stations. In those stations, the record successively kept over 30 years and authorized by Meteorological Services amounts to 95 stations in and around the Province.

On the other hand, the observation network of evaporation measured with the modified American Weather Bureau Class A pan with protective mesh was established by MEWRD and Meteorological Services in 1960's and continues recordings in thirteen stations in the Province.

The river gauging by using an automatic recorder is conducted at perennial rivers flowing into major dams such as Kyle, Bangala and Manjirenji in the Runde River catchment. The records of these stations observed over ten years are kept in 33 stations of the Province, but a gauging in the catchment of less than 50 sq.km is not seen in the Province.

The general climate of the Province is classified into northern and southern regions of 21° latitude, where representative meteorological stations of Masvingo (middleveld) and Buffalorange (lowveld) are presented respectively.

Figure II-1-1 Temperature and Rainfall in the Province



1.3.2. Hydrology

Rainfall in Masvingo Province is characterized by its clear contrast of precipitation between north and south regions stretching 350 km length and divided respectively by 21°S of latitude. Generally, the range of annual rainfall, varying in the rage of 320 - 1 120 mm, is separated into respective two zones of the Province, namely the northern and southern regions bordered by the latitude of Chiredzi - Triangle.

In the northern region of the Province, where Kyle - Bikita area consists of the highest annual isohyet core (1 000 - 1 200 mm) of 80 km length in the east and west, the mean annual rainfall is recorded more than 600 mm with the exceptionally scarce areas of the Chivi (500 mm) and the Sabi River (400 mm).

On the other hand, the southern region is distinguished by the decreasing rainfall with increasing of the south latitude. It features the country's lowest precipitation area confined by the isohyet between 300 mm and 500 mm in which communal lands of Sengwe and Matibi NO. 2 are located.

The annual evaporation in the Province records its lowest value (1 600 mm) in the Kyle-Bikita area and increases toward the provincial boundary, and the highest value (2 000 - 2 200 mm) is seen along the international boundary with South Africa. It means that the evaporation varies over the Province to a much smaller extent than the rainfall, and is to a certain extent inversely proportional to the rainfall distribution, thus making the low rainfall areas particularly exposed to droughts.

1.3.3. Water Resource

The hydrological zones of the Province are shared both by the zone "E" occupying the major part (2/3 of the Province) in north and zone "B" in south.

The hydrological zones in Zimbabwe consist of six major catchments (from "A" to "F") and further divided into 151 subzones, of which 25 subzones are allocated to Masvingo Province.

The relations between those two hydrological zones ("B" and "E") and further divided subzones are summarized as follows:

Zone	Main River	Tributaries	Subzones
"E"	Sabi	Nyazwidzi-Devure	S1 - 5
	Runde	Chiredzi	C1 - 5
		Mtilikwe	UTI - 5
		Tokwe	T1 - 5
		Runde	L1 - 4
"B"	Limpopo	Mwenezi	N1 - 2
		Bubye	B1 - 2

Comparing the Mean Annual Runoff (hereinafter referred to as MAR) of those catchments, the similar tendency with the rainfall distribution is observed in northern and southern regions of the Province.

On the northern region of 21°S in latitude, more than 50 mm MAR is common with some exceptional areas of the Chivi and Sabi Rivers. On the other hand, the southern region records less than 10 mm MAR in its major part of hydrological zone "B", in which it is also remarkable that the MAR decreases in accordance with the increase of latitude. The communal lands of Sengwe and Matibi No. 2 are just located in this region.

On the viewpoint of utilization of water resources, Mtilikwe river catchment, consisting of 100 -130 mm MAR subzones, is highly developed by two major dams of Kyle (storage capacity = 1 425 MCM) and its regulating reservoir of Bangala. In addition, the neighbour subzone named Upper Chiredzi which has 107 mm of MAR, is also utilized as its resource by the storage of Manjirenji dam (storage capacity = 285 MCM). Those big reservoirs make it possible to balance the uneven potential resources between north and south regions of the Province, in other words to make possible the irrigated farming for the large scale commercial areas which had long been abandoned by the lack of water in the southern area of Chiredzi - Triangle.

In communal lands, however, the development of water resources has still remained at a low stage. Even though the area is endowed with large amount of runoff, the existing facilities are too small to enhance the continuous irrigation practice. The scale of the facilities is inconsistent with the scale of the catchment area and the function has been lost because of siltation.

1.3.4. Siltation

For the planning of dam project in Masvingo Province, siltation is most serious and it is hard to grasp its characteristics in the quantitative terms. As a typical example, Nyatari pick up weir, which was constructed in Ndanga C.L. to obtain the direct abstraction from the Nyatari River for Zaka Township water supply in 1979, was completely filled with silt in the very short span of three effective rainy seasons.

In addition, according to the AGRITEX's siltation survey (in 1983) primarily concerned with small dams in communal lands of the provinces, 62 per cent of its storage capacity was lost, which attains to around double of the average value of other four provinces where the value ranges between 25 per cent and 35 per cent.

Considering these conditions, the Design Division of MEWRD re-evaluated the magnitude of siltation for the existing dams and recommended to apply below mentioned two guidelines for the dam designing in 1984.

For major dams a siltation for 20 years is estimated at 6.5 per cent of Mean Annual Runoff. This represents a loss of 10 per cent of the total storage capacity over a 20 year period with siltation for a dam with a storage ratio of 0.65.

Smaller dams should not be constructed with a storage ratio of less than 10 per cent of MAR. Dams of this size may lose half their storage capacity by siltation within 20 years.

As those values are based on the countrywide average basis, the adoption of this design criteria to Masvingo Province known as the high siltation area is necessary to take special attention indeed.

Considering these situations, the Report of "Soil and Water Conservation" which summarized its draft in 1985 by the Interconsult A/S under the Siltation and Soil Erosion Project of MEWRD, gives the light to the fairly positive correlation between soil erosion and sediment yields.

This result is based on the countrywide survey conducted in 14 000 sq. km of selected 30 major dam's catchments, in which high to middle velds of the Province are especially stressed to have close investigation, so that 11 100 sq.km equivalent to 19 per cent of whole provincial area (about 40 per cent of communal lands) is included to its study area. Major results of the study concerned for the Province are able to be summarized as follows:

1) Range of annual siltation ... 20 - 700 ton/sq.km/annum
2) Sediment yields in the middleveld are in the range of five times or more than those of the highveld.
3) The relation between soil erosion and sediment yields is expressed in the linear correlation with a co-efficient of 0.72.

The degree of erosion in the Province is also surveyed by the Natural Resources Board. It expresses that the middleveld in the northern area of 21°S in latitude consisting of the districts of Bikita, Gutu, Masvingo, and Zaka, is seen as the seriously eroded zone. On the other hand, the lowveld consisting of the communal lands of Matibi No. 2 and Sengwe, is also remarkable as the severely eroded zones exceeding the average of countrywide except the area of large scale commercial farmings around Triangle.

1.3.5. Water Rights

The water right in Zimbabwe is fully administrated and judged by the Water Court under the Ministry of Justice in Harare. As to the potable and irrigation water by utilizing surface runoff, the Hydrological Department of MEWRD is in charge of management of both existing and requesting rights for the countrywide. Those rights are systematically kept in order on the maps with the scale of 1/100 000 which are further subdivided into the river system based on the hydrological subzones and show the number of right and discharge of final grant on the abstraction spot.

The water rights maps consisting of 67 sheets to cover the whole Province are necessary to examine whether the existing rights will be affected by the construction of proposed meidum size dams or not. According to the maps, it is predominant that water rights in the areas of commercial farms are highly intensive compared to those of communal lands.

The authorised rights in the communal lands are scarce. The granted abstraction limited both by daily and annual amounts is valid for the small irrigation area such as several hectares only with a few exceptions. Generally, in the case that the proposed dam site is located in the upstream of a river system, the influence of the dam storage should be considered up to where those effects are entirely lost.

However, the proposed dam sites, of which catchment mostly in the range of 10 - 30 sq.km, is located at the secondary or further subdivided tributaries of big rivers consisting of several hundred thousand sq.km of catchment area such as Sabi, Runde and Bubye in which many usages with authorised rights can be seen. In this case, the water controls of the newly built dams are considered to negligibly influence the existing rights of the downstream.

The notable water right in the Province is the 3 968 sq.km of Kyle catchment covering around 8 per cent of the whole province as the 'Water Control Area' of conservation. In this catchment, the plan of irrigation

dam is only allowed by means of insuring the alternative resource from other catchment except the rural water supply for the people and cattle.

On the other hand, the confirmation of existing water rights on the said maps makes it clear that seven damsites in the four communal lands (i.e. Bikita (2), Masvingo (2), Mtilikwe (1) and Chivi (2)) are located in the catchments of the existing water rights.

1.4. Current Irrigation

The Study Area contains nine existing irrigation schemes. Table II-1-3 describes these schemes in terms of irrigated area, plot holders, water source and water conveyance method. The size of irrigated area in these existing schemes varies between 6 - 120 ha with average size of 45 ha. The average allotment size in irrigated hectares is approximately 0.18 ha.

The usual method of applying irrigation water in the field is by furrows supplied with water from irrigation canals through portable syphons. The rotational irrigation method is employed in the current practices of water use in the irrigation schemes.

As regards to cropping patterns of these irrigation schemes, maize is a dominant summer crop. Groundnuts are next in importance, followed by vegetables. In the winter season, maize is the most important crop, followed by vegetables and sugar.

Table II-1-3 Existing Irrigation Scheme

Name of Scheme	District	Irrigated Area (ha)	No. of Plot Holders	Year of Construction	Year of Rehabilitation	Water Source		Conveyance by canal		Conveyance by pumping		
						Name	Capacity (cu.m)	Length (km)	Capacity (cu.m/sec)	Capacity (cu.m/min)	Diameter of pipe (mm)	Length of pipe (km)
1. Mapanzure	Masvingo	48	318	1968	1982	Gozho Dam	1.36×10^6	1.53	0.192	-	-	-
2. Makonese	Chivi	65	396	1972	1981	Makonese Dam	2.0×10^6	0.9	0.1	2.0	300	0.5
3. Musvuvugwa	Chivi	59	565	1970	1984	Runde River (Flow)	-	-	-	4.6	250	0.8
4. Banga	Chivi	45	405	1972	1984	Banga Dam	0.9×10^6	0.3	0.09	-	-	-
5. Gudo's Pool	Gaza Komanani	11	96	1984	-	Sabi River (Sand Abstraction)	-	-	-	1.2	160	0.7
6. St. Joseph's	Gaza Komanani	15	106	1980	1983	Sabi River (Sand Abstraction)	-	-	-	1.8	160	0.3
7. Rupangwana	Gaza Komanani	6	49	1978	1985	Sabi River (Pool)	-	-	-	1.2	160	0.3
8. Chilongu	Gaza Komanani	120	207	1963	1982	Runde River(Pool)	-	-	-	3.8×2	375	-
9. Manjinji	Gaza Komanani	35	93	1967	1985	Borehole	-	-	-	2.0	160	0.2

Sources (1) MEWRD, Masvingo

(2) AGRITEX, Masvingo

1.5 Land Use

1.5.1. General

The land of Zimbabwe is divided into five Natural Regions shown below on the basis of soil, rainfall and other climatic factors.

Region I; region for specialized diversified farming
Region II; region for intensive farming
Region III; region for semi-intensive farming
Region IV; region for semi-extensive farming
Region V; region for extensive farming or grazing.

The land in Masvingo Province falls into three Natural Regions III. IV and V. Especially latter two regions are predominant. Relative shares of these regions are 11,27 and 62 per cent respectively.

Region III is characterized by rainfall ranging 650 - 800 mm per annum and fairly severe mid season dry spells. Region IV has rainfall of 450 - 650 mm per annum and periodic seasonal drought and severe dry spells during the rainy season. And in the last Region V, rainfall is too low and erratic for even drought resistant fodder and grain crops.

Nevertheless, in communal lands, most farmers try to grow grain crops such as maize, sorghum or millets, even in Region V, while sometimes suffering from drought.

1.5.2. Land Use in Communal Lands

The land use in the Province is divided into communal farming areas, commercial farming areas, resettlement scheme areas, small-scale commercial farming areas and national parks. Each portion occupies 37, 24, 7, 4 and 10 per cent of the total area. About 77 per cent of the population lives in the communal lands.

Total areas of the communal lands in the Province is 23 243sq.km. The arable lands are cultivated by every farmer who has a right to use a particular piece of land, while grazing lands are publicly used by all inhabitants in the village as a communal resource.

The distribution of households by holding size of arable land in communal lands are given in table II-1-4 and the average holding size of 5.3 acres (2.12 ha) is not so large as an individual farm. The number of parcels by a household ranges mostly from one to two as shown in the Table II-1-5.

The ratio of arable land to grazing land varies from place to place and from time to time. In general, in the northern and central parts of the Province, the population has greatly increased since the land was originally allocated for individuals. Due to the pressure of the ever increasing population, cultivated land has continuously increased, and correspondingly, grazing land has decreased. As a result, in the communal lands of Gutu District, for example, the ratio of arable land to grazing land has reduced from the original 1:4 to 1:1.

In the southern part of the Province, the ratio of grazing land is still fairly high, though it is depending on its agricultural situation (low population density and high dependence on livestock), however, in Sangwe and Maranda Command Lands, overgrazing problems are taking place.

Predominant crops on the arable land are grain crops of which maize ranks first in Natural Region III, but it is often overtaken by drought resistant crops in Natural Region V.

Table II-1-4 Distribution of Households by Holding Size (acres)

Holding Size (acres)	Number of Households	Percentage of Households
0	9 968	6.5
Less than 1	779	0.5
1 but less than 2	11 403	7.4
2 〃 〃 〃 3	17 557	11.5
3 〃 〃 〃 4	19 566	12.8
4 〃 〃 〃 5	21 823	14.3
5 〃 〃 〃 6	13 660	8.9
6 〃 〃 〃 7	15 013	9.8
7 〃 〃 〃 8	9 558	6.3
8 〃 〃 〃 9	9 558	6.3
9 〃 〃 〃 10	6 030	3.9
10 and above	18 008	11.8
Total	152 923	100.0

Source : The Demographic Socio-Economic Survey in Masvingo Province (1983/1984)

Table II-1-5 Distribution of Households by Number of Parcels (provincial level)

Number of Parcels	Number of Households	Percentages of Households
0	9 968	6.5
1	100 171	65.5
2	37 164	24.3
3	4 923	3.2
4	615	0.4
5 and above	82	0.1
Total	152 923	100.0

Source : The Demographic Socio-Economic Survey in Masvingo Province (1983/1984)

Compared with the southern flat areas, the topograhpy of the northern and central areas are a little to fairly undulating or slopy, and contour cultivation is a common practice basically in these areas. In some parts of the arable lands and most of the grazing lands, however, little measures have been taken to protect the lands. This has led to severe erosion (sheet erosion and gully erosion), causing siltation in the streams, rivers, weirs and dams, particularly in the areas of sandy soils derived from granite.

There are plenty of indigenous woodlots in the communal lands like Maranda, Sangwe, Sengwe, Matibi No. 1 and Matibi No. 2. But in most of the communal lands some shortage of firewood and timber seems to take place. So, afforestation like gum tree planting has been encouraged by the Government. At present, over 650 hectares of such planting are giving advantage to the people.

1.6. Soil

1.6.1. General

The soil classification and mapping in Zimbabwe were formulated by Dr. Thompson and Dr. Purves, which are widely accepted guides to the soils of this country. According to this classification, the soils of Masvingo Province show a remarkable correlation with the underlying parent rocks or materials from which they are derived. They are mainly classified into the following three soil groups.

1) Fersiallitic soil group
2) Siallitic soil group
3) Vertisal group

Besides, some soil groups cover relatively small areas.

1.6.2. Fersiallitic Soil Group

The fersiallitic soils comprise the majority of the soils derived from granite in Zimbabwe. This group is sub-divided into several soil

families and among these 5G type covers most of the northern half of the Province. Most of these soils consist of moderately shallow to moderately deep, pale coarse grained sands throughout the profile. Because of the low water holding capacity, they tend to dry up during the dry season, and due to the relatively impermeable nature of the underlying granite, also tend to form high water tables for short periods during the rainy season. While the soils better drained on the higher parts of the upland tend to have reddish brown or yellowish red subsoils with a little higher clay content.

In general, the fersiallitic soils derived from granite have relatively low inherent fertility. So productivity of these soils is subject to deteriorating under intensive or continuous cropping unless they are properly managed. Most of the soils derived from granite are so highly erodable that if due conservation measures are not taken, their productivity will be severely declined. This type of soil covers most of Gutu, Serima, Chikwanda, Zimutu and Chivi communal lands, and considerable part of Bikita, Ndanga, Matibi No. 1 and Maranda Communal Land.

In southern range of 5G zone, there often appears 5P type that is a fersiallitic soil family derived from gneiss. This is covered with brown to reddish brown sandy loam over similar sandy clay loam.

1.6.3. Siallitic Soil Group

The siallitic soil group in this province occurs in the southern low veld, and mainly classified into two soil families, 4P and 4M type. 4P type is formed on silliceous gneisses and gives rise to shallow to moderately shallow brown to reddish brown loamy sands over sandy loams, or sandy loams over sandy clay loams. While 4M type is derived from mainly sandstone or quartzites of Triassic formation and gives rise to moderately shallow to moderately deep soils, texturally similar to 4P.

In general, except very sandy types, the siallitic soils are not only inherently fertile but also have a relatively high water holding capacity. Therefore, though most of them occur in the low rainfall areas, they have

the high agricultural potential. Most of 4P type is distributed out of communal lands, while 4M type covers some parts of Sangwe, Sendgwe and Matibi No. 2 Communal Lands.

1.6.4. Vertisol Soil Group

The vertisol soil group is associated with a large tract of basalt in the south of the Province. These soils mainly composed of dark brown to black clays, have a well-developed granular surface and are fully base-saturated. The vertisols generally have a high inherent fertility except that they are intractable in excessive wetness. Therefore in the low rainfall areas, this irrigation potential would be very high. As to communal lands, these soils appear in most of Matibi No. 2 and some part of Sangwe and Sengwe.

1.6.5. Other Soil Groups

Besides these main soil groups above mentioned, the soils which have ferrallitic characteristics, called orthoferrallitic soil group and paraferrallitic soil group, spread over in Bikita, Ndanga, Mtilikwe and Masvingo communal lands comparatively wide. They are derived from a kind of granite, and the former includes relatively high contents of clays in subsoils and the latter is strongly leached and highly porous.

In addition, there are Lithosol group in a part of Matibi No. 1 and Sengwe communal lands, and some other soil groups in small areas scattered throughout the Province.

1.6.6. Variations in Detail

The preceding descriptions are all based on the soil map with the scale of 1:1 000 000 and its guide book. However, the soils tend to vary from area to area in their details, much more than above mentioned, due to topography, climate, natures of parent rocks etc. Thus, even if an area is classified roughly into the same soil type, some spots or patches of different soil types can be sporadically found within the area, and from the

viewpoint of irrigation, the above classified soil groups do not necessarily coincide with the soil types classified into those suitable for irrigation, because a soil group (family) has several variations in soil texture, soil depth etc. The selection of the areas with irrigable soils is now initiated by AGRITEX.

1.7. Crop Production

1.7.1. General

Almost all cultivated areas of communal lands in Masvingo Province are planted with maize, sorghum, mhunga (bulrust millet), rapoko (finger millet) or groundnuts. These crops are primarily grown for home consumption and the surplus is usually oriented for sales. Yields of these crops fluctuate year by year because of erratic rainfall. In 1982/83 to 1983/84 severe drought hit the crops on the land without any yield in most of the southern lowveld area. It is said that the acceptable yield may only occur once in three to five years in these areas.

After long continued drought, bumper crop in 1984/85 was favoured by normal rainfall.

1.7.2. Main Crops

On the whole, maize is a preferred staple food crop, though in some parts of the southern communal lands, sorghum is more important.

As maize requires a log of soil nutrients and moisture, the farmers provide their best plots for planting this crop. But because of the shortage of water, infertile soils or insufficient farm management, average yield is considerably low. Even in 1984/85 it was 810 kg/ha according to statistics. However, in optimum condition it must be increased to 20 - 30 bags/ha (1.8 - 2.7 ton/ha) and actually, it has been achieved by some good farmers.

Sorghum, mhunga and rapoko are extremely drought tolerant crops, and do well in most parts of the Province. These grains are used as the subsidiary foods and sometimes as the traditional brewing materials, though some of sorghum and rapoko in wetter areas are grown as cash crops. The planted area of sorghum is relatively high in Chivi, Gaza and Batanai Districts similar to mhunga in Bikita, Gutu, Chiredzi and Mwenezi and rapoko in Gutu, Zaka and Chivi.

Groundnuts is also grown widely as the crop that comes after maize in the rotation practices. Most of the farmers grow it to meet basic subsistence needs and the surplus is marketed. Though it does not have so much planting share due to its low yield, a shortage of high quality seeds, and its low prices, with the national surplus of maize, it is recommended to increase groundnuts planting as an alternative. Ndanga communal land (Zaka District) has the relatively high planting area of this crop.

Besides these major crops, there are some crops such as cotton, sunflower, soya beans and oriental tobacco which are introduced as cash crops, but the growth of these crops still remains a minor one.

Usually, most dry land crops are grown once a year during rainy season with a variability among regions. As shown in figure II-1-2 and figure II-1-3, existing cropping types can be classified into following three categories: (1) maize predominant type, (2) sorghum predominant type and (3) mixed cereal type.

Cropping shares, periods and yield levels for the component crops in each crop are shown in Table II-1-6.

In addition, some vegetables such as tomatoes, cabbages, onions, pumpkins are grown in the small garden plots near the houses whenever water for them is available.

1.7.3. Farming Practices

The common farming practices are as follows:

1) Land preparation

Most of land preparation is performed by use of draught animals (cattle and donkeys supplementarily) and single furrow ploughs. Usually average depth of ploughing is considerably shallow. A large pair of oxen can plough 0.1 - 0.2 ha of land per day.

2) Planting

Most crops are hand-planted after start of the rains. But mhunga and rapoko are often broadcast before the rains.

3) Manure and fertilizers

Manure is the main source of nutrients in communal lands. Potential manure production by cattle is estimated as one ton per year, while the requirement of manure for maize is said to be about four ton per hectare. So available quantities of manure would not be enough to maintain soil fertility. A lot of farmers now use some fertilizers which are mainly ammonium nitrate, Compound D (8, 14, 7), L (5, 18, 10) or S (6, 6, 17) and single superphosphate for maize and gypsum for groundnuts. But the use of fertilizer in communal land is still on the low level (40 - 50 kg/ha in case of compound or ammonium nitrate).

4) Varieties

The popular maize seed is almost hybrid varieties such as R 215, R 201, or R 200 (all white dented variety). Red Swazi is recommended as the variety of the sorghum which is grown in low and medium rainfall areas. The varieties of groundnuts recommended are Natal Common and Plover, but high quality seed has not been used sufficiently.

Figure II-1-2 Existing Dryland Cropping Types

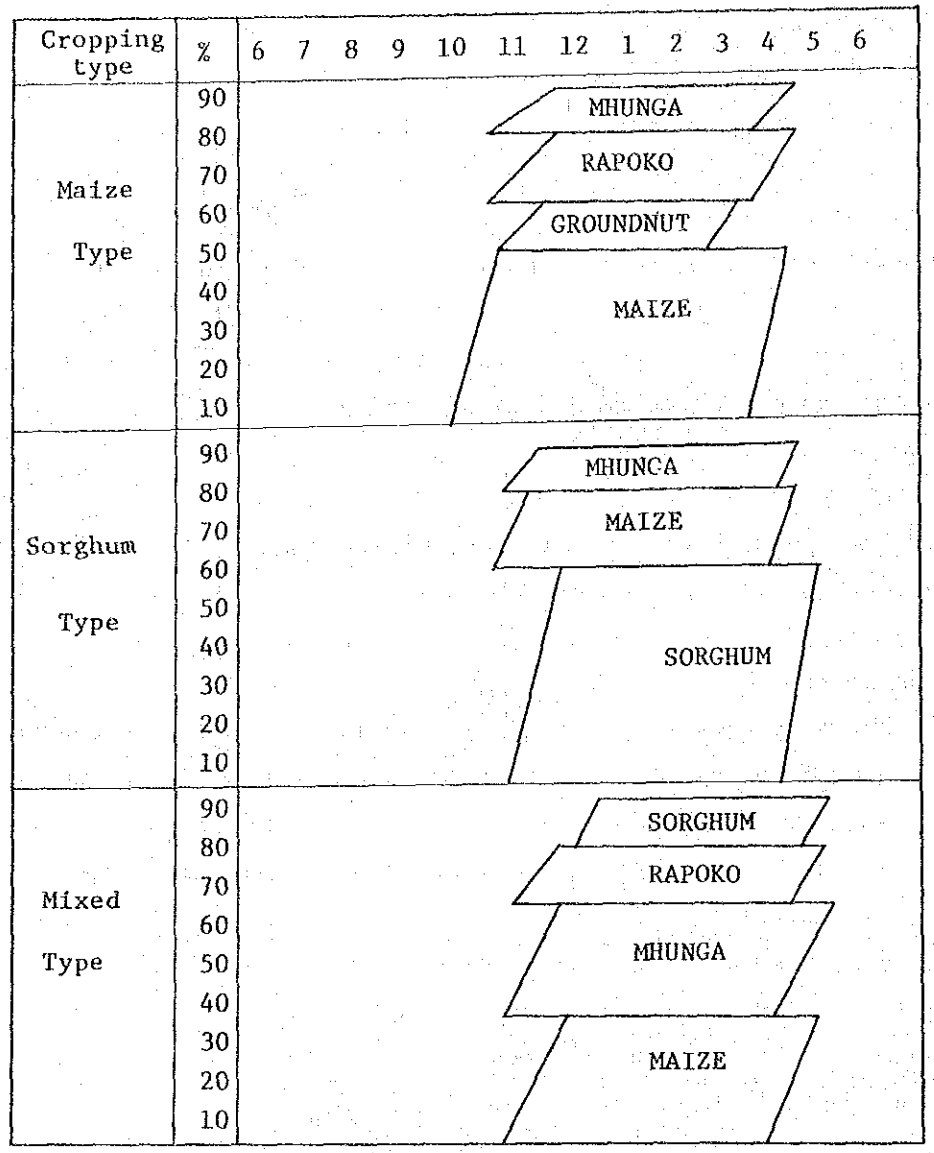


Table II-1-6 Yield of Main Crops

	Bench mark yields in 1984/85	Yields under Optimum Condition
Maize	18 bags/ha	20 - 30 bags/ha
Sorghum	11 bags/ha	15 - 30 bags/ha
Mhunga	8 bags/ha	10 - 20 bags/ha
Rapoko	9 bags/ha	10 - 20 bags/ha
Groundnuts	11 bags/ha	10 - 15 bags/ha
Cotton	842 kg/ha	1,000 - 1,300 kg/ha
Sunflower	7.5 bags/ha	20 - 30 bags/ha
Soya beans	4 bags/ha	10 - 15 bags/ha
Oriental tobacco	860 kg/ha	700 - 1,000 kg/ha

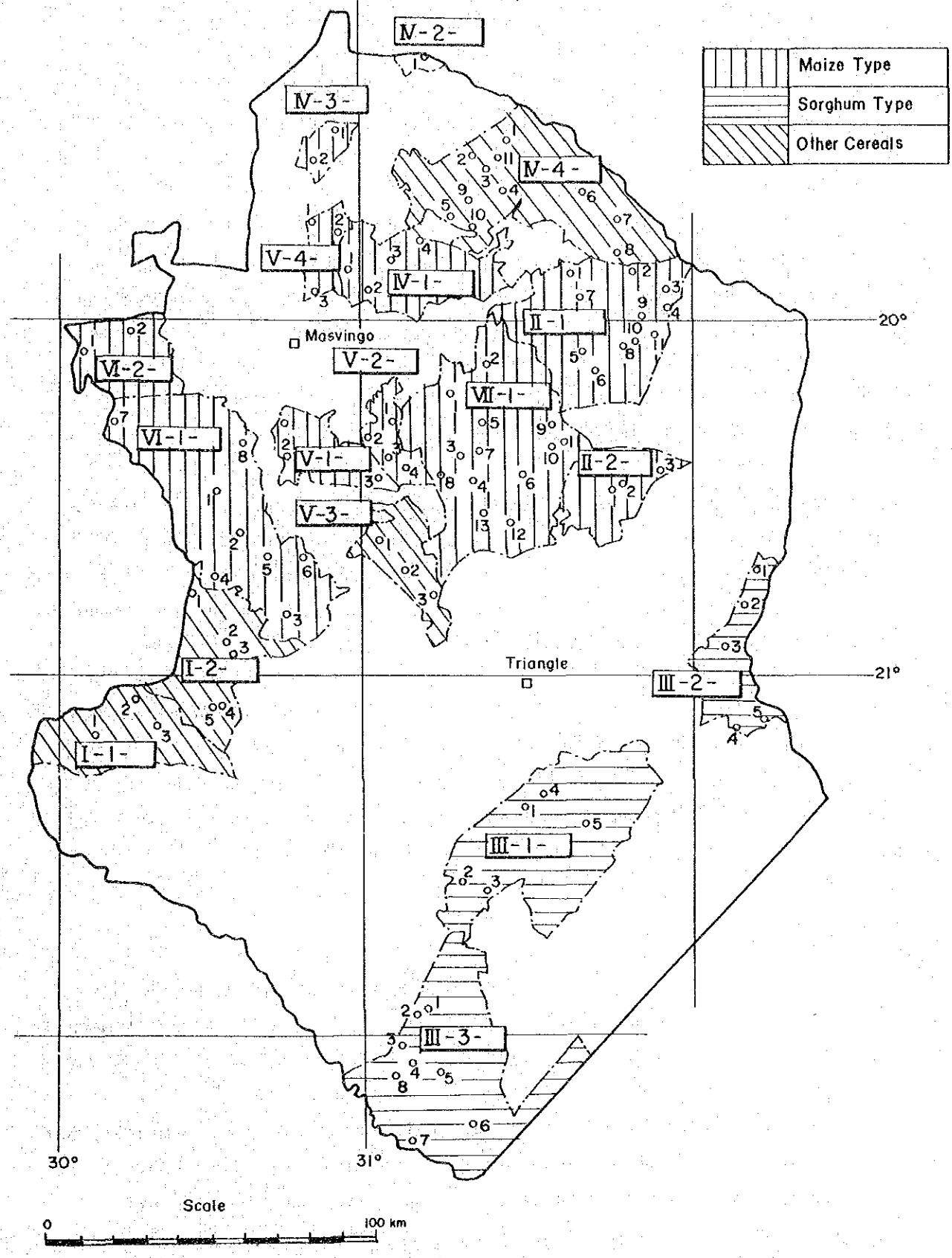
(1 bag = 91 kg,but 40 kg for groundnuts, 55kg for sunflower)

Source: AGRITEX

Figure II-1-3

MAP OF EXISTING CROPPING PATTERN

(Current Situation)



Note: c.f. Chapter 3.6.1 Dryland usually has only one crop per year, and this map indicates a generally predominant crop type. For example Maize type includes maize g'nut and rapoko while other cereals does mhunga, sorghum and maize, etc.

Mhunga and rapoko do not have the improved seed varieties. It is noted that the majority of existing varieties, in particular indigenous ones of sorghum etc., are of higher drought resistance, which is well adapted to current land conditions, rather than of high yield response.

5) Weed and pest control

Most farmers weed grain crops twice in the season by hand, animal drawn cultivator or hand hoes. Generally, chemical pest control is practiced only for limited control of stalkborer, with thiadine or dipterex.

1.7.4. Crop Production under Irrigation

Several small to medium sized irrigation farming is performed in communal lands. Though the total irrigated areas are still quite little, crop production under this irrigation is remarkably high. The land is used intensively throughout the year. Early maize, some vegetables or beans are introduced in winter, in addition to summer crops.

For example, in the Mapanzure irrigation scheme, average yield per hectare in the past five years was 6.3 ton for maize, 3.6 ton for groundnuts and 17.0 ton for tomatoes. In the existing irrigation schemes, only 0.1 - 0.4 ha of irrigated plot is allocated to a participant farm family in addition to the existing dryland plots as referred in 1.5.2.

1.8. Livestock Production

The commonest domestic animals in the Province are cattle, goats, sheep, poultry, pigs and donkeys. These livestock figures in the communal lands in the Province are shown in Table II-1-7.

Cattle are by far more important animals, not only economically but also socially for farmers. Economically, they are used as draught power, produce manure, transport materials and supply milk and meat. While socially, they are kept as life and risk insurance, bridewealth and even owners' status symbol.

Breeds of cattle are basically of the indigenous Mashona type, and admixture of Africander and Brahman. But in communal areas, different breeds of cattle are reared together in the same way and mating is not selective.

The stockowners in communal lands own cattle with average herd size of about 6 heads. However, more than 40 per cent of the households of the farmers do not have cattle at all. The distribution of households by number of cattle is shown in Table 3-7.

So, the number of cattle per household comes to 3.5. One of the causes of non-holding might be the recent recurrence of three consecutive dry years. It is said, for example, that about 50 per cent of cattle died of the drought in Chivi Communal Land. Anyhow, it is evident that there is a critical storage of draught power. Even if the farmers without cattle could hire them from cattleholders, they are often too late for timely ploughing.

Another important role of cattle is to produce manure. Cattle are usually pastured in grazing land in the daytime, but are penned overnight in unroofed kraals, and in the dry season they are fed with grain stover. Therefore the manure is produced in the kraals, and utilized in farming. The chronic shortage of beef supply, which is often experienced in recent years, result in the accelerated marketing with premium prices in southern part of the Province.

In general, the herd size of cattle in the southern part of the Province, especially in Chiredzi District, is larger than other areas. The farming of these areas is predominantly supported by livestock. Because in these areas, most of which fall into Natural Region V, livestock offers a better security than the crops grown under unreliable and poor annual rainfall. There is a great potential for livestock development in the understocked Sengwe Communal Land. And the stocking rates are still reasonable in Matibi No. 2.

Table II-1-7 Number of Livestock in Communal Lands

District	Cattle	Sheep	Goats	Pigs	Donkeys	No. of Stock Owners
Bikita	95 150	6 125	25 931	3 822	2 225	15 251
Gutu	123 850	13 564	43 327	943	5 251	27 100
Masvingo	71 172	4 711	20 156	1 505	3 244	12 767
Zaka	113 380	14 872	37 308	8 053	4 808	17 085
Chivi	78 228	2 967	10 016	4 387	8 490	15 304
Gaza	62 032	2 599	4 829	649	1 347	4 498
Batanai	30 075	1 871	17 541	353	4 905	4 714
Total	573 887	46 709	175 108	19 712	30 207	96 732

Source : Masvingo Provincial Development plan

Table II-1-8 Distribution of Houeholds by Number of Cattle

Number of Cattle	Number of Households	Percentage of Households
0	65 796	43.0
1 - 5	52 999	34.7
6 - 10	23 258	15.2
11 - 15	6 399	4.2
16 - 20	2 379	1.5
21 - 25	903	0.6
26 - 30	451	0.3
31 - 35	246	0.2
36 and above	492	0.3
Total	152 923	100.0

Source : The Demographic Socio-Economic Survey in Masvingo Province (1983/1984)

However, in most of the other communal lands, over-stocking, overgrazing and low take off rates are serious problems. Usually recommanded stocking rate is 4 - 8 ha per livestock unit according to productivity of grazing land. But the areas available for grazing has been reduced by encroachment of cultivated land due to the increasing farming population. For instance, the ratio of cultivated land to grazing area in Gutu District is estimated to be approximately 1:1 and present stocking rate (hec. per livestock unit) in these areas may be less than 2 ha/unit as against recommended 7-8 ha/unit.

Other small livestock are less important than cattle, but they provide a source of food and additional income.

1.9. Fish Farming

Recently, fish farming is encouraged by the Government as a source of valuable protein to improve the nutrition of communal farmers. World Food Day held on Thursday October 16 1986 has taken an increasing interest in fish as a food.

In the centre of the Province, there is the largest artificial lake - Lake Kyle, in which a lot of fresh water fish are raised and the large scale commercial fish farming is conducted. In Gutu District, commercial fishing does occur on some dams and in Zaka District, there are some large scale dams which have the potential for fish industry.

However, in communal lands, fish farming is not for cash income but mainly to obtain food for villagers themselves on a subsistence level, and it has still not been developed as expected. Because it not only needs enough experiences and techniques, but also requires perennial and sufficient water which is not easily provided.

Generally, the fish farming in communal lands is practiced in small to medium scale dams on fish ponds. In this context, fish pond means artificially impounded water such as diverted water pond, dammed-up pond, seepage pond or reservoir made of bricks or cement, all in family size.

In case of dam, it is mostly constructed by the local authorities, mainly for domestic water demand, livestock watering and/or irrigation, and these purposes often determine their size. But anyhow, they provide opportunity for fish farming. While, in the case of fish ponds, communal farmers can build their own fish ponds by forming co-operatives. AGRITEX has promoted to build these fish ponds and has achieved 250 ponds in 1984/85, 236 ponds in 1985/86 respectively.

In dams, fish population usually consists of the species appearing in the rivers or streams connected with the dams. Some species frequently found are Barbel, Yellowfish, Hunyani Salmon, Bulldog, Bottle nose, Bream etc.

The best kind of fish used for fish ponds are various Bream species, especially Mozambique Bream, Green-headed Bream and Red-breasted Bream (Tilapia).

It is recommended that in case of medium size dam, 3 - 10 ha of water surface can be suitable for fish production and most effective space of small scale dam is about 3 ha. The following stocking rate of dams is also recommended:

Size of dam surface	Amount/ha.	Size of fish
Up to 5 ha	5 - 10 kg	10 - 250 g
5 to 10 ha	10 - 25 kg	10 - 250 g
Over 10 ha	Over 25 kg	

In the fish ponds, seed fishes are collected and supplied from Lake Kyle. The requests of seeds are met by Fishery Seed Farm. 1 kg of seeds are enough to supply as a stock to a reservoir. The charge is Z$25 per kg, including prices of a container and oxygen-generating chemical.

1.10. Public Health and Schistosomiasis

1.10.1. Public Health

Although numerous health facilities in rural area were destroyed during the Independence War, they have been re-constructed and also some are newly constructed since the Independence in accordance with the governmentpolicy aiming at improvement of health services in rural area. As of 1985, there are 138 health facilities inclusive of those under construction, namely, 15 hospitals, 10 rural service centres, 49 rural hospital centres, 64 clinics in the Province.

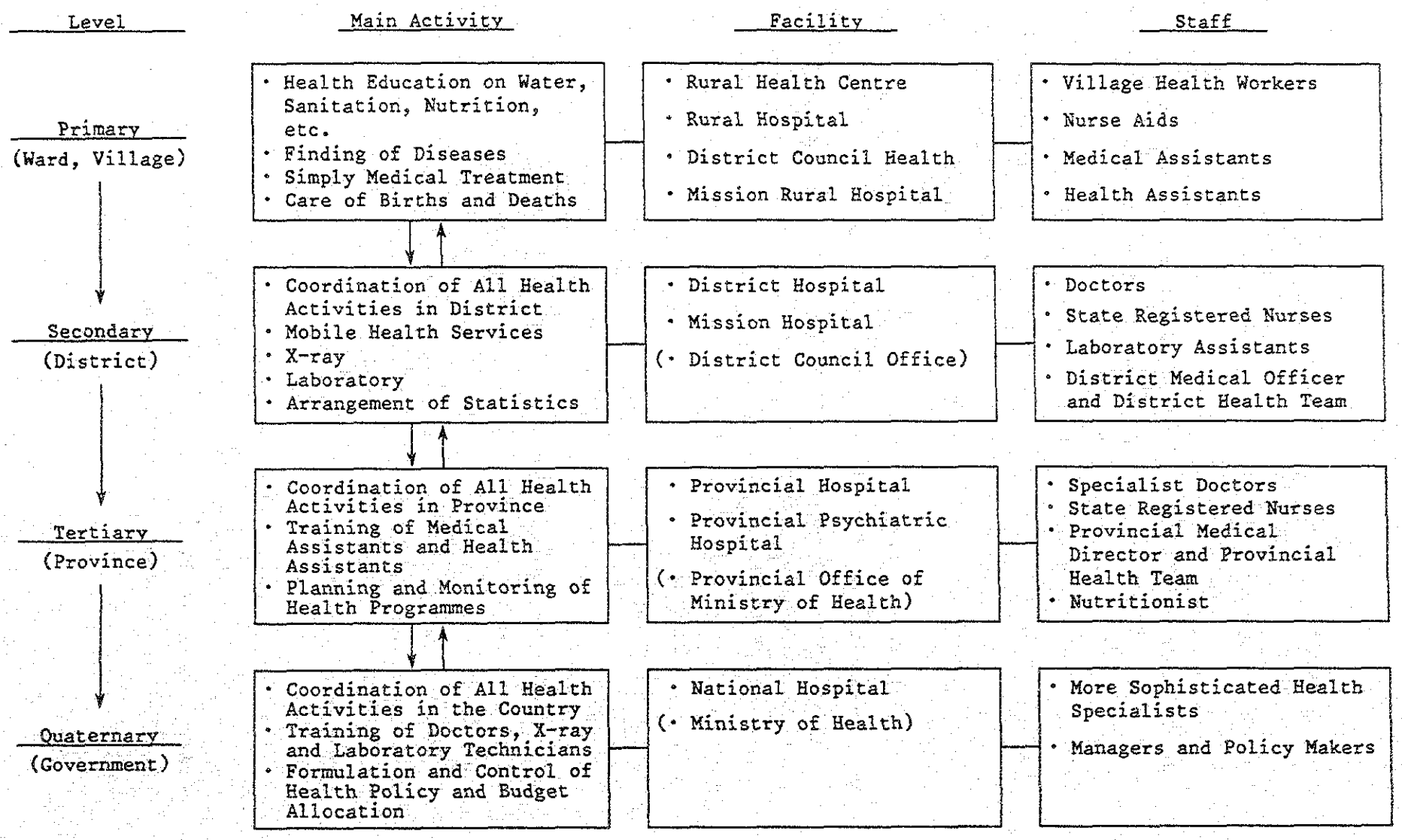
Ministry of health divides the hospital service organization into four levels in order to perform rural health services efficiently, as seen in Figure II-1-4. Special emphasis has been put upon health services at the primary level, village and ward. The ultimate aim is that all the rural people can get health services within a ten km distance and that one village health worker is staffed for 50 to 100 families. But the present situation in Masvingo Province are much different from this target and the shortage of staff and the lack of health facilities and equipment are found.

The major diseases in the Province are sexually transmitted diseases, malnutrition and water-related diseases such as diarrhoea, schistosomiasis, malaria and eye infections. For this measure, the Provincial Office of the Ministry of Health has carried out the health campaign in order to improve 1) farmers' nutrition standard, 2) rural water situation, and 3) the disposal of contaminaiton through health education among rural people.

1.10.2. Schistosomiasis

Schistosomiasis is one of most prevalent diseases in the Province and the occurrence in the exsisting irrigation areas are often reported. The number of patients is reported at about 40 000 in 1985. Bilharzia exists throughout the Province, especially in the areas along Runde and Sabi Valleys.

Figure II－1－4 Structure of Health Services



1.10.3. Control under Irrigation Schemes

Irrigation schemes sometimes lead to the major occurrence of bilharzia because sluggish water in irrigation canals and night storages provide suitable habitats of snails. To reduce snail breeding, the following measures are effective.

1) Rational design of dams
2) Rational water operation
3) Providing sufficient number of toilets (Blair latrines) in the irrigation fields
4) Staffing snail rangers
5) Use of molluscicide chemicals
6) Weeding water weeds in irrigation facilities
7) Prevention of use of sluggish water
8) Health education of the community

Great emphasis should be placed on health education in order to awaken farmers' self-care and awareness against the diseases. Irrigation management committee, village health workers and ward (village) development committee should positively deal with the health education of irrigators in collabolation with one another after the implementation of the Project.

1.11. Rural Water Supply

1.11.1. General

Most inhabitants in the Study Area utilize the surface water and groundwater sources for domestic and livestock use. Most village women are engaged in carrying water on foot with a container of about 20 litres on their heads for three or four times daily. In the areas where available water supply for domestic use is not sufficient, the women sometimes walk more than 10 km for water sources in the dry season. To fetch water is the burden for women in communal lands, particularly in the dry season.

1.11.2. Water Source and Use

The basic guideline for rural water supply by the Government lies in borehole for domestic use. Nevertheless, according to 'National Household Survey' carried out by Central Statistical Office in October 1983, more than 70 per cent of households use the water from unimproved water sources such as unprotected wells, springs, rivers, streams, etc. The rural people tend to be dependent on improved sources, i.e. protected wells and boreholes as well as perennial rivers and river-bed digging during the dry season because most unimproved sources are virtually dried up.

Since the Independence, a number of boreholes and wells have been established by MEWRD, D.D.F. and several international assistances throughout the Province. Some boreholes, however, have not improved the rural water supply situations as were expected because they cannot yield sufficient amount of water to meet rural people's requirements in the dry season. On the other hand, the rural people are still accustomed to utilizing surface water sources adjacent to their hoesteads even after the provision of primary water supplies. It is because much labour for carrying water for long distance can be saved. The dwellers' major dissatisfaction with boreholes is a long distance travel and often long waiting time for their turn.

The Report on 'The National Master Plan for Rural Water Supply and Sanitation' of which data were given in July 1984 showed the density of persons per existing borehole of 644 and the number of boreholes per sq. km. of 0.07 in the entire communal lands. The former figures ranged between 121 in Sengwe C.L. and 2 038 in Denhere C.L. and the latter varied from 0.02 in Chikwanda C.L. to 0.11 in Zimutu C.L.

Piped water supply has been promoted in the densely populated areas such as growth points, district service centers and rural service centres. As of 1984, more than 60 per cent of the above centres in the Province was still not provided with piped water systems.

Recently, several medium size dams have been implemented for the purpose of domestic water supplies in the densely populated areas in communal lands, e.g. Jerera with Nyatare dam and Gutu - Mypandawana with Woodlands dam.

According to the field survey, average daily water demand per capita per day at the homestead was estimated at six to ten litres. It would be impossible to estimate total daily water demand per capita because most dwellers utilize rivers for clothes washing and bathing. The Ministry of Health has recommended that clean water of 30 - 50 litres per capita per day is required from the hygienic point of view.

Water supply for livestock is a serious problem for the farmers throughout the Province. About 60 per cent of households in communal lands keep cattle. Some of them have to take their cattle to perennial rivers, small dams and boreholes for more than 10 km from their villages for cattle watering.

Garden watering is a type of water use in rural areas, in particular, in the northern part of the Province. There are many gardens under vegetables adjacent to water sources. The main source for gardening is the surface water like rivers. Many schools and clinics have the vegetable gardens being supplied with water from their boreholes. There are several communal vegetable gardens operated by the groups of women along co-operative lines.

In recent years AGRITEX has built a number of small size dams and weirs for livestock and/or gardening.

The quality of water derived from boreholes is not satisfactory in certain areas, especially in the southern part of the Province, due to the salinity on fluorine content.

1.12 Farm Management

1.12.1. Dryland Farming

Communal farmers cultivate farmland under a traditional usufruct right, and even newly established households are usually endowed with new "right of avail" on vacant fields or public grazing land. However, progressive parceling of arable land in densely populated central and northern parts of the province has led to smaller holdings and widely spread land degradation. Cultivation on stream banks or floodplains is also accelerating erosion and land degradation.

Slopy fields with coarse soils of granite origin predominate in Southern Gutu, Masvingo, Bikita and Zaka, and these fields are often conserved with traditional contour bunding and grassy channels. Generally, areas with the inclination up to eight degrees are cultivable on fine textured fertile soils like red soils. Flat lands covered with weathered granitic soils are so infertile that sorghums or millets are often grown after a long spell of fallow followed by a burning of weeds and scrubs. Fallow plots are also used for private pasturing of the cultivator's livestock.

Farm labour supply is sufficient throughout the province. On the whole, arable land holding sizes range 3 to 4 ha. in the south of the province, proportional to larger family members. In these areas drought resistant cereals are extemsively raised, and manpower requirement of this type of farming is usually readily met by family labour, without any shortage during the season. On the other hand, nost holdings in the central and northern parts of the province are as 2.5 ha or narrower, whereas average numbers of family members are less and higher percentages of them are out-migrated. According, labour supply is not so loose as in the southern part taking account of higher extent of labour-consuming cash crop production, though there is a tendency of surplus in annual labour supply against demand.

Land preparation and sowing falls in October, which brings the first labour peak during October and November. Besides, some crops, such as sunflower and banbara beans are planted in December. Harvesting season falls during April and June, when rainy season is over, forming the second labour peak. A few crops like oriental tobacco and cotton require 100 to 200 man-days per hectare for their harvest, processing and packing. In rural areas, farmers at large still conserve a traditional collective practice by village or by kraal, for land preparation, sowing or harvesting. During off-season, from late June to September, manure is collected from kralls and applied on fields, or vegetables are grown by womens' groups on taguta gardens developed near perennial streams.

Input use are still in a low level, and most peasants use manure, decaded litter, earth clod taken from ant hills for inputs. However, certified seed has recently been introduced to cereal or cash crop raising, through extension activities, and purchased seed covers larger part of areas under maize, groundnuts, sorgham, cotton, sunflower, etc. Use of chemical fertilizers, insecticides, fungicides and herbicides is mainly limited to cash crops, for example, cotton, oriental tobacco and green millies. Agricultural implements like ploughs, hoes, sickles and hatchets are renewed, once in several years. Draught animals like cattle and donkeys are commonly used for various practices such as ploughing, carrying and manuring, and in most cases four cattle are necessary to draw implements. Weeding, liming and harvesting are generally practised manually, daily practice of which usually starts early in the morning (5 or 6 a.m.) and continues until around 5 p.m. with a midday break for two hours, and farmers are engaged in field practices for five to six days in a week.

1.12.2. Farming in the Existing Irrigation Schemes

Each irrigation schemes in the Province has its production programme established by the Provincial Agritex, based on which extension activities are rendered to plot-holders. Nevertheless, the initial cropping programs are often subject to alterations brought about by various constraints. Typical among them are: troubles of pumping facility, out-break of chronic diseases or pests, outstanding changes in mark access of

cash crops or increased competition for marketing outlets, tenacity of plotholder's traditional diet behavior. These factors unexpected at the initial stage often affect farming performances at the matured stage of the schemes. Generally cropping patterns in the schemes are eventually shifted from initially planned diversified crops with more than twice of dryland cropping intensities to those with too heavily biased to maize, with particularly limited cropping intensity during winter seasons.

An optimum way of labour allocaiton within a farm is required for any plotholders in existing schemes especially to start summer crops at the beginning of rainy season, because they have to cater both for dryland and allotted irrigated fields. Those with larger allocated plots are subject to insufficient crop management which often results in poor harvests or lower quality of produce. Holding patterns in major irrigation schemes are shown in the following table.

Table II-1-9 Plot Allocation of Existing Irrigation Schemes

Name of scheme	Number of plotholders	Average area/ plotholder	Maximum area of allocation	Minimum area of allocation
		ha	ha	ha
Chilonga	207	1.57	2.9	0.1
St. Joseph	106	0.13	0.3	0.1
Manjinji	93	0.32	1.2	0.1
Rupangwana	49	0.13	0.2	0.1
Gudo pool	96	0.11	0.2	0.1
Musvugwa	565	0.10	0.3	0.1
Makonese	369	0.10	all 0.1	-
Banga	405	0.13	0.4	0.1
Mapanzure	318	0.14	0.2	0.1
Mushandike (Resettlement)	34	2.00	all 2.0	-

With regard to fertilization, basal doze of 35 kg of compound fertilizers are commonly applied to maize and a top dressing of 15 kg of ammonium nitrate as a single N component is again applied to it during the primordia stage. Manure application is essentical for higher crop response to chemical fertilizers, and application of 1 to 2 tons of manure per annum per ha will prevent nutrient loss from leaching caused by watering. Similarly, tractors held by D.D.F. are hired by plot holders in some schemes for deep plowing (Z$ 40 to 50 per ha as hire charge) once in a few years with a view to increasing retention capacity of soil water coupled with ample manure application, to elevate yield potential of fields under irrigation. In case of groundnuts, most plot holders grow it without applying purchased fertilizer, other than gypsum for soil pH amendment, applied at the rate of 25 kg per 0.1 ha before flowering stage, making full use of residual effect from the previous croppings. For vegetables, much heavier doze of manure prepared from cowdong and goat droppings is usually applied, with split application of compound fertilizers or ammonium nitrate at the rate of 9 kg per 0.1 ha every two weeks, thus avoiding leaching loss. For sugarbeans, one of the legumes only raised under irrigation, they apply compound fertilizers at the rate of 50 kg per 0.1 ha as based doze, followed by a top dressing of single super phosphate, at the rate of 25 kg per 0.1 ha before flowering.

Pest and disease control also constitutes an indispensable element in the irrigated farming because irrigated farms are only the places where crops stand during winter seasons, when drylind is completely barren. This is the major reason why winter crops on irrigated fields are specifically susceptible to pest attacks. Among control practices, spray application of dipterex for the control of maize stemborers and of dimethsate to maize plant hoppers. The latter pest is a vector that spreads maize leaf streak virus whose infection is now widely prevalent among the schemes where maize is continuously cropped. However, radical countermeasures should include not only chemical method but also abstaining of continuous cropping as well as pursuance of established crop rotation, eradication of host crops and weeds within the radius inclusive of the periphery plots surrounding project farms during certain period of the year. Such trials are now under way in Makonese irrigation scheme.

A number of irrigation schemes try to save their input costs by bulk purchases through their purchase and marketing cooperatives. Meanwhile plotholders make sue of credit offered from A.F.C. Whenever farming performance of the individual plotholder declines due to his lack of effort or negligence of discipline, he may be evicted and replaced by a newly selected one from applicants in the waiting list. Such system inevitably encourages plotholders to keep better management for their allotted plots with the application of sufficient labour and inputs.
As a result, productivity levels of many of the irrigation schemes have shown rising trends as observed in some performance records.

1.13. Agricultural Economy

1.13.1. Agriculture and Food Situation

Over 90 per cent of the communal population is engaged in sedentary agriculture. And most of the products are appropriated to the home consumption. Their agricultural productivity still remains at a low level due to depleted water and cultivable land resources, and their food situation tends to be affected by climatic conditions.

With a view to coping with drought damages prevailed in three consecutive years from 1982, the Government implemented a series of drought relief measures. These measures were temporarily interrupted during bumper crop period recorded in 1985, but they have recently been resumed. District council staff members are responsible to appraise the extent of drought damages within the affected areas which are officially delineated based on the information from AGRITEX. Drought relief foods are provided and supplied through G.M.B. by the Ministry of Labour Manpower Planning and Social Services, mostly in the form of maize, maize-meal and beans, according to the appraised results. The amount of relief supply reached 126 thousand tonnes during four years of the activities.

Table II-1-10 Estimated Relief Performances in Masvingo

	Received Amounts (1 000 bags)		Received Persons (1 000 persons)	
	Maize & Meal	Sugarbeans & Groundnuts	Adults	Children
1982	118	20	314	591
1983	863	17	2 232	3 790
1984	300	1	1 236	2 377
1985	75	12	569	755
Total	1 356	50	4 351	7 513

Notes: Maize, Meal ---------- 91 kg/bag
Sugar bean & Groundnuts ------- 50 kg/bag

Source: Ministry of Social Affairs

Per capita quantity received per annum amounts to nearly 35 kg, which is equivalent to one fifth of individual, annual cereal demand.

The overall demand-supply balance within the Province has been maintained by the smooth flows of products from the surplus areas to the deficit ones. However, taking account of demand-supply status of other foods than grains or of financial burden for relief measures, current food situations are still unstable. Urgent measures of agricultural development and marketing improvement are called for in communal lands.

1.13.2. Manpower and Farm Management

The potential labour force in communal lands is estimated at nearly 320 thousand, or 35 per cent of the total communal population, and most of them, equivalent to 1.8 persons in a farm family, are engaged in farming activities.

According to the population census in 1982, eight per cent of the population born in the Province emigrated out of the Province, and twelve per cent of them also emigrated from their native villages to other places within the Province. Most emigrants are considered stemming from farm

population. The population movement is mainly caused by the surplus man power within agriculture, chiefly by youths seeking for cash income sources in non-agricultural sectors. One or two such non-resident wage earners are usually found in a farm household. Nevertheless, a constraint of limiting employment opportunities already started blocking the current trends in population movement.

All the areas in communal lands belong to the state. Average plot-holding size per farm family ranges two to three hectares. However, a slow differential process in individual in asset holding has started, which may induce an income differentiation among farmers, judging either from off-farm income levels or from patterns of daily activities.

On the other hand, farming situations in communal lands would not likely allow any individual differences in incomes or assets, as observed in the influence of home remittances by non-resident workers. Besides, there is an overall tendency of over-population in areas with higher farm productivity, especially in highly productive areas. Thus, the concentration of local population is also observed in the existing irrigation scheme areas.

1.13.3. Agricultural Economy

Surplus produce after the reservation for home consumption is a major source of farm cash income. Value of sales per family would averagely range from Z$40 to Z$50 as estimated from the sales to G.M.B. The sales to other than G.M.B. is dropping, and an average farm cash income per annum is estimated at Z$60 - 70. The income from livestock sector would not reach the level of crop sector, except in the southern part of the Province.

Though the official statistic data are not available, the amount of annual remittance from non-resident workers to their home families is calculated at Z$190 per non-resident worker, assuming that the worker gets official minimum wage of Z$153 per month, and spends Z$4.5 per day for his living allowance and all the rest is remitted to his family.

Besides, agricultural by-products, handicraft products and picked-up natural food etc. also consist of minor farm-income sources, which is estimated at half the amount of annual grain sales (equivalent to Z$20 to 30). Hence, total annual income of a farm family will only amount to Z$250 to 350, of which agricultural income ranges Z$80 to 100. Farm families in communal lands are in a transitional stage to a typical monetary economy, occasionally supplemented by traditional exchange economy.

1.13.4. Marketing of Agricultural Products

The agricultural marketing in communal lands still remains at a low level because of sedentary farming and the following lack of purchasing power. Vegetables and other perishables produced in communal lands are generally retailed in stalls or by itinerant vendors in business centres, bus terminals and road sides. They are also transported to urban areas in the Province for sale, but their supply is always unstable both in qualities and in quantities, and marketing quantities tend to drop during dry seasons. This leads to lower competitiveness as compared to the products in commercial areas, which makes their access to markets much harder. Vegetables and other perishables are also supplied from Harare, Mutare and Bulawayo to Masvingo town, the biggest provincial centre of food consumption. Such products from outside the Province generally have much competitive power toward urban consumers with fully purchasing power to those produced in the Province, even if transportation charges have to be added on prices, for example Z¢12.5 per kilogram between Harare - Masvingo (300 km).

The principal source of cash income in communal lands is surplus grains, remained after the replenishment of communal farmers' granaries, which are sold to G.M.B. and other buyers approved by the authority. Recently, increasing proportion of grains from communal lands is marketed to G.M.B. as shown below.

Table II-1-11 Amounts of Sales from C.L.s to Masvingo G.M.B.

(Unit: ton)

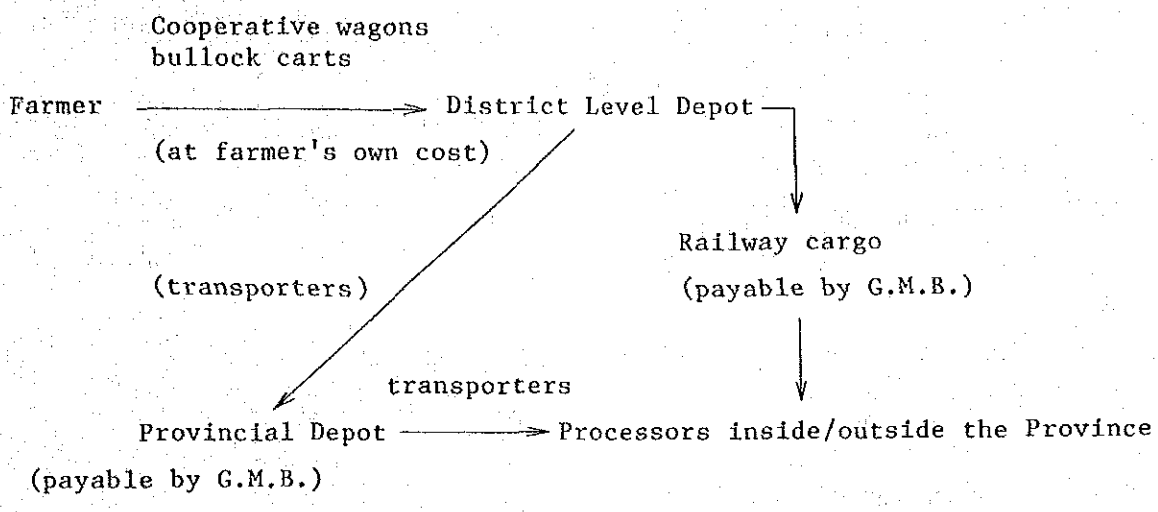
Crops	1981/82	1983/84	1984/85	1985/86
Cotton	9 612	394	1 533	1 482
Maize	1 898	2 974	87 137	28 452
Sorghum	35	827	1 435	2 385
Groundnuts	57	1	596	67
Soyabean	0	4	30	8
Sunflower	-	66	342	940
Mhanga	-	679	8,780	2 591
Rapoko	-	72	4,604	2 023

Note: Data for the season of 1982/83 are not available because the amounts of sales were very small due to the severe drought.

Source: AGRITEX, Masvingo

The Grain Marketing Board (G.M.B.) is a semi-governmental agency responsible for state level supply and distribution of grains, beans, etc. Depots established at the district level receive and store grains under canvass-sheet covering, to which necessary chemical fumigation is applied. Farmers carry their products to the nearest depot at their own cost, where they receive cash from their sales as well as redemption of deposit charge of grain bags. Here they are subject to the repayment of farmers' loans, i.e., both principals and interests at the rate of thirteen per cent per annum.

The value of products sold from a farmer averages at around 235 kg per year, and the flow of sales is shown as follows:



Other than grain marketing, the Cotton Marketing Board is in charge of marketing raw cotton, etc. Storehouses and cotton lint processing plants are located only in Chiredzi in the Province. Cotton produced in the Province is marketed to the C.M.B. at Birchenough Bridge, to Chiredzi or to Kadoma (outside the Province), but its economic production areas are limited by the transportation charges at farmer's own cost with the rate of Z¢28 per ton per km.

1.13.5. Cooperatives and Agricultural Credit

Number of cooperatives in the Province has steadily been increasing, with the growth rate of more than ten per cent per annum. Since Independence 250 cooperatives were established in eleven different domains of activities, as shown below.

Table II-1-12 Number of Cooperatives and Participants, Masvingo 1985

Sorts of Coopeartives	No. of Cooperatives	No. of Participants
Marketing & Supply	145	20 304
Group Farming	7	485
Fishing	3	32
Transport	4	60
Industry	65	1 561
Saving & Thrift	1	25
Credit	1	122
Food & Vegetables	2	27
Consumers	10	113
Venders	11	238
Mining	1	80
Total	250	23 047

Source: Ministry of Cooperative, Masvingo

Members affiliated in these cooperatives in 1985 reached as much as 23 thousand (of which farmer members are counted as 21 448) with the growth rate of 74 per cent from the previous year. The major activities of cooperatives are group purchasing for agricultural inputs at lower costs. Of the total cooperatives, those of marketing and supply represent 58 per cent in number, and 86 per cent in membership. The annual turnover of the whole cooperatives in the Province recorded Z$2 040 000, of which 85 per cent was shared by marketing and supply cooperatives. They possess their own buildings which serve as offices, warehouses and stores built in business centres and collect commission of one to two per cent of sales for group purchasing which is appropriated to their management expenses.

The share of communal farmers to the total amount of agricultural loans lent from the Agricultural Financing Corporation (A.F.C.) in 1985 barely reaches twelve per cent throughout the country and only one per cent in the Province. The farmers participating in irrigation projects tend to utilize A.F.C. loans more frequently, because they apply more agricultural inputs. A.F.C. loans are granted to the applicants who passed the check

appraisal by A.F.C. under the following credit conditions; Interest Rate: thirteen per cent per annum (plus one per cent for compulsory insurance fee), Term: within one year as short term loans, two to five years as middle term loans. Loans utilized by communal farmers in the Province indicates, as is shown below, a rising trend with an average amount of Z$400 per farmer.

Table II-1-13 Amount Credited for Communal Lands by A.F.C., Masvingo

Year	Less than one year		2 to 5 years	
	No. of Accounts	Credited Amount	No. of Accounts	Credited Amount
		Z$		Z$
1980/81	300	47 899	0	0
1981/82	900	161 184	0	0
1982/83	2 100	402 757	500	83 143
1983/84	3 450	724 628	1 000	122 938
1984/85	5 000	1 939 759	1 650	533 154
1985/86	5 100	2 249 362	1 250	513 342

Source: A.F.C., Masvingo

CHAPTER 2. SELECTION OF POTENTIAL DAM SITE

2.1. Condition and Method of Selection

Before the visit to Zimbabwe a preparatory study on provisional list of potential dam sites has been performed in Japan. The list showed tentative dam sites for the discussion with the Government of Zimbabwe.

A procedure and condition for selection of potential dam sites based on available data are as follows:

(1) Selection Study of Dam Sites on the Map of 1/50 000

The Study Team has obtained the latest 1:50 000 map that should be most accurate map for public use. The map involves not only land features and contours, but also water flow of creek, houses and huts, public institutions (business centre, school, clinic, airport, etc.) and others which might be useful for the selection of potential dam sites. In the study based on the 1:50 000 map the following concept has been involved.

(i) The medium size dam project of water resources has a reservoir with storage of about one (1) to three (3) MCM. The catchment area for the reservoir is roughly estimated to be more than about 10 sq.km. From the viewpoint of dam cost, however, it is recommendable to render a catchment area of reservoir smaller. This will reduce a dead storage volume caused by sediment load and scale of spillway. It is roughly assumed that a catchment area of reservoir might have 10 to 50 sq.km. From the hydrological consideration the catchment area of about 10 sq.km for the reservoir in the north and middle and for rather larger area for the south of the Province would be mininimum.

(ii) A dam site has irrigable area in the downstream or nearby. And close setting of reservoir to township on public

institutions will produce an effective and multipurpose use of water. This will also contribute to an immediate effect about social interest after or in a dam construction.

(iii) A dam site is preferable to be located in higher position to distribute water easily.

(iv) Setting of a dam should avoid an overlapping with existing dam and dike.

(v) Also setting of dam should avoid the location on the wide river or near the rapid and fall.

In consideration of the above items 115 dam sites were picked up from the communal land area.

(2) Checking by Aerophotograph

An interval of contour line in 1/50 000 map is 20 meters and it is fairly rough for dam site identification. To confirm the proper location of dam sites, an observation of aerophotograph scaled 1/25 000 has been performed on each dam site. Some dame sites have been transferred to new sites.

(3) Comparison with Existing Dam Scheme

On the scheme of medium size dams in Masvingo Province made by the Government of Zimbabwe, 15 projects were completed and three (3) projects are planned. After the comparison with existing or planned dam schemes, a few dam sites were eliminated to avoid the duplication. Finally 115 dams were selected as potential dam sites in the study in Japan.

2.2. Potential Dam Sites

The list of dam sites made in Japan was mainly based on topographical

condition through the 1:50 000 map. Social and agricultural aspects such as needs for water or agriculture development potentiality have not been taken into consideration on the selection of dam sites because of lack of relevant data and information in Japan. In advance to the field investigation, meetings for the selection of dam sites were held among the Study Team, District Administrators, regional extension officers of AGRITEX and engineering officers of the District at each district administrator's office. Consequently 94 dam sites in the seven districts were selected as potential dam sites to be studied in the Phase I Study. It counts 75 dam sites from the dam list made in the study in Japan, and 19 dam sites newly proposed by the meeting.

CHAPTER 3. THE PROJECT

3.1. Runoff at the Dam Sites

3.1.1. Runoff in Hydraulogical Subzones

The mean annual runoff (MAR) and its coefficient of variation (CV) for every hydrological subzone were revised in November 1982 by the Hydrological Branch of MEWRD, based on the latest data.

The MAR varies in the wide range from the lowest (MAR = 4 mm) of Lower Bubwe subzone (B-B1), configuring southern border of the Province, to the highest (MAR = 130 mm) of Mid Umtilikwe subzone (E-UT2) covering the catchment of Bangala Reservoir. On the other hand, the coefficient of variation, that is a measure of the variaiton in runoff from year to year, ranges between the highest (CV = 160) of Lower Bubwe subzone (E-C2), which marks the remarkably low runoff in Zimbabwe, and the lowest (CV = 80) of Upper Chiredzi subzone (E-C2), which consists of the catchment of Manjirenji Reservoir in Zaka District.

The hydrological subzones of the Province are classified into four groups in accordance with the magnitude of MAR of each subzone by Interconsult A/S in order to have the general view for water resources development as shown in Figure II-3-1.

The figure shows clearly that the southern region of the Province between 20°30' and 22°30' in latitude consists of subzones of which MAR is less than 40 mm. In this region, the MAR of Chiredzi District is distinguished from other areas by the low value of less than 20 mm, especially the lowest MAR of less than 8 mm is notable in subzones along the Limpopo Valley.

The northern region of the Province, on the contrary, is marked with the comparatively high MAR of more than 40 mm, in which values of Kyle Dam catchment of more than 100 mm is remarkable. However, it is not practical to apply the MAR of subzone with area of more than 500 sw.km to each proposed dam site due to the small catchment (10 - 30 sq.km). Accordingly, the runoff for each dam site is required.

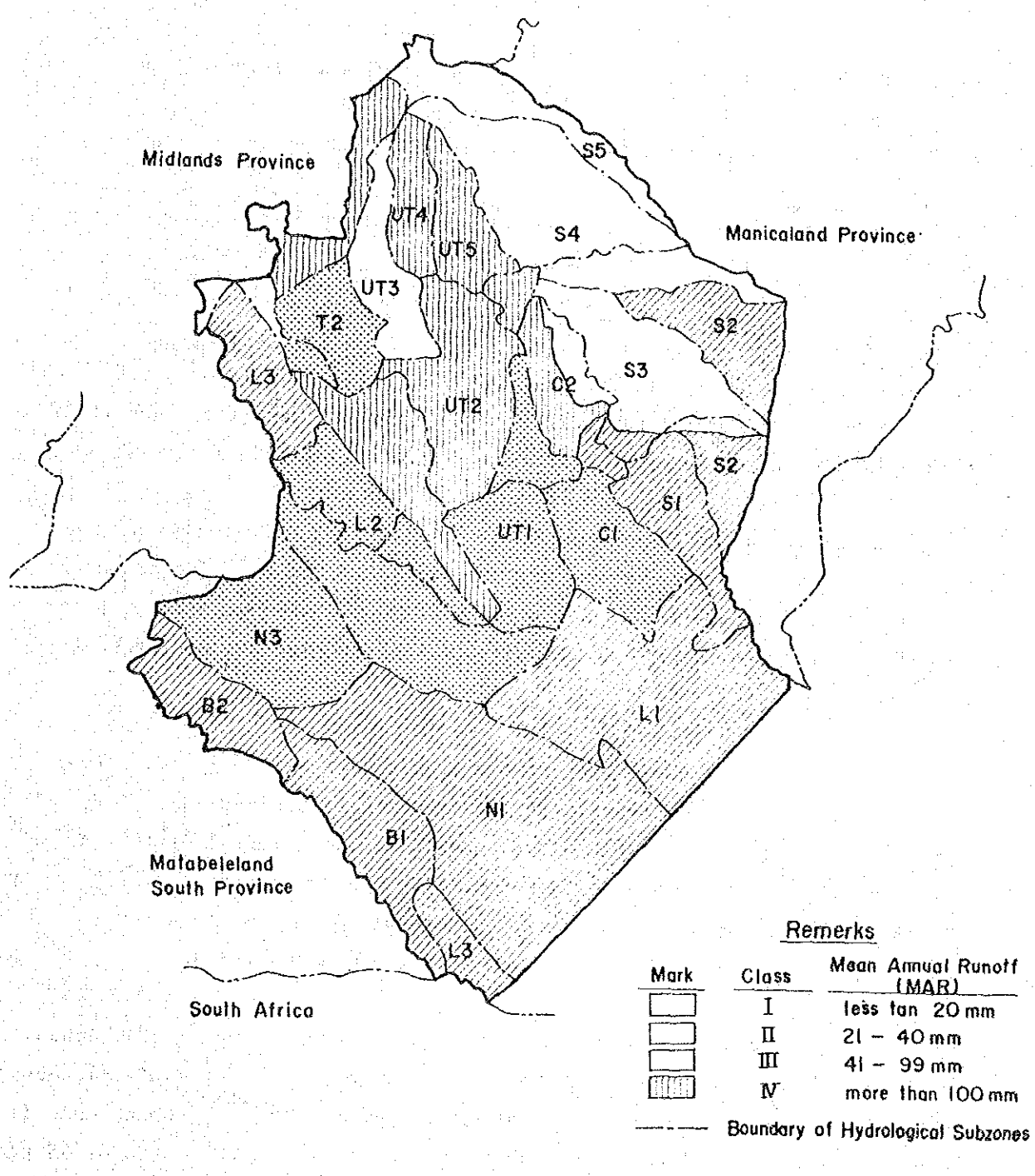
3.1.2. Runoff at Dam Site

The relation between mean annual rainfall and MAR of granite subzones in Zimbabwe were reported and expressed by the formula in the paper of "Potential Water Yield in Semiarid Regions" by T.B. Mitchell, based on the examination of 246 values of annual rainfall and runoff from river gauging stations. The proposed formula is as follows:

$$Q = P - (P^{-3} + 1000^{-3})^{-1/3}$$

where Q is the annual runoff (mm) and P is the annual rainfall (mm).

Figure II-3-1 Hydrological Classification



NOTE : Copied from the Report of "Hydrology" under National Master Plan Plan for Rural Water Supply and Construction.

To examine the adaptability of this formula to the proposed dam sites of the Province, the available data of rainfall and runoff are selected from the "Hydrological Summaries 1980" on the following viewpoints.

1) The rainfall is well representative of the mean value of the runoff catchment.
2) The runoff catchment is enveloped by the isohyet as mild as possible.

The selected stations are as follows:

Examination Data for Runoff

Period	Rainfall Station	Runoff Station
1972 - 1980	Masvingo P.W.E.O. (EE/19)	Mpopinyani Kyle Dam (E.54)
1975 - 1980	Manjirenji Dam (EE/21)	Chiredzi Manjirenji Dam (E.108)
1963 - 1980	Esquilingwe Weir (EE/13)	Umtilikwe Esquilingwe (E.4)

As shown in the Figure II-3-2, the fairly good correlation between proposed formula and examined values are proved in the duration of which both rainfall and runoff data are available, so that the adaptability of the formula to estimate the MAR at dam sites of the Province is confirmed for practical use.

As a result of a plotting of the mean annual rainfall on a normal probability paper, three representative stations in the Province (i.e. Makoholi, Kyle Dam and Buffalo Range) show that the rainfall of 10 year's probability (non exceeding) is 55 per cent to the mean annual rainfall on an average and tends to reduce the ratio according to the latitude toward the southern region of the Province as shown in the Figure II-3-3.

The proposed dam sites are fallen on the isohyet map of mean annual rainfall published by the Department of Meteorological Services (1984 second edition) to have the value of MAR for each proposed dam site, which make it possible to get the 10 year's probable rainfall based on the ratio of 55 per cent of the mean annual rainfall.

Figure II-3-2 Runoff Correlation of MEWRD Formula and observed values

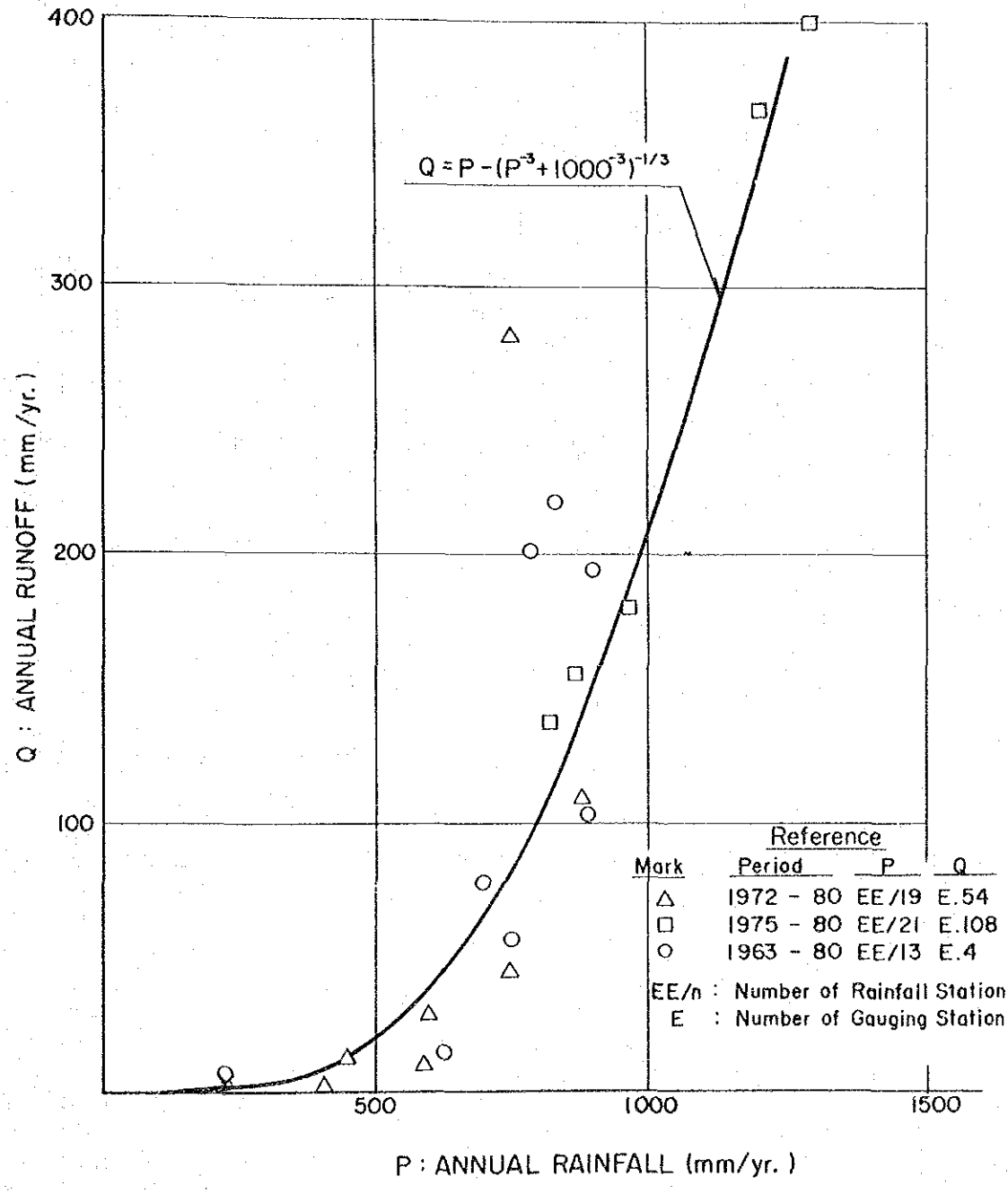


Figure II-3-3 Probability of Annual Rainfall

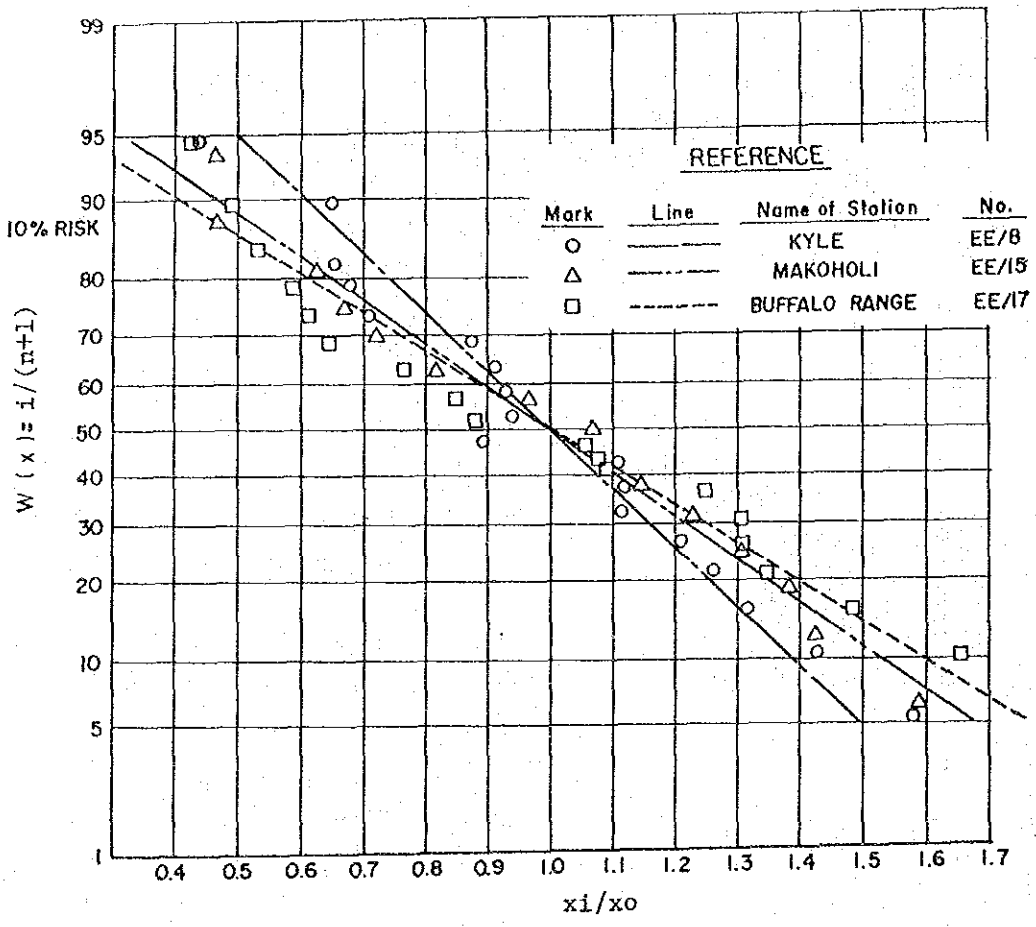


Table II-3-1 Probability of Annual Rainfall

Station / Year	Kyle				Makoholi				Buffalo Range			
	Xi	N	xi/xo	i/(n+1)	Xi	N	xi/xo	i/(n+1)	Xi	N	xi/xo	i/(n+1)
1962/63	959	9	0.994	47.4					520	10	0.882	52.6
/64	625	17	0.648	89.5					290	17	0.492	89.5
/65	687	14	0.712	73.7					315	16	0.534	84.2
/66	845	13	0.876	68.4	584	10	0.821	62.5	379	13	0.643	68.4
/67	1217	4	1.261	21.1	758	8	1.067	50.0	451	12	0.765	63.2
/68	425	18	0.440	94.7	328	15	0.462	93.8	248	18	0.421	94.7
/69	898	11	0.931	57.9	768	7	1.081	43.8	647	8	1.097	42.1
/70	657	15	0.681	78.9	447	13	0.629	81.3	501	11	0.850	57.9
/71	911	10	0.944	52.6	520	11	0.732	68.8	357	14	0.605	73.7
/72	1171	5	1.213	26.3	934	4	1.314	25.0	773	5	1.311	26.3
/73	632	16	0.655	84.2	331	14	0.466	87.5	347	15	0.588	78.9
/74	1527	1	1.582	5.3	1128	1	1.587	6.3	978	2	1.658	10.5
/75	1075	8	1.114	42.1	1013	2	1.425	12.5	623	9	1.056	47.4
/76	1124	6	1.165	31.6	876	5	1.232	31.3	794	4	1.346	21.1
/77	1375	2	1.425	10.5	819	6	1.152	37.5	821	3	1.392	15.8
/78	1273	3	1.319	15.8	985	3	1.386	18.8	1061	1	1.799	5.3
/79	1084	7	1.123	36.8	477	12	0.672	75.0	739	7	1.253	36.8
1980	878	12	0.910	63.2	692	9	0.974	56.3	771	6	1.307	31.6
	xo=965				xo=711				xo=590			

NOTE: xi=Annual Rainfall (mm./yr.), N=Order, i/(n+1)=Plotting position, Xo=Successive Mean(mm)

3.1.3. Flood at Dam Sites

The practical estimation of the Maximum Probable Flood (MPF) in Zimbabwe is derived by MEWRD and applied to the design criterion of "A Guide to Design and Construction of Medium Sized Dams in Rhodesia", in which the flood flow is estimated only as a function of the catchment area with taking the MPF to be equal to a flood of 10 000 years recurrence interval. The formula of MPF is proposed as follows:

$$\text{Log e (MPF + 1)} = 1.175\ (\text{Log e (A + 1)})^{0.775} + 3.133$$

where : MPF = Maximum Probable Flood (cu.m/s)
A = catchment area (sq.km)

The design flood of the spillway is also studied by MEWRD in the recent paper of "Assessment of Design Flood Hydrographs" (January 1986), in which the return period to be employed for the spillway design is determined through the classification of proposed dams with relation to the hazard potential.

According to the rule of this classification, the medium size dams of the Province are grouped into "Class 2" by adopting the "Low" of hazard potential.

Consequently, the 500 years recurrence period estimated from below mentioned formula is applied to the design flood of the spillway.

$$Q = 0.541 \times MPF$$

where Q; design flood discharge (in cu.m/s).